Original article

Embedding assessment in a simulation skills training program for medical and midwifery students: a pre and post intervention evaluation

Running head: Evaluation of a simulation based education program

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Abstract

Background: Simulation based programs are increasingly being used to teach obstetrics and gynaecology examination, but it is difficult to establish student learning acquired through them. Assessment may test student learning but its role in learning itself is rarely recognised. We undertook this study to assess medical and midwifery student learning through a simulation program using a pre-test and post-test design and also to evaluate use of assessment as a method of learning.

Methods: The interprofessional simulation education program consisted of a brief pre-reading document, a lecture, a video demonstration and a hands-on workshop. Over a 24-month period, 405 medical and 104 midwifery students participated in the study and were assessed

before and after the program. Numerical data were analysed using paired t-test and one-way ANOVA. Students' perceptions of the role of assessment in learning was analysed qualitatively.

Results: The post-test scores were significantly higher than the pre-test ($P < 0.001$) with improvements in scores in both medical and midwifery groups. Students described the benefit of assessment on learning in preparation of the assessment, reinforcement of learning occurring during assessment and reflection on performance cementing previous learning as a post-assessment effect.

Conclusion: Both medical and midwifery students demonstrated a significant improvement in their test scores and for most students the examination process itself was a positive learning experience. **Introduction**

Teaching intimate obstetric and gynaecological clinical examination skills to medical and midwifery students can be challenging¹. To add to the cognitive load, and further hamper learning, clinical examination skills are sometimes taught to students simultaneously with communication skills. Simulation can address this challenge by providing an opportunity for learning through repeated practice until mastery of the skill is achieved². The term "Chunking" refers to breaking up information into small procedural steps^{3,4} that can be learnt independently. It has been shown to reduce the cognitive load perceived by the student⁵. Practice through simulation has been shown to improve the efficiency and accuracy of the task performance, hence laying the foundation for introduction to clinical practice⁶.

Simulation can be a component of "blended learning" where two or more complementary approaches are used to teach the same material³. This may include educational methods such as theoretical knowledge through a lecture and demonstration of a skill by the tutor. Such learning can then be supplemented with students examining a mannequin or task trainer to learn the various procedural steps organized in a strategic sequence. Granados⁷ demonstrated this with students learning digital rectal examination where rectal and prostate mobility and hardness were modelled with surface textures and spring mechanism. This also applies to the field of obstetrics and gynaecology where certain procedures are not visually evident to the learner, such as performing a Pap smear or assessing cervical dilatation in a labouring woman. These procedures can be learnt by repeatedly performing them on pelvic simulators, allowing learners to improve both their skills and comfort level with the procedure⁸. The knowledge acquired from lectures and videos can also be applied to clinical practice on mannequins. This relates to the concept of a "flipped classroom"⁹⁻¹¹, where short video-lectures are viewed by

the students at home and the in-class time is utilised for interactive learning projects and exercises. Compared to delivering a lecture such an approach increases the efficiency of the tutors supervising structured activities.

To date, the various areas of assessment of simulation programs have focused on student anxiety, confidence, satisfaction, skills, knowledge and interdisciplinary experience¹². We have previously described our Women's Health Interprofessional Learning by Simulation (WHIPLS) program in regards to medical and midwifery students' interdisciplinary experiences and confidence¹³. In this study we sought to assess if there was any benefit to student learning afforded by participating in this program. The overarching research question was "How much learning had been attained by medical and midwifery students through the WHIPLS simulation program?". Students' approach to a test introduced before and after the simulation session and how having a test affects their learning was also studied.

We sought to demonstrate if medical and midwifery students' performance improved after the intervention (the simulation program). At the same time we question what learners think about the assessment tagged to the program and if it contributes to learning itself. The research question is relevant to both teachers and learners to develop a better understanding of the role of an "exam" as "learning" rather than as an "assessment" tool.

Methods

We have described the WHIPLS program in detail elsewhere¹³. Briefly, these on-going workshops consist of a brief preparatory reading, a lecture, a pre-recorded video demonstration and a hands-on skills learning workshop. Each workshop is conducted with groups of 6-8 medical and midwifery students using a simulation model (Model Med, Melbourne, Australia) and supervised by a clinical facilitator. The workshop involves three skill stations (two on obstetrics) focused on learning the examination of women in the first stage of labour (both latent and active phase), second and third stages of labour (which included the student conducting a normal vaginal birth and estimation and management of blood loss) and (one on gynaecology) performing a speculum, pap-smear and a bimanual palpation on a gynaecology trainer. The description of the intervention is demonstrated in a sequential step-wise flowchart (Figure 1). The workshops are undertaken every 3 months.

