

Pair Scanning

Integrating the Student Sonographer Without Impacting Patient Care

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Objectives—Ultrasound departments in Canada frequently reduce patient bookings to support student training, which impacts not only patient care but also revenue generation. Therefore, physicians and employers are reluctant to host student sonographers, and educational programs struggle to find sufficient clinical placements for their students. Two research questions were investigated: (1) Can a pair scanning technique effectively integrate the student sonographer into the workplace without impacting patient volumes? (2) Does the pair scanning technique prepare the student sonographer for entry-level practice faster than traditional practice?

Methods—This research project was divided into 2 phases. The first phase used action research to develop the pair scanning protocol at a single site with a single preceptor and student. The second phase used a mixed methods approach to test the transferability of the pair scanning protocol across multiple sites, preceptors, and students.

Results—In phase 1, the student sonographer performed a greater number of total examinations than the rest of her cohort (who were at different placement sites), and the higher performance of independent examinations by the student sonographer under the pair scanning technique was statistically significant [$H_{(4)} = 36.297$; $P < .01$]. In phase 2, the pair scanning group and the control group performed equally, with no statistically significant differences.

Conclusions—The pair scanning protocol is effective at integrating the student sonographer into the work flow without impacting patient care. It prepares the student sonographer for entry-level practice equally with traditional practice and may be most effective with the weak to average student.

Key Words—action research; clinical competence; education; preceptorship; sonography; ultrasound education

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We thank Li Zhang for performing the statistical analysis on the phase 1 data. This article is dedicated to our coauthor, Kathleen Foran, who passed away in September 2016. Kathleen was a wonderful colleague, friend, and teacher who was passionate about raising the standards of sonography education and practice in Canada.

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The sonography preceptor model in Canada traditionally requires a requisite reduction in patient bookings to accommodate students. The rationale behind this reduction is that the student sonographer requires extra time to complete the examination, extra time is required for the supervising sonographer to reexamine the patient, or both. This paradigm impacts patient volumes and revenue generation. Therefore, ultrasound departments are reluctant to host sonography students, and many sonography programs struggle to find and keep sufficient clinical placements.

This paradigm of sonography training has not yet been effectively challenged. In Alberta, critical labor shortages of sonographers resulted in a collaborative approach between ultrasound departments and educational institutes to increase the clinical capacity for students by placing multiple students with a single preceptor.¹ Although feedback from these projects was positive, for these types of initiatives to

not impact patient bookings, dedicated student examination rooms are required above and beyond the regular workload.

Many educational institutes have focused on internal educational strategies, such as simulation, to better prepare students for their clinical placement in the hopes of increasing the students' readiness for clinical practice. However, the transition from a controlled laboratory setting to a busy contextual ultrasound department still requires bridging. As sonography enters the medical field, medical educators are rigorously examining their methods of clinical sonography training.²⁻⁴ Therefore, in the fall of 2013, the Canadian National Institute of Health in Ottawa embarked on a research project to develop and research a pair scanning protocol that could integrate the student sonographer without impacting patient volumes.

Materials and Methods

This research project, divided into 2 phases, asked the following questions: (1) Can a pair scanning protocol effectively integrate the student sonographer into the workplace without impacting patient volumes? (2) Does the pair scanning protocol prepare the student sonographer for entry-level practice faster than traditional practice?

The first phase used action research⁵ to develop the pair scanning protocol. The second phase used a mixed methods research design⁶ to test the pair scanning protocol for transferability across multiple clinical sites, preceptors, and students. These phases were conducted in the fall of 2013 and 2014, respectively.

Phase 1: Developing the Pair Scanning Technique

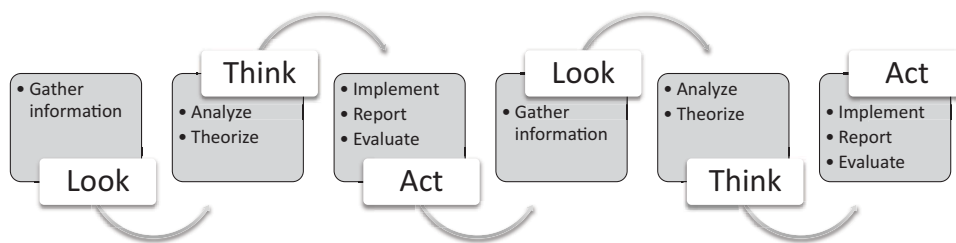
Phase 1 engaged a sonographer and student with a Canadian National Institute of Health educator to develop a pair scanning protocol that could successfully

