Sonography education in the clinical setting: The educator and trainee perspective

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Abstract

Introduction: Sonography is a complex clinical skill. However, in spite of its complexity, little has been published about how these skills are taught in Australia or internationally. This paper explores Australian sonographer educators' and trainees' perceptions regarding the teaching of sonography skills, with a specific focus on the procedural dimension of the process. A secondary aim is the identification of the Australian sonographer educator workforce and teaching settings.

Methods: Data were collected from trainee and educator sonographers via an online survey and semi-structured interviews, following ethics approval and informed consent. All data was anonymous or de-identified. Descriptive statistics were generated for quantitative data and qualitative data were analysed using thematic analysis.

Results: The online survey of 72 full responses found that a majority of Australian sonography education occurs in general sonography private practice (52%), with most practices employing up to three trainee sonographers concurrently (78%). Forty-nine per cent of sonographers self-identified as primary clinical supervisors, with the majority (58%) of these holding no teaching qualifications. Fifty per cent of participants reported using a five-step method of teaching the procedural dimension of the process. Qualitative findings revealed four themes related to sonography skills teaching including importance of repeated observation and practice, identification of the teaching model, providing opportunity for feedback and having flexibility to adapt the skill teaching model when applicable.

Conclusion: This exploratory mixed-methods study highlights the educator and trainee perspectives of sonography skills teaching. Based on these findings, the authors propose that sonography skills teaching maximise the opportunities for trainees to engage in observation, hands-on learning and obtain constructive feedback. It is also suggested that sonography practices support educators to extend their education skills to ensure high-quality clinical teaching.

Keywords: clinical education, clinical skills teaching, sonography education.

Introduction

Complex clinical skills are defined as tasks for which 'performance requires the integrated use of both controlled (conscious, conceptual) and automated (unconscious, procedural or strategic) knowledge to perform tasks'.[1] According to this definition, sonography is a complex clinical skill, as it requires an extensive knowledge of human anatomy, physiology and pathology, along with visuospatial awareness; all of these are necessary to interpret the two-dimensional image produced by an ultrasound machine into a three-dimensional mental image of the scanned area of interest. Sonography clinical skills teaching focuses on teaching trainee sonographers using real patients, thereby enhancing the authenticity and diversity of the learning experience, while also adding to its complexity.

Different models exist across the health professions for teaching clinical skills, and these are generally based on a developmental perspective of learning.[2] The most common clinical skills teaching model is the traditional 'see one, do one' (observation and performance) apprenticeship approach.[3] In this model, students observe a master practitioner or expert performing a clinical skill on multiple occasions and then perform that skill themselves under close supervision until they are deemed competent to perform the task independently. Other clinical skills teaching models include Walker and Peyton's[4] four-step model, George and Doto's[5] five-step skill teaching

model and Faarvang and Ringsted's[6] modified six-step approach. These models are described in more detail in Table 1.

While some empirical literature exists on sonography education, much of it focuses on undergraduate medical curricula and other health professions using sonography in practice.[18–21] There is also a growing body of work within sonographer education focused on identifying the core skill set in sonography and developing and validating a survey on sonography skill teaching.[22–25] Despite the extensive insights provided by Nicholls *et al.*,[22–25] much remains unknown about educator and trainee perspectives of sonography education in the clinical setting.

To address this gap in the literature, this first Australian study of its kind seeks to answer the following questions: What do sonography educators and trainees view as the key elements of sonography skills teaching and learning? Where is sonography education delivered and by whom?

Methods

Research approach
This study used prospective recruitment and a mixed-methods research approach involving both quantitative and qualitative methods.[26]

Participants, sampling and recruitment
Study participants were recruited from two sources: the first group were a convenient sample of sonographers registered as members with the Australasian Society for Ultrasound in Medicine (ASUM) and were recruited by an email sent from ASUM to approximately 3000 sonographer members. The second group were a purposive sample of trainee sonographers and recent graduates from one sonography clinical workplace. Recruitment of the second group occurred via an email from the Human Resources department. Both groups received an Information Sheet about the project. Consent was implied for group one, and signed consent forms were obtained from participants in group two.

Data collection
Data were collected from the first group, ASUM members via an online survey (hosted via Survey Monkey), which asked questions relating to participant speciality and location, clinical skills teaching models used (along with perceived benefits and limitations), as well as frequent modifications encountered in skills teaching. The survey was open for approximately four weeks from August 2017, with one follow-up email after 2 weeks.