We conducted a pre-test and post-test assessment of all medical and midwifery students

attending the WHIPLS program over a two-year period, January 2013 to December 2014. Monash University Human Research Ethics Committee approved the study. Participants in the study consisted of medical students in their fourth year of undergraduate training (5-year program) and third year midwifery students (four year dual nursing/midwifery degree program), at Monash University, Melbourne, Australia. Medical students attended the WHIPLS program at the beginning of their obstetrics and gynaecology clinical placement while many of the midwifery students were already in their clinical placements. The test was conducted without any prior warning to the participants, in an examination environment 1-2 days prior to the workshop. The pre-reading material, lecture and training videos were all a part of the WHIPLS program and hence, these resources were provided only after the pre-test but before attending the workshop. The post-test was also conducted in a timed examination environment immediately after the workshop. The participants were not provided with the answers until the submission of the post-test. After the post-test, the correct responses were discussed and a group feedback provided regarding their performance.

Pre-test and post-test validity

Content validity

A panel of experts from medical and midwifery undergraduate teaching developed a 23-item multiple choice question (MCQ) assessment. Each question had four options (A-D), were equal in weighting (one mark each) and no marks were deducted for incorrect responses. The panel blueprinted the learning material covered during the workshop and all topics were sampled in the MCQ assessment in comparable numbers (Table 1). An independent panel of experts (who were not involved with the program and were blinded to the intent of the assessment) evaluated the questionnaire to assess the adequacy of response options.. Both tests were marked by independent assessors, who were not involved in the study. Both the pre-test and post-test used the same MCQs, which were designed as clinical vignettes around the concepts that were taught in the program.

Internal structure evidence

Individual item statistics for all questions were obtained to assess reliability across all items. Reliability tests were conducted using Cronbach alpha and discrimination statistics were obtained to assess if there was consistency in performance of individual students across all items in the test. The overall Cronbach α for the pre-test was 0.56 (range 0.51 to 0.57) and 0.63 (range 0.62 to 0.64) for the post-test. The test for reliability was average but was

considered acceptable for both the pre-test and post-test questionnaire. The narrow range of variation in the alpha scores across all 23 items (in both the tests) also qualifies that the spread of marks across all questions was even in distribution.

Data collection and analysis

All pre-test and post-test assessment responses were entered separately for medical and midwifery students, as baseline knowledge was deemed to be generally greater in the student midwife group. Midwifery students were in the third year of their program and most had some practical experience, whereas the medical students were just entering their first rotation and had no previous exposure to this learning. Only those students who had completed both the pre-test and the post-test were included in the analysis. Frequency statistics of student performance in the two tests were reported for both medical and midwifery groups. The data were analysed with the IBM SPSS statistics program version 23 (IBM, Armonk, NY, USA). A two-tailed paired t-test was used to compare the difference between the mean scores in the pre- and post-test and a one way ANOVA test was used to compare the performance of the medical and midwifery students in the pre- and post-tests.

A paper-based questionnaire was used with an open-ended question asking students about what they thought about having the test before and after the WHIPLS program. A conventional content analysis¹⁴ was performed on the response to the open-ended question addressing the students' opinion on having the test before and after the WHIPLS program. The key categories were identified from the text. Some categories overlapped but items were counted only once. Two assessors (AK and DN) were involved in the process of assigning categories to minimise researcher bias, the key themes were then agreed upon after negotiation.

Results

Over two years, 405 medical and 104 midwifery students participated in the workshop. Of these, 22 medical and 9 midwifery students were excluded from analyses because they had not attempted the pre- test. Data from 383 medical and 95 midwifery students were available for analysis.