train student sonographers without impacting patient volumes. The protocol was developed at a clinic with daily bookings of 14 to 16 patients and up to 22 examinations performed. The clinic performed abdominal, superficial structure, gynecologic, and obstetric (first and second/third trimesters) sonographic examinations. Carotid, lower venous extremity, shoulder sonography, and interventional procedures were not performed. All bookings are scheduled for 30 minutes. Action research was selected as it is a democratic research process that facilitates the challenging of our norms and practices to enhance our professional worlds.⁵ In action research, participants are elevated to coresearcher status who then collaboratively work through an inductive research process of look-think-act (Figure 1).⁵ Informed consent was obtained orally to maintain the spirit of a democratic and collaborative process. The action research activities are outlined in Table 1.

Methods

The student self-reported case numbers into an electronic log book (CompTracker, Edmonton, Alberta, Canada). Cases were ranked as observed (the student did not perform any portion of the examination), assisted (the student performed part of the examination), or independent (the student performed the entire examination). After the term ended, daily data entries from the cohort (n = 7) were manually exported from CompTracker and compiled to weekly totals of independent and total examinations in Excel (Microsoft Corporation, Redmond, WA). These weekly data were reviewed for outliers, which were removed and then analyzed by calculating the total cases logged and the independent cases logged (Table 2). The student participating in the pair scanning protocol logged the most total and independent cases over the rest of the class. We note that independently logged cases did not correlate with total cases

Figure 1. Action research inductive process.⁵



performed. Finally, a Kruskal-Wallis 1-way analysis of variance and Nemenyi post hoc test were then performed on the remaining data ($n = 5$) in SPSS (IBM Corporation, Armonk, NY).

The student and sonographer also submitted biweekly reports on their activities. In addition, the sonographer tracked the pair scanning protocols that were successful, the number and types of patients and examinations seen in the clinic, whether the clinic had any overtime, and the dates of successful summative competency testing using the Canadian Clinical Skills Assessment (Sonography Canada, Kemptonville, Ontario, Canada). This assessment tool evaluates 32 procedural steps as well as the student's diagnostic assessment of anatomy and abnormal findings. Students must achieve 14 required cases in the generalist specialty (abdomen, superficial structures, gynecology, first- and second-/third-trimester obstetrics, carotids, and lower venous extremities), which include normal and abnormal/technically difficult cases. These data were then compiled into a 16-week spreadsheet along with the student's log-book data. The research team gathered 3 months after the semester ended to review the spreadsheet week by week, and the sonographer and student reflected on the experience, highlighting salient details. The research lead took notes and finalized the pair scanning protocol.

Results

The Kruskal-Wallis test revealed a statistically significant difference in total independent logged cases between the

different students (sites) [$H_{(4)} = 36.297$; $P < .01$], with mean ranks of 58.91 for the pair scanning student, 37.66 for student 2, 31.31 for student 3, 56.62 for student 4, and 18.00 for student 5. Numbers of independent cases logged in all areas by the pair scanning student were significantly greater than those logged by other students except obstetric and gynecologic cases logged by student 4, who was placed in an obstetrics and gynecology rotation.

The biweekly reports indicated that the student moved from guided observation after 1 week and was participating fully at week 5. In week 3, the student completed an abdominal scan in 45 minutes; in week 6, she could perform the procedure in 34 minutes. The routine abdominal protocol at the site consists of the interrogation of 6 structures/organs of the abdominal cavity, including the right and left lower quadrants, and results in 50 images and 6 sets of measurements, providing no abnormality is seen. From week 4, the student performed 70% to 90% of the examinations booked at the clinic, with the sonographer only performing second-/third-trimester obstetric examinations.

