peer reviewed **ORIGINAL ARTICLE**

Optimising clinical ultrasound skills transfer in a resource-constrained teaching institution

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ABSTRACT

Background. Equipping students with knowledge, skills, and attitudes to engage in safe and competent ultrasound practice is important. Due to increasing numbers of students, limited training resources and busy clinical departments, it may be impossible to maintain effective clinical skills competence transfer to students. The use of simulation based learning, accompanied with student generated videos, are methods which could be used to assist in the transfer of clinical skills' competence in ultrasound.

Objective. To develop teaching and learning approaches that optimise clinical ultrasound skills transfer in training vascular technology in a resource-constrained teaching institution.

Methods. A qualitative study was adopted. Three stages of teaching and learning were designed and implemented. The stages were: a face-to-face lecture followed by a clinical placement experience; a face-to-face lecture followed by viewing of a YouTube video; and a face-to-face lecture, and student generated videos of students performing Doppler ultrasound scans of the carotid and vertebral arteries on each other. A follow-up interview was conducted to identify students' preferred method of skills competency transfer for the localisation of the carotid and vertebral arteries.

Findings. The students indicated that skills acquisition was more effective in teaching and learning through the student generated videos while scanning each other. This improved student engagement and helped students to develop empathy for patients. A face-to-face lecture and clinical attachments were not preferred as students indicated challenges such as the pressure of work and failure to get patients with the examination they needed to practice.

Conclusion. The study showed that practical ultrasound simulation and video recording is an effective way of training which could be adopted in a resource-constrained training institution where computer simulation is not available.

Keywords competence, role play, simulation, ultrasound training

LAY ABSTRACT

Hands-on skills training of student ultrasonographers involved then doing video recordings of ultrasound scans that they did on each other. They showed their videos to other students for comment to improve their skills.

INTRODUCTION

Clinical education plays a pivotal role in the preparation of students so they can successfully transition into complex contemporary health environments. In ultrasound training, it is important that students are equipped with knowledge, skills, and attitudes to engage in safe practice as health professionals. Gibbs indicates that this can be achieved in simulation based education (SBE) where students develop psychomotor skills outside of a clinical setting.[1] The same author argues that the introduction of SBE in health education is an enabler of a cost effective way of skills transfer, which is what is required in third world countries. To achieve a cost effective way of competency transfer, Blooms's taxonomy[2] of learning objectives to transfer knowledge, skills and attitude should be incorporated. In clinical education attitude relates to how knowledge and skills are combined in the care of patients as well as decision-making in a clinical setting. In ultrasound imaging improving the quality of patient care is important; this depends on how integrated the training approach is in order to incorporate all three learning objectives. Sullivan and McIntosh,[3] defined skill as a task or a group of tasks to be performed to a specific level of competency in the use of motor skills, which involve manipulation of instruments and equipment. Edwards and colleagues[4] contend there is a link between the inherent skill of an ultrasonographer and the diagnostic quality of an ultrasound image. The consequences of low quality work include short-changing patients which may cause the wrong diagnosis and may result in loss of life. But there is a need to ensure 'attention to the acquisition and refinement of both psychomotor skills and the cognitive aspects of clinical reasoning for competent practice'.[4] Hence the aim is to train students to be competent in performing high-quality ultrasound scanning in order to help physcians make a correct diagnosis to deliver the correct treatment to patients.

Literature reports many new and innovative approaches to strengthen teaching, learning, and assessment of students.[5] Innovative learning approaches such as blended and flipped learning are rapidly

transforming education through the integration of face-to-face and technology-enhanced lecture delivery with the aim to improve learning experiences in university environments.[6] SBE is an approach that has been demonstrated to improve students' acquisition of clinical competence without causing harm and discomfort to patients.[7-8] In other disciplines, for example in civil aviation, simulation is used to train professionals in performing an actual skill before exposure to real-world tasks. The primary reason for implementing SBE it to ensure that there are no errors that may result in loss of lives.[1]

SBE learning allows students to be interactive rather than passive; it also creates a risk-free environment with no potential harm for a patient. The negative finding of Gibbs regarding his study on simulation in ultrasound was that there is no cross-pollination among the students.[1] This minimises the chances of students learning from each other. According to Sadler[9] education should develop and foster the following: sophisticated cognitive ability, integration of knowing, complex problem solving, critical opinion, lateral thinking and innovation in a learner. Tolsgaard et al's study[7] concluded that ultrasound training by simulation leads to a great improvement in clinical performance rather than just clinical training only. Powell-Laney, Keen and Hall[10] argue that it is not just simulation that enhances skills transfer; the use of human simulators enhance decision-making in clinical nursing. Vogel and Harendza[11] agree with Powell-Laney et al[10] in terms of training using human simulation. The emphasis in these studies is on improved skills transfer. The principles also apply to ultrasound.