Pre-WHIPLS test and post-WHIPLS test results

Pre-WHIPLS test scores were normally distributed while the distribution of scores for the post-test showed a negative skew (Figure 2 and 3). The overall mean (SD) scores for the pre-test and post-test assessments were 10.6 (3.42) and 18.54 (3.02), respectively (Table 2). The overall post-test scores were significantly higher than the overall pre-test scores ($p < .001$). The respective pre and post-test scores for the medical students were 9.91 (3.12) and 18.56 (3.05), ($p < .001$) and for the midwifery students 13.54 (3.02) 18.47 (2.87), ($p < .001$) (Table 2). The ANOVA showed significant differences between medical and midwifery students' pre-test scores ($p < .001$), while no significant differences were found between the scores of these two student groups in the post-test scores ($p=0.8$).

Students' opinions of the assessment

Two hundred and fifty-four students (182 medical, 37 midwifery, 35 unidentified) provided 364 comments on the testing approach. The key themes are listed in Table 3, arranged in chronological order of occurrence.

“Pre-WHIPLS effect”

Students had mixed opinion on the usefulness of the pre-test ranging from being useful to “direct or channel learning” ($n=29$) and not being useful “due to no previous clinical exposure or perceived as being intimidating” ($n=25$) with 16 comments about the complete assessment (both pre-test and post-test) not being useful. Seven students acknowledged that they did not like the pretest at the time but realized its importance later.

“During WHIPLS effect”

Themes that focused on the “during intervention effect” indicated that the test was an instrument to direct the tutors' teaching in the workshop and monitor its progress ($n=21$). The test was also seen to improve student engagement during the WHIPLS workshop.

“Post-WHIPLS effect”

The most frequently recorded theme related to “recognition of enhanced learning” ($n=103$). The second most prominent theme was “benefit of feedback from testing” ($n=57$). The test was also acknowledged to reinforce learning by revision of the content ($n=26$). The post-test also helped to identify gaps to promote future learning ($n=27$) in the clinical placement.

Discussion

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Medical and midwifery students demonstrated significantly improved test scores in the post-WHIPLS test, providing evidence for a positive knowledge gradient in each student group. Although the medical students, being new to obstetrics and gynaecology, scored relatively poorly in the pre-test, both groups scored similarly in the post-test. This suggests that the teaching content was well aligned with the assessment. Although, the midwifery student group did bring skills learnt in clinical practice, which enhanced their baseline score, but interestingly, following the intervention, the medical students had caught up on the knowledge assessment. Our work with the medical and midwifery learning groups supports students' beliefs that the program helps to improve both their confidence in performing core clinical skills in obstetrics and gynecology¹³ and measure knowledge. The combination of improved confidence and evidence of acquired learning further reinforces that Simulation Based Education benefits both participant groups, even if they start at different levels of learning.

A review of other programs that assessed skills and knowledge in undergraduate nursing simulation¹² demonstrated an improvement in information seeking, procedural clinical skills, problem-solving which was also observed in undergraduate medicine training^{15,16}. Clinical skills that can be learnt in clinical practice can also be learnt in a simulation program¹⁷. Their respective assessment tools hold the potential of being utilized as a summative assessment for credentialing or assessing competence¹⁸. These assessment tools can examine the skill itself (informative about student learning and competence). Alternatively, knowledge based on the skill can be assessed (as we have done, as it is more generalizable, feasible and easier to score and standardize with a large group of students).

In this study, we have evaluated “how much” learning was acquired through the workshop¹⁹ providing a mid-level evaluation of a simulation program with an objective measure of change in learning. There are numerous studies on participation satisfaction with the simulation activity (including our previous study)^{13,20}, while demonstrable change in participant behaviour and clinical outcome is scantily reported and will be considered a high-level outcome based evaluation. The evidence for acquired learning also forms phase 1 of translation research²¹. In clinical research, translation phase 1 consists of preclinical activities that assess the efficacy of care. In reference to simulation, this would assess “what” and “how much” the student has learnt, that can potentially be applied to a patient care setting. Further work into application of these skills with the objective of improving patient outcome then constitutes phase 2 and 3 of translational research and can impact change in future educational

practice.