For the second group, trainee and recent sonography graduates from one sonography clinic, semi-structured interviews were used from May 2017 to explore personal experiences and reflections of clinical skills learning. The interview questions were individualised based upon trainee status (i.e. trainee vs recently qualified sonographer) and background (vascular vs. general sonography). The latter modification was due to vascular and general sonography disciplines being regarded as two separate departments within the research site, with different training methods. The interviews were conducted over a four-month period by the first author and audio-taped with interviewee consent.

Data were stored on the first author's private computer, and audio files were deleted from the recording device once transcribed. Online survey data and transcribed interview data will be stored for a period of approximately five years before being disposed.

Data analysis
Percentage and range statistics were generated for the quantitative online survey data. The interviews were transcribed by the first author. Thematic analysis[25] of qualitative data from both the online survey and interviews was carried out by the first author and discussed with the second author. Analysis was performed using a 'line by line' coding method to highlight emerging themes and to identify a thematic framework for the entire data set.[27]

Ethics approval
Participants received no incentives for participation and were informed that participation was voluntary. Online survey participants' privacy was maintained through the use of anonymous survey data. Interview subjects' confidentiality and privacy were maintained by removing any identifying data and replacing names with codes (Interviewee 1–6).

Ethics approval was obtained from Flinders University (project number 7728), and ASUM consented to send a link to the online survey to their sonographer members. Permission was also obtained from the first author's workplace.

Results

Sonographer educator workforce and teaching settings
Ninety-six sonographers responded to the online survey. Of these, only 72 respondents provided a full set of responses, yielding a response rate of 2.4%. This provided the basis for the analysis. The majority of respondents were from a general sonography background (52%), and 41% were working in urban private practice (Figure 1). Most practices employed zero to three trainee sonographers, mostly in an urban private practice setting (Figure 1) with the number of trainees employed in each clinical practice ranging from zero to greater than six. Forty-nine per cent of the participants were currently involved in educating trainee sonographers and 49% were the primary clinical supervisor. Fifty-eight per cent of supervisors possessed no clinical education qualification (Figure 2). Fifty-two per cent of respondents used a clinical skill teaching model that most closely resembled George and Doto's five-step model, 22%

Table 1: Clinical skills teaching models.

Approach	Strengths of approach according to studies undertaken	Weaknesses of approach according to studies undertaken
Traditional Two-Step 'See One, Do One': • *Step One – See One* – student observes tutor perform skill on multiple occasions and is encouraged to ask many questions to ensure a cognitive understanding of task at hand. • *Step Two – Do One* – student performs skill under close clinical supervision. Through repeated practice, competency at skill is obtained.[3,7,8]	• Ability to learn in context.[3] • Ability of student to build strong rapport with senior mentoring staff.[3]	• Opportunistic nature.[3] • Difficult to gauge competence if senior staff fail to ensure proficiency of student.[3] • Relies heavily on role modelling and role model's ability to articulate tacit knowledge.[9–11]
Walker and Peyton's (1998)[4] Four-Step Approach: • *Step One – Demonstration* – student observes tutor perform skill with no narration, providing a visual map of skill. • *Step Two – Deconstruct* – student observes tutor perform skill, whilst tutor describes in detail the steps they are taking (consolidates skill in student's mind). • *Step Three – Comprehend* – student observes tutor perform skill, while describing what the tutor is doing (vital to ensure student has cognitive understanding of skill, and knowledge necessary to perform skill). • *Step Four – Perform* – student performs clinical skill under close clinical supervision by tutor.	• Decreased time to perform skill at first independent practice.[12] • Higher level of perceived self-confidence and skill proficiency[4] • Potential to modify to small group setting, therefore increasing usability and flexibility of model.[13,14]	• Repetitive, slow and fails to ascertain prior skill level of student before teaching.[15] • Greif *et al.*[7] and Orde *et al.*[8] compared the use of a traditional two-step model to Walker and Peyton's[4] four-step model in teaching clinical skills of percutaneous needle puncture cricothyroidectomy and laryngeal mask insertion, with both studies concluding that there was no statistically significant difference in outcomes between the two methods.
George and Doto's (2001)[5] Five-Step Model: • *Step One – Conceptualisation* – The cognitive phase. In this step, the student reaches an understanding about the skill at hand (i.e. why it needs to be done, where it should be performed, etc). • *Step Two – Visualisation* – The student observes the tutor perform the clinical skill. • *Step Three – Verbalisation* – the skill is performed whilst the tutor narrates how they are performing the skill, highlighting essential components. • *Step Four – Practice* – student performs the skill under close supervision. This step may be broken down into subcomponents, therefore enabling the learner to repetitively practice small parts of the skill. • *Step Five – Correction and Reinforcement* – student errors are corrected by tutors, along with the use of positive reinforcement to cement correct skill performance.	• Virdi and Sood[16] found the five-step approach optimises teaching time, whilst gradually exposing the student to elements of the skill. • Increases speed of learning.[16]. • Produces a satisfactory learning experience for the student.[5,16] • Virdi and Sood's[16] study found that the utilisation of the five-step model may be useful for teaching a range of clinical skills that require multiple steps.	• At first glance, teaching with this method may seem time-consuming.[5]