During the research meeting, the sonographer did find the first 4 weeks of the experience to be exhausting, but at the end of week 3, the sonographer noted that time delays had decreased because the student's confidence level had increased and she was better at coordinating and synchronizing her activities to the sonographer's work flow. The sonographer noted that pair scanning provided her an opportunity to evaluate

Table 1. Action Research Design and Activities

Cycle	Description
Cycle 1	
Look	The typical workload of the sonographer was analyzed, including a half-day observation.
Think	The sonographer and research lead developed a 16-week protocol with strategies that split the workload between the sonographer and the student with the student increasing responsibilities over time.
Act	The student and the sonographer implemented, tested, and adjusted the protocol over the 16-week clinical placement. The student and the sonographer independently collected and submitted qualitative and quantitative data.
Cycle 2	
Look	The research lead compiled the qualitative and quantitative data from the project. Quantitative data were analyzed. The student was placed in a traditional placement and kept a weekly journal for 3 weeks for her to be able to compare and contrast this protocol with traditional training methods.
Think	The research team met to analyze the qualitative data, review the quantitative findings, and determine conclusions 3 months after data collection.
Act	This phase was deemed successful. A pair scanning protocol was developed and recommended for testing with the next cohort of students.

The pair scanning protocol was developed by using the action research inductive process of look-think-act,⁵ and a summary of these activities is outlined here.

her own practice ergonomically because the student mimicked her body mechanics. She was able to rest her shoulder, which had a repetitive strain injury.

The student preferred this method over traditional practice primarily because she enjoyed working consistently with one person and having constant feedback about her performance. The research team estimated that had the student continued with pair scanning, she would have completed all of her remaining competencies in lower venous, carotid, and second-/third-trimester obstetrics by week 22 (the clinical placement totals 32 weeks). This project received no complaints from patients, clinic staff, the manager, or the reporting physician.

The pair scanning technique effectively integrated the student sonographer into the workplace without impacting patient care and prepared the student sonographer for entry-level practice faster than traditional

practice. Therefore, a pair scanning framework was finalized (Table 3), and the research team recommended testing this framework for transferability.

Phase 2: Testing for Transferability

The second phase of this research project involved testing the pair scanning protocol developed in phase 1 for transferability using mixed methods.⁶ Mixed methods research allows for both quantitative and qualitative data to be collected and analyzed. Encouraged by the outcomes in phase 1, 6 preceptors and students were easily recruited to test the pair scanning technique, and written informed consent was obtained. Nine clinical sites/preceptors were in the control group. Data were again collected in the form of logbook numbers and weekly/biweekly reports. The weekly/biweekly reports were kept confidential from the program faculty, which

Table 2. Phase 1 Results: Total Versus Independent Cases Logged (n = 5)

Sonographer	Total Cases		Independent Cases		Independent/ Total, %
	Total	%	Total	%	
Pair scanning	635	28	300	46	47
Student 2	525	23	80	12	15
Student 3	422	19	70	11	17
Student 4	380	17	191	29	50
Student 5	274	12	10	2	4
Total	2236		651		29
Mean	447	20	130	20	

The total and independent cases logged by the pair scanning student were compared with the total and independent cases logged by the cohort in traditional placements (control group).

Table 3. Overview of the Pair-Scanning Protocol

Step	Description
Orientation	During the first week(s), the student is expected to learn all of the equipment, the physical space, and work flow of the department. The student observes a few of the booked cases and assists with a maximum of 1 case per day.
Guided observation	The student helps get the patients into/out of the room and completes the technical impression while observing the sonographer perform the case. After the case, the student can complete the technical impression, observing alternate cases. The sonographer reviews and corrects the technical impression before it is submitted.
Pair scanning	The student is given 5 minutes to scan the first part of the examination. The sonographer watches and helps the student and then finishes the examination once the student's time has run out. The student is given more time as her abilities increase until the student is able to perform the examination accurately within the required time frame.
Independent scanning	During the independent scanning, the guided observation roles are reversed. The sonographer helps get the patients into/out of the room as required and completes the technical impression while the student scans.

This pair scanning protocol was developed in phase 1 and tested for transferability in phase 2.

allowed both the pair scanning and control group sites to receive the same support from the program.

Methods

Once the semester was completed, logged cases were again collected from CompTracker and analyzed in Excel by the same method as in phase 1, but instead, the data were averaged across the pair scanning group ($n = 6$) and the control group ($n = 9$) after outliers were removed. With only 8 independent groups, the Mann-Whitney U test was performed in SPSS to determine whether there were significant differences in total and independent logged cases between the pair scanning and control groups. Finally, a graphic analysis was performed by graphing the average logged cases (total and independent) on a week-by-week basis to compare student progress over the 16-week term.