In Zimbabwe, hands-on clinical training is done in clinical departments. Students are part of the workforce as they train. However, there are limited clinical institutions, as well as heavy workloads, thus students may find it difficult to learn and grasp as much as they are required to do in order for them to be competent practitioners after qualifying. The impact may be the risk of making the wrong diagnosis and may compromise quality of care. This requires that the same diligence applied in civil aviation[12] should be applied in the training of ultrasound scanning. Gibbs[8] recommends that simulation using new technological developments may be an answer to such a problem.

The enrollment of students in ultrasound training in Zimbabwe used to about nine per every intake. In 2018 there were 22 students. This increase resulted in students failing to get enough clinical exposure and hands-on experience because of the busy schedule of the clinical ultrasound departments. These limitations have a negative impact on clinical ultrasound competency transfer. Studies in ultrasound training indicated that students are required to develop cognitive ability and integration of knowing complex problems.[9] Motor skills are important for one to be able to manoeuvre ultrasound equipment to come up with the best results.[4] This requires students to have more clinical exposure than just learning theory in class.

In developed countries computer-based simulators have been used in ultrasound training to overcome the problems of limited exposure and hands-on experience of students within clinical settings.[13] Training institutions in low-middle income countries have limited resources thus they experience challenges in terms of the costs associated with the acquisition of such equipment. To overcome this challenge required a search for student-preferred cost-effective ways of transferring ultrasound clinical competencies to them. According to Gibbs[8], computerised ultrasound simulator training improved student assimilation of practical skills without pressure or fear of exposing a patient to a risk. Provision of timely feedback by clinical supervisors is important in ultrasound training.[3] Very busy clinical departments could impact on timeous feedback to give adequate support to a student. Sullivan and McIntosh[3] encourage competency based training. They are of the opinion that a unit of progression in competency-based training is when there is a mastery of specific knowledge and skills which should be learner-preferred.

The study aimed to determine a student preferred cost-effective way of training for students enrolled in a post-graduate diploma in medical ultrasound in terms of vascular technology in view of limited financial resources and busy clinical departmentss.

RESEARCH METHODS

A qualitative study was done using different methods of clinical skills transfer to post-graduate diploma in medical ultrasound students. The students had to identify the most effective teaching method in fostering an understanding of theory and also developing competency in the localisation of human carotid and vertebral arteries. The investigator was interested in how the teaching approaches shown in Figure 1 engaged the students.

STUDY SETTING, STUDY POPULATION AND SAMPLING

The study was undertaken at the School of Radiography in a university affiliated public hospital. This was the most suitable place because the lecture rooms and the ultrasound clinical departments were available. The study population was 22 students enrolled for part 1 of a post-graduate diploma in medical ultrasound. They were all invited to participate in the study. Convenience sampling was used.

As shown in the flowchart in Figure 1 the study was carried out in three stages. In the first stage a 90 minutes face-to-face lecture on how to locate the carotid and vertebral arteries was presented. Possible pitfalls in the scanning process were highlighted as well as how they affect grey scale images and the Doppler waveform. After the lecture, the students went to the clinical departments for clinical attachment where they worked under clinical supervision. In stage 2a face-to- face lecture was delivered. This was followed by showing students a YouTube video on how to perform a Doppler ultrasound scan of the common carotid and vertebral arteries. Stage 3 involved a face-to-face lecture. The students were then divided into four groups: n=5 x 2 + n=6 x2 (n=22). Each group had to perform a Doppler ultrasound scan of the carotid and vertebral arteries on each group member. They recorded the best procedure on video and presented it in a classroom setting. The students of the other groups then had to comment on the quality of the video and had to identify pitfalls and how they could be corrected if they were any. The videos captured the scanned image, hand movement, and voice of the student performing the scan who described what was being done. The groups had to identify a suitable time when the clinical departments were not busy to do the assignment: after hours or during weekends. Group interviews were conducted to find out from the students their preferred method of skills