Table 1. Continued

Approach	Strengths of approach according to studies undertaken	Weaknesses of approach according to studies undertaken
Faarvang and Ringsted's (2006)[6] Modified Six-Step Approach: • *Step Zero – Conceptualisation* – assess student's needs prior to clinical skill demonstration. • *Step One – Observation* – demonstration of clinical skill by tutor. • *Step Two – Deconstruction* – tutor performs clinical skill whilst narrating to the student. • *Step Three – Comprehension* – tutor performs exam whilst student describes what the tutor is doing. • *Step Four – Performance* – student performs clinical skill while narrating to tutor what they are doing, outlining clinical reasoning behind each step. • *Step Five – Feedback* – tutor provides constructive feedback based upon Step Four.[6,17]	• Faarvang and Ringsted[6] deduced that the conceptualisation step of the modified six-step approach correctly identified student's prior knowledge and experience with skill at hand. • Residents evaluated the method highly for relevance and perceived learning outcome, and stated that the addition of feedback was beneficial in highlighting adaptations that may take place when performing the skill in a clinical setting.[6]	• Few long-term data exist regarding the impact of this model on learner outcomes.[6]

indicated a preference for the traditional two-step model, 17% utilised Walker and Peyton's[4] four-step approach, and 9% of respondents indicated that they used an undisclosed method of clinical skills teaching. Ninety per cent of sonographers believed their skill teaching method was an effective way to teach clinical skills.

Trainee and educator views of sonography skills teaching and learning

Presented here are the qualitative data for the study generated from six interviews and the open-ended online survey questions, of which 49 respondents provided all seven open-ended responses. Four main themes were identified relating to sonography skills teaching: importance of repeated observation and practice, identification of the teaching model, opportunity for feedback and flexibility to adapt the skill teaching model when applicable.

Importance of repeated observation and practice

This theme highlighted the value and importance of repeated observation and practice to ensure trainee competency is reached before independent practice takes place. Educators responding to the online survey believed that repeated observation was particularly important for difficult examinations, for beginners and learners without a clinical background. The interview data illustrated that trainees equally valued observation as a central component of their sonography skills development. All interview respondents indicated a high level of satisfaction with the sonography skills training they received. As one sonographer stated 'I personally think watching and doing makes a lot more sense than reading something and then being thrown in'. When asked whether they would like to see

any modifications made to their sonography education practices, interview respondents expressed a desire for further supervised practice.

Identification of teaching model

Five of the six interview participants indicated that their clinical skills training most closely followed George and Doto's[5] five-step model, but without having the method named for them by their tutor. The remaining respondent had received clinical skills instruction using the various clinical skills teaching models, with each being specifically named in teaching sessions. Of these methods, the remaining respondent indicated a preference for methods which use a comprehension step, most notably seen in Walker and Peyton's[4] four-step approach and Faarvang and Ringsted's[6] modified six-step approach. The main reason cited for this preference is 'it reinforced my own learning to tell someone else….and it cemented the steps that I needed to take. Whether I could physically do it when I scanned was irrelevant, I knew what I needed to do'.