The reports submitted by preceptors and students were compiled after the students graduated, blinded, and analyzed by content analysis.⁷ We looked for content that illustrated 2 concepts: (1) compliance with the pair scanning protocol; and (2) whether the experience was positive or negative.

Results

The pair scanning group ($n = 5$) logged more total cases, and the control group ($n = 9$) logged more independent cases (Table 4). The mean numbers of total and independent cases logged by the pair scanning group were higher than those logged by the control group. We note again that logged independent cases did not correlate with total cases performed. Logged total cases were not statistically significantly different between the pair scanning group (mean rank, 8.70) and the control group (mean rank, 6.83; $U = 16.500$; $z = -0.801$; $P = .438$). Logged independent cases were also not statistically significantly different between the pair scanning group (mean rank, 6.80) and the control group (mean rank, 7.89; $U = 26.000$; $z = 0.467$; $P = .699$).

The total and independent cases logged were averaged across the pair scanning and control groups and graphed on a week-by-week basis (Figure 2). Across the 16 weeks, both groups logged cases in a similar pattern, except that the pair scanning group maintained a more consistent number of total cases.

Content analysis of the reports was performed manually.⁷ The content was coded for emotive language (eg, excited, frustrated, tiring, or great), and the number of positive and negative statements were then totaled for each week with repetitive statements on a single topic only counted as a single statement. We identified emotive comments in an average of 77% of preceptor reports and 80% of student reports, with preceptor comments being 47% positive and student comments being 52% positive. On a weekly basis, the preceptor and student emotive comments were congruent (equally positive or negative), with the students being more emotive in general. These emotive comments were made in response to the pair scanning protocol, the preceptor experience in general, and other factors. For most weeks, the positive comments were better than or equal to the negative comments, except in weeks 7, 8, and 10. In these 3 submissions, the negative comments outweighed the positive because remediation efforts with struggling students were intensified.

Descriptions of the student-preceptor activities were then compiled and analyzed for compliance to the pair scanning procedure. We analyzed 10 respondents and found comments about the pair scanning protocol in 6.8 of respondents' comments, with preceptors and students featured almost equally (preceptors, 3.5; students, 3.7). We looked for self-declaration that the pair scanning protocol was being adhered to or not as well as indicators such as when and how the students were performing examinations in relation to their preceptor(s). The pair scanning protocol was adhered to 53% of the time across the 16 weeks of the clinical placement,

Table 4. Phase 2 Results: Total Versus Independent Cases Logged

Group	n	Total Cases			Independent Cases			Independent/ Total, %
		Total	Range	Median	Total	Range	Median	
Pair scanning	5	602	335-854	565	111	27-171	143	18
Control	9	492	362-692	479	134	22-242	132	27
Total	14	1094		456	245		137	22

The average of total and independent cases logged by the pair scanning group was compared with the average of total and independent cases logged by the cohort in traditional placements (control group).

ranging from 25% to 70% on a weekly basis. Weeks 2 and 8 recorded the lowest levels of compliance. The lack of compliance in week 2 can be attributed to overwhelming pressures to skip the orientation and move directly to the performance of patient examinations. The lack of compliance in week 8 can be attributed to sonographers finding alternative strategies to incorporate the student, modifying the protocol for remediation, and transitioning out of the protocol when the student was deemed competent.

In general, the students were very keen to begin patient examination activities during their orientation period. This pressure to avoid the boring (eg, learning bookings, the picture archiving and communication system, and the ultrasound unit) and participate in the interesting (performing patient examinations) resulted in some lapses in the purpose of the orientation period. (Note: comments included here have been corrected for minor errors in spelling and grammar.)

“The first week was very exciting at times and a little boring at times. Observing and scanning was fun, but learning the picture archiving and