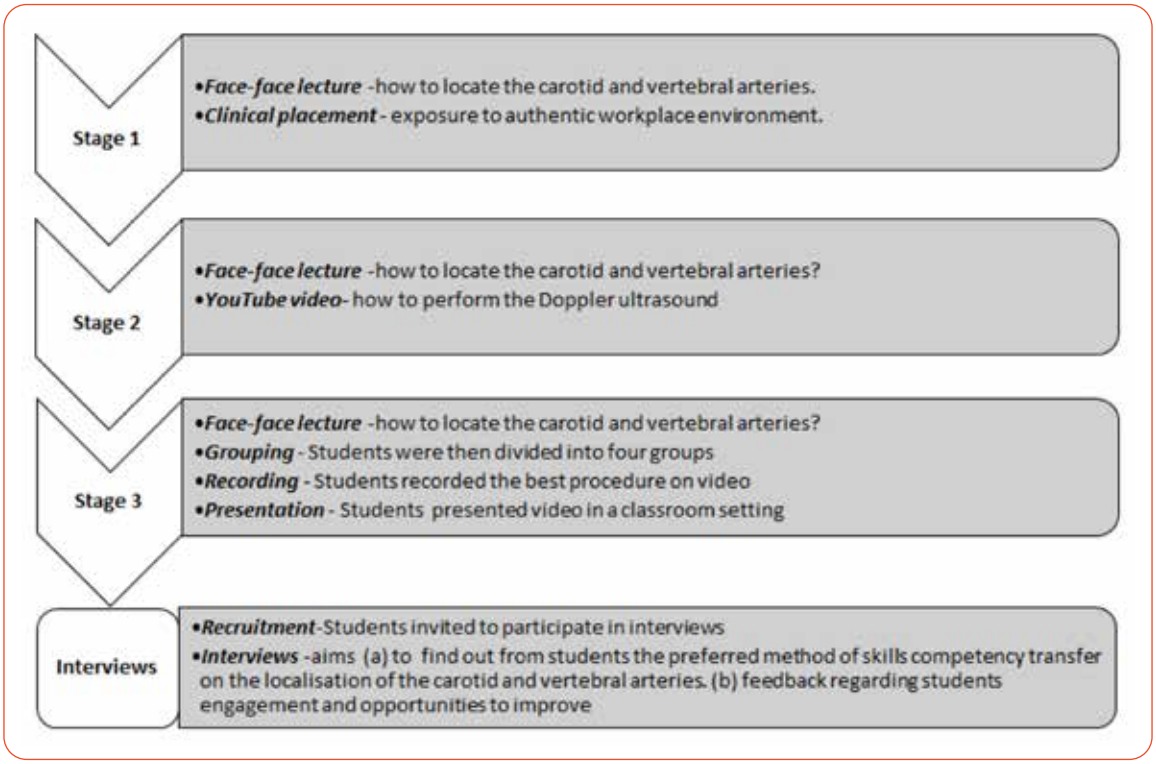

Figure 1: Flowchart indicating stages involved in teaching and the interview.

competency transfer on the localisation of the carotid and vertebral arteries. The students in each group had to choose the best method that made it easier for them to grasp the concept being taught. They had to give reasons for their respective group's preference for analysis purposes. Feedback regarding students' engagement and opportunities to improve teaching was also gathered. A follow-up interview was conducted.

ETHICS APPROVAL

Ethics principles in terms of participation, consent, and confidentiality of data were used to underpin the design of the study. Institutional approval to conduct the study was obtained with reference number 01/19. The students were informed of the study and it was emphasised that participation would not impact their grades. They were requested to sign a consent form if they wanted to participate in the study. There were no known risks that they could be exposed to when they underwent ultrasound scanning. All who participated benefitted as the study was part of the training process for them to acquire a post-graduate in medical ultrasound qualification. If an abnormal appearance were to be found on any student during the scanning process, then such a student would have been referred to the institution staff clinic for further management. No student was penalised for refusing to participate in the study.