Opportunity for feedback

All respondents felt that the addition of more consistent and frequent feedback was of the utmost importance for sonography skills acquisition. Reasons for lack of feedback included time constraints and lack of instruction for tutors on how to deliver efficient feedback. Most educators believed their chosen model of skills instruction was beneficial as it allowed immediate feedback for the learner. Interview data reinforced that frequent feedback was cited as the main element that trainee sonographers would like increased in the clinical education setting, with one interview respondent stating that 'I sought extra feedback…I prefer being told what I need to work on, and I
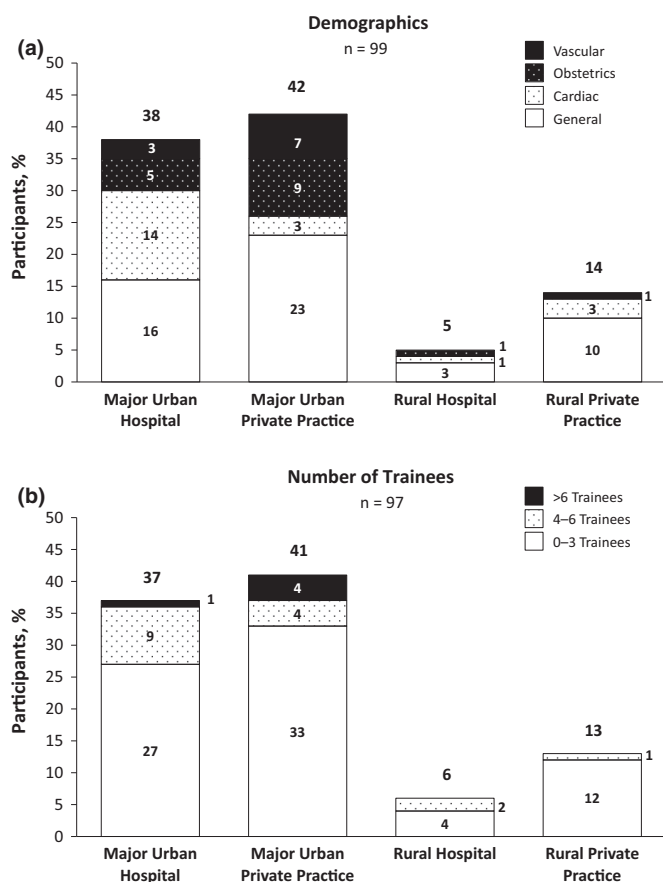
Figure 1: Sonographer speciality, geographical location and number of trainees represents the distribution of survey respondents' clinical speciality across four main types of clinical practices, along with the average number of trainees across the four main types of clinical practices as described by survey respondents.
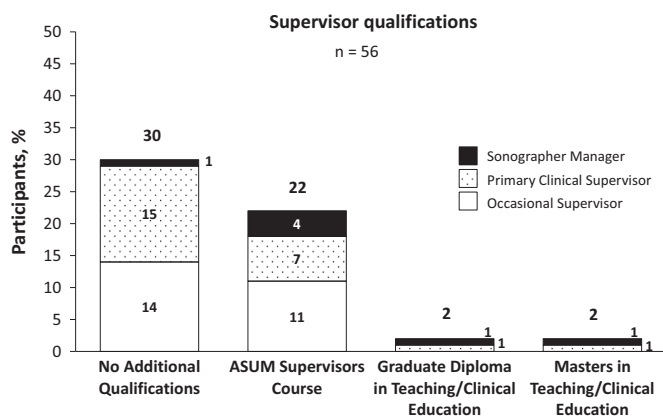

Figure 2: Current role in sonography education and supervisor qualifications describes survey respondents' current role in sonography education and displays survey respondents' current role in sonography education and whether any further qualifications or courses have been undertaken.

think that most sonographers do'. Another stating, 'I *always* like feedback'.

Flexibility to adapt skill teaching method when applicable

Educators also recognised the limitations of the clinical skills teaching models in considering the context of learning in sonography practices, including the level of the student (i.e. advanced vs. beginner learner), the difficulty of the examination in question (including varying the examination based upon findings and patient/doctor needs) and time constraints due to scheduling issues. Most sonographer educators demonstrated flexibility when using clinical skills teaching models by adapting their teaching rather than strictly adhering to the steps as outlined by the previously discussed models. For example, they indicated that one of the most frequent modifications they made was to allow more time for repeated practice – including hand over hand scanning when necessary. Sonographer educators also highlighted the importance of adapting their skills teaching method by breaking complex studies down into more manageable parts. This recognises the need for learners to have a thorough and in-depth understanding of the scan itself, along with knowledge regarding relevant anatomy and being able to correctly identify pathology. When asked whether they would like to see any modifications made to their sonography education practices, respondents expressed a desire for a comprehension step to be included after the initial stages of observation, expressing the benefits of consolidation of skill along with repeated practice.

However, it is important for educators to recognise the differences in how trainees learn. Some trainees also expressed a desire for a comprehension step to be included after the initial stages of observation, thereby illustrating the benefits of consolidating skills along with repeated practice. Whereas one recently qualified sonographer disagreed with a comprehension step modification stating that 'for me, that would feel awkward'.