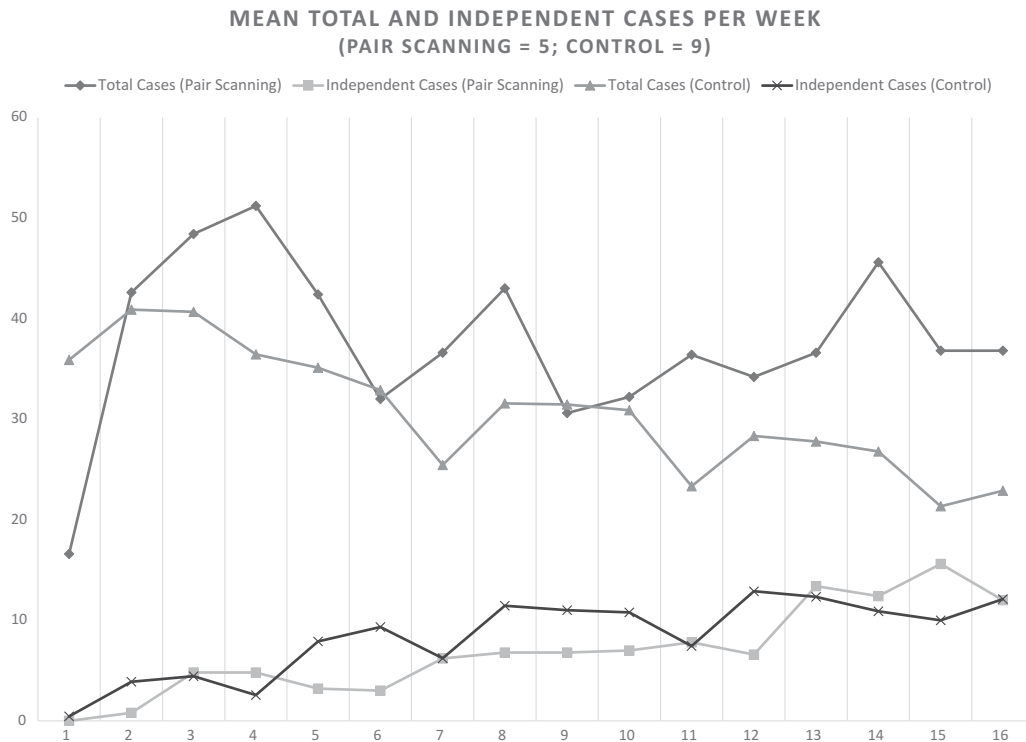
communication system and paperwork was boring.” (student 1)

“I am slowly getting the hang of using the picture archiving and communication and ultrasound systems and am confident I will know how to use them fully by the end of next week. I think the lack of scanning has prevented me from accomplishing this task this week.” (student 2)

“I attempted to follow the protocol, but the student was not very receptive to learning the paperwork and computer work that goes along with the job. (The student’s) only interest was to be in the room scanning.” (preceptor 3)

Students were permitted to observe more cases than expected and perform patient examinations. In 3 of 5 sites, the students reported that they performed their first scan, and 1 student indicated observing approximately 13 cases per day. The orientation period provides a space for the student to become accustomed to the work flow of the department as well as learn the equipment operations and protocols before jumping into the regular workload. The orientation also facilitates an easing in of the student into the preceptor’s workday

Figure 2. Phase 2 results: total and independent cases logged averaged across the pair scanning and control groups.



because, generally, preceptors found having a student shadowing them tiring.

“The hardest thing this week was adjusting to having a student with me.” (preceptor 2)

Adherence to the pair scanning protocol was demonstrated by allowing the student to scan at the beginning of the procedure with the preceptor completing the examination as time ran out. The student would be allowed to examine the patient for 5 minutes before the sonographer took over the examination. As the student’s examination skills increased, the student would be allowed more time until able to complete the examination in the regular booking time.

“I scan through as much as I can for about half of the allotted exam time, and my preceptor takes over at the end to finish the exam and sweep through, making sure I didn’t miss anything.” (student 1)

Nonadherence to the pair scanning protocol was demonstrated by adopting alternative techniques that may/may not successfully integrate the student. For example, preceptors would create time at the end of the case for the student to examine the patient, or they would alternate cases so the student would have time to complete a full examination.

“If time permits, (my student) completes the scan.” (preceptor 2)

“Now, I scan the entire exam in whatever time it takes me. (My preceptor) has me observe the next patient and do the paperwork, while (my preceptor) quickly scans and catches up on time.” (student 4)

The low compliance in week 8 correlated with some students reaching a satisfactory level of performance, and the pair scanning protocol was stopped.