FINDINGS

All 22 students participated in follow-up interviews. The findings pertained to acquisition of ultrasound skills, and student engagement as discussed below.

(a) Acquisition of ultrasound skills

All the students indicated that they gained more skills when they created their video during scanning and then presented it for other students to comment on the production. All agreed that producing their videos was the most effective way of skills transfer. They also pointed out that a lecture, to cover the theory, was an important foundation for the clinical practice they did.

They were asked to comment on their experience when they were attached to a clinical department to work under supervision. They highlighted that at times there were no patients for the examination they were supposed to learn. They also indicated that in most cases they failed to get hands-on experience because patients, especially those referred from private clinics for ultrasound examination, were not willing to be scanned by students. In some departments there are scheduled times for each examination to be completed and these times were too short to allow for students to gain enough clinical exposure.

They thought the YouTube videos were helpful as a preparatory lecture for clinical practice. The videos had limitations; students still needed to gain clinical competency by undertaking examinations themselves. The videos did not allow them to gain practical experience.

(b) Student engagement

The video recording, and YouTube component, were designed to improve student engagement. Students indicated that scanning each other and producing videos was more interactive than just being made to join a team of busy ultrasonographers. Some highlighted they experienced some discomfort when they were incorrectly positioned. This made them appreciate what a patient would experience during scanning. This helped them develop empathy for patients. Also, it was easier to correct their mistakes after class discussions because they could link what was being discussed with the hands-on experience they had in their groups.

DISCUSSION

The results of the study show that it is pos-

sible to develop a cost-effective way of training ultrasound students. Video production, combined with hands-on practice, was a way of simulation that is at a slightly higher level than that which was discussed by Gibbs.[8] The simulation in the study done by Gibbs was machine simulation where a student used a machine almost like a game to practice. In this study however in the video recording, the simulation was interactive and was done on a real person. According to Sadler[9] simulation that is followed by class discussions inculcates complex cognitive understanding in students. Parsh[14] pointed out that a combination of voluntary study with the use of multimedia applications and feedback from peers provides a good learning opportunity for basic skills. The findings in this study are in keeping with the opinions of Parsh. In other words the use of simulation and video recording of it, followed by a class presentation and discussion with peers, creates an environment suitable for students to learn and understand vascular ultrasound scanning concepts better.

Gibbs[8] contends that computer simulation will encourage interactive learning, however, there may be limited acquisition of soft skills such as communication and demonstration of empathy for a patient. Unlike machine simulation, the method in this study that involved students practising on each other was what happens in clinical practice that involves patients. The students gained hands-on experience; they were however not under pressure of demands of patients or time constraints. When patients are being scanned by a student the main reason is to determine the presence of an abnormality. In the process a student learns how to do the relevant clinical examination. This brings about pressure on students on the following issues.

- What would happen to patients if they (students) miss the pathology?
- Would a patient who paid for the examination be happy with their performance?
- Would the qualified personnel checking the whole process create an atmosphere that fosters learning or one that causes students to be anxious?

When students produce clinical videos they can still refer to lecture resources during a practical. The thrust of producing the best video for a class presentation ensures that students practice the technique repeatedly until they come up with what they think is the best. Repetition to produce the best video helps them to grasp the technique better than when in a clinical setting.

Besides encouraging hands-on experiences, the use of groups in learning creates a shared representation of the world as described by Barber, Rajaram and Fox.[15] According to them this results in collective memories that help students to remember what they have learnt. They caution that collaborative learning may also result in poor group recall. While collaborative learning may be helpful at the encoding level, if a group is too big then collaboration may have a negative effect.[15] In this study the groups were small and restricted to a maximum of six in a group. This enabled the students in each group to perform the task encouraged by collaborative learning. Small groups means there is a higher chance that everyone will participate.

In the work groups, the students were involved in role-playing which is a form of simulation. A study by Comer[16] on patient care simulations through role-play revealed that the pass rate of students on that particular course increased because of the use of role-playing in the training. The findings of this study are in keeping with the study by Comer. The ultrasound students felt learning by simulation benefitted them more than other methods of clinical skills transfer.