Discussion

This study explored educators' and trainees' perspectives of sonography clinical skills teaching and learning, as well as the nature of the sonography workforce. This study found that most sonography education occurs in major private practices in a general sonography discipline, and while almost half the educator group self-identified as primary supervisors, most had no clinical teaching training. The qualitative results revealed that both educators and trainees believed sonography skills teaching was characterised by several key elements including repeated observation and practice, identification of the skill teaching model, importance of feedback to sonography education and adapting of skills teaching to context.

Observation of the clinical skill is of utmost importance to demonstrate to the learner what is expected of a competent, qualified sonographer[28] and to ensure the learner has a concrete example of the skill of identifying relevant pathology and

anatomy. Lake and Hamdorf[28] and Aggarwal et al.[29] have highlighted the need for repeated, deliberate practice of the taught clinical skill for learners to effectively master the skill competently and independently in a range of clinical contexts.

This study showed that identifying the teaching model being used does not always happen but is an important precursor for adapting teaching. The identification of the model may allow educators to explicitly focus their teaching on the steps of the model, adapt and refine their teaching, thus improving trainee satisfaction and learning outcomes. One of the most notable findings from previous literature is the importance of the deconstruction and comprehension of the clinical skill that exists throughout several clinical skill teaching methodologies.[30] In a study by Krautter et al.,[30] all four steps of Walker and Peyton's[4] approach were used, both independently and in combination, and results showed that Walker and Peyton's[4] third step (comprehension) represented a crucial instructional sub-step and may lead to superior learning outcomes.

The importance of feedback on skill performance was also identified in this study. Feedback has long been considered by many educationalists as the 'cornerstone of effective clinical teaching'.[31] Feedback is essential in sonography teaching to allow for improved student performance, which in turn leads to better patient outcomes, and has been directly based upon observation of scanning behaviours.

This study also recognised the importance of context (e.g. the examination being taught, differences among individual learners), with many educators adapting their teaching methods for each individual trainee (e.g. a beginner learner will generally need much more assistance than an advanced learner) and in varying examination circumstances (e.g. a difficult examination, or when faced with a nervous or anxious patient). Considering the adaption of skills teaching based upon context, it is important to teach sonography examinations over a suitable time period to ensure the learner has had adequate exposure to the task at hand to be able to competently perform the skill independently.[3]

The first author of this study is a vascular sonographer and sonography educator whose own training followed the traditional 'see one, do one' approach. This insider position was invaluable for informing the design and conduct of the research study. This was balanced by having a second member of the research team who was an outsider to sonography education, but who is highly involved in the education of healthcare practitioners.

Implications for practice

Educators and trainees alike report great value in repeated observation, practice and feedback in sonography teaching. This study indicated that trainee sonographers would prefer more feedback and highlighted the need for sonographer educators to dedicate more time to the feedback process. However, this also relies on organisations recognising and responding to

this need by allowing their sonographers more time for the education process, including modifying the teaching approach to suit the context, the patient and the trainee. Of further interest, there is some scope for the clinical teaching model being used to be made more explicit by educators in the teaching encounter: this may serve a dual purpose of helping trainees recognise the steps involved in acquiring a clinical skill and prompting educators to reflect on their teaching practice.

This study also found that a majority of sonographers involved in the education of trainee sonographers possess no additional educator qualifications, highlighting a need for investing in the education of a sonography educator workforce to optimally support future trainees and junior sonographers.

Study strengths and limitations

This was the first Australian study to provide insights into educator and trainee views about sonography education in the clinical setting. The main limitation of this study was the 2.4% online survey response rate, which narrows the conclusions we can draw about the Australian sonography educator population. A small sample size of interview participants from a single practice can also be viewed as a limitation of this study. Due to the first author working alongside the interview participants, one cannot completely discount conflict of interest, coercion or unequal relationships between the author and interviewee as a possible limitation of this study; however, all necessary steps were taken to mitigate this.

Conclusion

Quality sonography education is underpinned by regular feedback, frequent observation and practice and the adaptation of sonography clinical skills training and teaching practices according to context.

There is scope to support sonography educators to extend their education skills to maximise the educational experiences of trainee sonographers. Future research should include a larger sample of sonography educators and trainee sonographers across a range of sonography disciplines and workplaces in Australia, to provide a broader cross section of perceptions.

Authorship statement

The authors acknowledge that the original research conforms to the AJUM's authorship policy, and both authors are in agreement with the content of the submitted article.

Conflict of Interest

None declared.

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