In our program, we have assessed baseline knowledge through the pre-test (a tool for a self-performed gap-analysis by students, hence, identifying “what” they could learn). The post-test assists students in “recognition” and “cementing” of acquired learning and at the same time, identify gaps for future learning. This may provide insight into factors that may assist/hinder learning; following which further learning programs can be aligned to address gaps in student knowledge. If assessments are routinely amalgamated into teaching programs, students are more likely to view them as an “adjunct” to learning, rather than an “assessment of” their learning^{22,23} and may feel less threatened by the idea of being assessed. The introduction of formative assessment has been found to improve student motivation and self-esteem while also encouraging further learning²⁴. Test-enhanced learning has also been demonstrated²⁵ with both pre-assessment effect (learning in anticipation of an assessment) and post-assessment effect (after reflection or a feedback session)²⁶. Assessment to promote learning (in a simulation program) has a positive impact on learning, where an increase in self-confidence was reported in preparation for a future patient contact²⁷, yet has not been extensively studied. This aspect of our study was assessed using a content analysis and hence, may not get a high frequency for many of the themes identified. It suggests that the pre-test may be recognized by the students as an “approach” to signpost the aims of the teaching activity and direct the course of their learning through the simulation and the post-test assessment, an activity to check and reinforce student learning.

We were unable to measure the students’ competence in performing the skill (e.g. students could be observed performing the procedures like the speculum and bimanual examination, but did not have time to be assessed ‘on-the-spot’). Secondly, we assessed the students immediately after the workshop and results may be affected by “short-term memory” or “recall”. We justify our repetition of the test at this short interval (three days) as the test comprised of core learning skills and concepts, which are necessary to acquire prior to clinical exposure. The reinforcement of learning through the repeat test is seen as an advantage here, especially, because the focus of the paper is also on using test as a “learning” tool and not just for the purpose of quantifying learning.

An outcome-based evaluation tool such as ours (with a pre and post-test) can help to validate faculty observations in the clinical setting, guide debriefing, and identify potential areas for

curriculum revision and student remediation ²⁸. McGaghie Issenberg, Barsuk, & Wayne (2014) ²⁹ have identified outcome measurement, skill acquisition, curriculum integration and educational/ professional context as the key components of a successful simulation program. For future studies, we recommend evaluation of simulation programs with focus on retention of skills and change in clinical performance. These can be translated into educational/ clinical practice and ultimately, lead to assessment of patient outcome, which will help to fill the gap in the existing literature.

Conclusions

The pre-test and post-test evaluation of the WHIPLS program demonstrated an improvement in learning in both medical and midwifery students. Although medical students had scant prior knowledge and skills compared to their midwifery counterparts, their performance in the post-test had improved to be at a similar level as the midwifery students, signifying the effectiveness of learning acquired through the WHIPLS program.

Both groups of medical and midwifery students reacted positively to the test and acknowledged that it helped them to self-assess and observe a change in their learning. The combination of the two tests were not only useful in providing evidence of learning but also perceived as a motivating factor to direct learning and hence, should not be only viewed as an assessment tool but also an instrument to complement learning.

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Table 1: Blueprinting the assessment

First stage of labour	5	Clinical examination skills and assessment of progress, identification of complications
Second stage of labour	6	Examination and management of second stage of labour, identification and management of complications
Third stage of labour	4	Management of third stage of labor, identification and management of complications
Speculum/Pap smear examination	5	Speculum examination technique, Cervical anatomy/ histology, Procedural technique of obtaining pap smear, Interpretation of cytology results
Bimanual palpation	3	Examination technique, common findings

Table 2: Pre-and post-test scores

Group	Pre-test			Post-test			p value*
	Mean	SD	Range	Mean	SD	Range	
Medical students	9.9	3.12	0-19	18.6	3.06	9-23	p<0.001

(n=383)							
Midwifery students (n=95)	13.5	3.02	0-19	18.5	2.88	10-23	p<0.001
Total medical and midwifery (n=478)	10.6	3.4		18.54	3.02		p<0.001

*t-test

Table 3: Themes after the content analysis on students' opinion on the pre-WHIPLS test and post-WHIPLS test

Chronological event	Theme	Number of responses
Pre-test (Prior to WHIPLS)	Pre-test not useful as no prior knowledge	25
	What to learn? Directs learning	29
	Provides evidence in regards to workshop goals	21
During WHIPLS	Helps improve student engagement	13
Post-test (After WHIPLS)	Recognition of enhanced learning	103
	Reinforces what has been learnt	26
	A direct comparison provides effective feedback	57
	Improved confidence by the post-test performance	11
	Identifies gaps to help future learning	27
	Both tests not useful	16

Both tests	The test failed to match the workshop teaching	9
	The test was intimidating but still helpful	7

Figure 1: A student's journey

Figure 2: Pre-test results

Figure 3: Post-test results

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