Another advantage is that by producing a video of their role-playing means students can replay the video repeatedly and this should bring back the group memories and should help them remember better than if they had just done the role-play without recording it. It is also helpful to a lecturer because the videos can be used to illustrate the same concept to other students.

The concept of video games can be adopted where the required manoeuvres are accompanied by the corresponding images on the video screen. While this may not be as good as a practical simulation it helps students to develop the required skills before they do an actual examination on a patient. It is also important to note that anxiety, which comes with working in the clinical department with other ultrasonographers, is also a good learning experience. This helps a student to adapt to the clinical setting faster after qualifying. While group simulations are encouraged and appear to benefit students, clinical attachments should not be done away with. The recommendation is that simulations should be done first before students are sent to work under supervision in clinical departments.

A disadvantage of having student volunteers scanning each other is the possibility of incidental findings. An article by Siegel-Richman and Kendal[17] highlights the importance of developing protocols for facilitators and students on what to do in cases of incedental findings. Another limitation is that while practical simulation can be done in ultrasound examinations there are some clinical examinations which are impossible to do practical simulation using students. These include penile erectile dysfunctional ultrasound test using vascular studies or transvaginal ultrasound. In such cases, machine simulation would be the best.

RECOMMENDATIONS AND FUTURE DIRECTIONS

A further study to identify machine simulation software to assist students in learning clinical examinations, which cannot be role-played, like transvaginal ultrasound, should be of great benefit to resource constrained training institutions. Machine simulation software is available in developed countries. In developing countries an institution could work with their local information and technology department, if available, to develop their system instead of buying expensive software.

CONCLUSION

Practical group simulation with recorded videos presented in class was an effective method of teaching. This assisted students to grasp clinical skills better than just sending them for clinical attachment where they work with the rest of the team in a busy department with limited resources and under pressure of high workloads.

This study is an example of rigorous efforts to ensure that effective teaching approaches are in place to optimise learning experiences in ultrasound scanning where there are limited resources.

ACKNOWLEDGEMENTS

The authors acknowledge training colleagues, clinical supervisors and the students for the support rendered.

CONFLICT OF INTEREST

There were no competing interests.

CONTRIBUTIONS OF AUTHORS

EYM (Harare Institute of Technology) was the principal researcher who designed the study, carried it out, analysed the results and wrote the article; CC (Queensland University of Technology) critically revised and edited the article for important intellectual content before the article was sent to the journal administrator.

REFERENCES

1. Gibbs V. The role of ultrasound simulators in education: an investigation into sonography student experiences and clinical mentor perceptions. Ultrasound (Leeds, England), 2015; 23(4): 204-211. doi:10.1177/1742271X15604665
2. Blooms BS, Engelhart MD, Furst EJ, Hill WH, Krathwohl DR. Taxonomy of education objectives: the classification of educational goals. New York: David McKay Company Inc, 1956.
3. Sullivan R,McIntosh N. The competency-based approach to training, 1996; Vol. 5).
4. Edwards C, Chamunyonga C, Clarke J. The role of deliberate practice in development of essential sonography skills. Sonography, 2018; 5(2): 76-81. doi:10.1002/sono.12146
5. Gerritsen-van Leeuwenkamp KJ, Joosten-ten Brinke D, Kester L. Assessment quality in tertiary education: an integrative literature review. Studies in Educational Evaluation, 2017; 55: 94-116. doi:https://doi.org/10.1016/j.stueduc.2017.08.001
6. Kiviniemi MT. Effects of a blended learning approach on student outcomes in a graduate-level public health course. BMC Medical Education, 2014; 14(1): 47. doi:10.1186/1472-6920-14-47
7. Tolsgaard MG, Ringsted C, Dreisler E, et al. Sustained effect of simulation-based ultrasound training on clinical performance: a randomized trial. Ultrasound Obstet Gynecol 2015; 46(3): 312-318
8. Gibbs V. An investigation into sonography student experiences of simulation teaching and learning in the acquisition of clinical skills. Ultrasound: Journal of the British Medical Ultrasound Society, 2014; 22(3): 173-178. doi:10.1177/1742271X14528491
9. Sadler DR. Indeterminacy in the use of preset criteria for assessment and grading. Assessment & Evaluation in Higher Education, 2009; 34(2): 159-179. doi:10.1080/02602930801956059
10. Powell-Laney, S, Keen C, Hall K. The use of human patient simulators to enhance clinical decision-making of nursing students. Education Health (Abingdon), 2012; 25(1): 11-15.
11. Vogel D, Harendza S. Basic practical skills teaching and learning in undergraduate medical education – a review on methodological evidence. GMS J Medical Education, 2016; 33(4): doi:10.3205/zma001063
12. Nagel DC. Human error in aviation operations. In EL. Wiener & DC. Nagel (Eds.) Human factors in aviation San Diego: Academic Press; 1988: pp.262-303.
13. Blum T, Rieger A, Navab N, Friess H, Martignoni M. A review of computer-based simulators for ultrasound training. Simulation Health, 2013; 8(2): 98-108. doi:10.1097/SIH.0b013e31827ac273
14. Parsh B. Characteristics of effective simulated clinical experience instructors: interviews with undergraduate nursing students. Journal Nursing Education, 2010; 49(10): 569-572. doi:10.3928/01484834-20100730-04
15. Barber SJ, Rajaram S, Fox EB. Learning and remembering with others: the key role of retrieval in shaping group recall and collective memory. Soc Cogn, 2012; 30(1): 121-132. doi:10.1521/soco.2012.30.1.121
16. Comer SK. Patient care simulations: role playing to enhance clinical understanding. Nursing Education Perspective, 2005; 26(6): 357-361.
17. Siegel-Richman Y, Kendall JL. Incidental findings in student ultrasound models: implications for instructors. Journal of Ultrasound in Medicine, 2017; 36(8): 1739-1743. doi:10.7863/ultra.16.08014