“We stopped using the pair scanning when I was comfortable, and my skill level was adequate.” (student 5)

“I only have to go in and check the case and don’t usually have to take any images.” (preceptor 5)

Although these deviations appear to have little impact on the average or strong student, allowing students to progress to patient examinations when they did not

demonstrate sufficient abilities with the equipment and protocols resulted in notable issues later in the term, as illustrated by these preceptor comments from week 7:

“My week 7 was extremely frustrating and exhausting. The student is still unable to follow an abdomen protocol for our department.” (preceptor 3)

“The same issues are still present with little progress. The student knows the protocols but is not yet comfortable with the machine.” (preceptor 4)

Although the overall positive and negative comments over the course of the term were mixed, the comments in week 16, at the end of the research project, were generally positive. The only negative issue brought forward was that the tight booking schedule of these departments did not facilitate the administration of Sonography Canada’s summative competency testing with the Canadian Clinical Skills Assessment.

“My experience following the pair scanning protocol was for the most part very enjoyable and successful. It was very easy to begin scanning with this protocol set. I began scanning most exams and would get as much as I could done, and my preceptor took over when needed due to time and or difficulty. We used this technique for most of the semester; as I got faster I would scan a full exam and then the preceptor would scan the next exam to make up for any time lost and put us ahead of time; that way I could scan the following exam. I thought it was very easy to use and optimized my ability to scan.” (student 1)

“Pair scanning was a very valuable tool for both the student and me. Without the constant daily repetition of pair scanning for each case, the student would not have progressed at all. Focusing on only one small area of interest at a time was the key to progress, as was repetition.” (preceptor 4)

Discussion

We demonstrated that the pair scanning protocol can integrate the student sonographer into the ultrasound department without impacting patient volumes. Our results suggest that the pair scanning protocol is equal to, and has the potential to be better than, the traditional precepting technique of providing additional examination time for the sonography student. It also benefits

patients who no longer need to have their examination time extended and undergo two separate sonographic examinations for student training. The pair scanning protocol is an effective protocol for supporting sonographers in their preceptor responsibilities.

The reports submitted demonstrated mixed feelings from both students and preceptors. However, many comments were related to the student training experience in general.^{8–10} The protocol worked well for learning, but there was insufficient time for competency testing. We found that the students overwhelmingly preferred the pair scanning protocol to traditional methods. We believe that this process better facilitates knowledge transfer from the sonographer to the student (which is the goal of the preceptor model), and the time constraints positively activate the student. It also supports the preceptor with time management.

The pair scanning protocol appeared challenging to adopt consistently, as the steps were rushed, and the protocol was modified or dropped once students achieved a satisfactory level of performance. If the designated preceptor was absent, the student worked with the other sonographers, either observing/assisting without performing patient examinations or reverting to traditional preceptor techniques. However, despite the inconsistencies of adoption, all students in the pair scanning group were integrated into the sonography work flow without impacting patient volumes. Further research is required to determine whether these noncompliant strategies should be incorporated into the pair scanning protocol.

We recommend that preceptor training with the protocol should be required, and it needs to emphasize the rationale behind the steps, appropriate modifications of the protocol, and how and when to transition out of the training protocol to indirect supervision. The key points in this training include accepting that the student does not have to participate in every case, and the student has to earn the right to be allowed to progress. Activities and strategies to help sonographers manage student expectations during the orientation and guided observation phases and maintain their own engagement during the independent scanning phase need further development. Other strategies would be to train students with the protocol before their clinical placements and to coordinate faculty visits/calls to the site during the first 2 weeks of the placement to reinforce the protocol. We recommend the addition of a final step to the pair scanning protocol that facilitates transition out of the protocol to indirect supervision:

Indirect Supervision: Once the student is able to perform all aspects of the examination within the normal booking times, summative competency testing can be administered. If the student passes the competency, the student can be left to examine the patient with the preceptor supervising from outside the room.

An unexpected finding of this research suggests that this protocol provides the student with more consistent volumes of patient examinations. We speculate that the pair scanning protocol provides a method for consistent engagement of the student in the daily workload, but further investigation is required.

In conclusion, this research project challenges the paradigm that students can only develop their sonography practice through special accommodations that impact patient volumes and revenue generation. This paradigm also contributes to the current practice in Canada of sonographers and their employers limiting and not participating in student placements. The sonography profession itself sets the standards for entering the profession, and the preferred standard is the demonstration of competence in the clinical setting. We hope that this research project will enable more sonographers to participate fully in student training. If the profession continues to opt out of student placements, then perhaps the question is not whether sonographers can integrate students into the workload without impacting patient care but instead whether the preferred standard of clinical placements for competency development is viable.

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