Dear ISRRT members

We are writing to you to give an update on the 21st ISRRT World Congress scheduled to be held this August 26-29, 2020 in Dublin Ireland.

As you will all be aware, the COVID-19 pandemic is affecting most of our countries around the world today in an unprecedented manner. The ISRRT is aware that many of its members are engaged in the battle of the COVID-19 as frontline health professionals. The ISRRT also acknowledges that most countries have implemented travel ban for health care workers which may be extended beyond the end of this year. It remains unknown when the COVID-19 pandemic will end, and when international travel restrictions will be lifted.

The ISRRT has now had several meetings with the Irish Institute of Radiography and Radiation Therapy organizing committee to find a viable solution for the World Congress. As organizations, it is with heavy heart that the ISRRT Board of Management and the Irish society planning committee must announce that **the 21st ISRRT World Congress will be postponed to August 17-21, 2021 Dublin Ireland**.

For those, people that have already registered for the 2020 World Congress, please be reassured that your registration fee will be moved forward and applied to the August 17-21, 2021 meeting dates. Hence, they are considered registered for the Congress in 2021. If you have additional questions relating to your registration please contact the planning committee at **ISRRT2020@advantagegroup.ie**.

The approved abstracts for the 21st World Congress in 2020 will be automatically upheld for the 17-21 August 2021 dates. A new email will be sent to all abstract writers, in order to RSVP and reaffirm plans for attending the 2021 meeting. Please note, that a new abstract section for COVID-19 is being developed and thus the opportunity to submit an abstract with the pandemic experiences to be accepted for next year's meeting track as well. Visit the ISRRT website for related information.

Hotels agreements are being renegotiated for next year's dates by the PCO and the Irish planning committee. The PCO and/or the hotel you have originally booked will be in contact with you to move you're booking if you have already booked accommodation. There is no need for you to take any action until they have been in contact with you.

Although we need to postpone, we are all very excited to host our ISRRT 21st World Congress on August 17-21, 2021. Furthermore, be assured that the postponement of the World congress to Dublin, 2021 will not impact the dates and year of the scheduled 22nd ISRRT World Congress which will still be held in Bangkok, Thailand, 2022.

ISRRT members, we appreciate your knowledge, skills, expertise and care as frontline health professionals in the COVID-19 pandemic. Let us all continue our efforts for every patient's well-being, stay safe and know that the ISRRT is always here to support you.

Donna Newman, ISRRT President and Dean Harper IIRRT President (23 April 2020)