Reviewer’s report

Title: An Economical Strategy for Early Medical Education in Ultrasound

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Reviewer: David Musick

Reviewer's report:
This paper describes a brief educational intervention designed to increase the skills of medical students in ultrasound technology. The topic is timely and important. However, the paper suffers from a number of flaws that require revision prior to its possible acceptance for publication. These flaws are addressed as follows:

1. The paper suffers from a large number of assertions that are not supported by either references or the data described. I will list these in detail below. But unproven assertions are generally not acceptable in a manuscript. In the discussion section, authors may introduce questions or other comments that are designed to stimulate further thinking about the topic by readers.

2. Both in the abstract and the text, the authors assert that the teaching workshop on ultrasound is "fiscally economical." This is an unsupported assertion. The authors do not report the cost of the ultrasound equipment, space used for the training or faculty time; in fact, the only data reported about any aspect of the training cost is the cost of transmission gel. I do not believe the authors have presented any real data on cost, either of their own course or in comparison to other similar courses or curricula. Therefore, I recommend that any reference to the cost of the training being more economical than other courses or ultrasound curricula be eliminated from the paper.

3. Page 1, abstract, background, 2nd sentence: authors state that many schools are hesitant to include formal ultrasound training as part of their curricula; this assertion needs at least one reference in support of the statement made.
4. Page 1, abstract, methods, line 21: suggest revising first sentence to state "Twenty-eight first year medical students volunteered to attend extra-curricular ultrasound training sessions covering topics….."

5. Page 1, abstract, results, line 39: the sentence states that "moreover, following analysis the p value for all test was found to be <0.0001." This statement is also made on line 29 of page 7. The meaning of this statement is unclear.

6. Page 2, line 36: insert the word "the" between the words "paved" and "way."

7. Page 2, line 56: "and more are sure to come in the future as new applications for ultrasound technology are developed." This is an assertion and should be removed, as it is not supported by any data or references.

8. Page 3, line 14: statement is made that some medical schools are "enabling their students to be leaders and teachers of ultrasound in both their clerkships and residencies." Although references are provided, I question the validity of this statement. Do these schools really allow medical students to teach residents about ultrasound techniques? Or rather is this the responsibility of the faculty? In the sentence prior to this one, the schools that have "integrated ultrasound into all four years of their medical training" are described as "pioneering medical schools." However, the authors have not provided sufficient information to establish that the schools mentioned have, in fact, provided ultrasound training in all 4 years of their respective curricula; nor do they provide any particular support for labeling such schools as "pioneering." This is an assertion and should be removed in favor of simply describing what the schools in question actually do; readers can/should decide for themselves whether such schools are "pioneers."

9. Page 3, lines 22-31: this section reads awkwardly and should be revised. The authors appear to be attempting a description of a study associated with reference #17. The wording used is highly similar to the abstract for reference #17. More detail is needed about what that study actually did and the conclusions reached by the authors of that study.

10. Page 3, line 42: another unsupported assertion appears here, as the authors state that "matters have exponentially worsened in this regard." If this assertion is supported in the literature, please cite a reference. Or, if it is intended that reference #18 supports a "worsening" of the problem of the over-crowded medical school curriculum, perhaps an actual quotation from that reference would be helpful here.
11. Page 3, line 56: another assertion appears here, "these early courses in ultrasound have been proven to increase students' competence and confidence in using ultrasound." Please support this statement with at least one reference.

12. First paragraph, page 4, line 18, the study design section: second sentence refers to the amount of instruction given to students as "an average of 8 hours teaching time per week." The paper should report actual amount of instructional time, not an average.

13. Page 4, line 39: should state "covered", not "cover."

14. Page 4, line 51, suggest inserting word "previously" between words "had" and "spent."

15. Page 4, line 55: suggest the sentence should being with "The curriculum" instead of "This study."

16. Pages 5 and 6: the relationship between the modules listed in Table 1 and the list of "11 commonly used sonographic views covered in this training program" is not clear. I'm not sure that both of these are necessary. Suggest combining the specific tasks with Table 1, making clear which of the specific tasks were covered during which of the six teaching sessions.

17. Page 5, lines 37-59: this description of the training sessions is unclear. For example, the third sentence states that each of the six sessions began with verbal explanation of anatomy and probe handling techniques. However, two sentences later the statement is made that "participants were largely allowed to learn tactile skill and probe handling by trial and error." Then, the first sentence after the list of 11 tasks on page 6 states that" every effort was made to minimize the time spent on instructor demonstration." It is further then stated that the instructor carefully evaluated each student in real time during every scan. This section presents a confusing picture of what actually took place during the six sessions.

18. Related to #17 above, it is also stated on page 5, line 52 that each pair of students was given 15 minutes to attempt to acquire diagnostic quality images of "one or two" of the 11 tasks commonly used in sonography. Which was it - one or two? This statement is imprecise. The section should state exactly what each pair of students did, or was expected to do, and whether or not they actually did it.

19. Page 7, line 34: do not use abbreviations in regard to statistical analysis; spell out "min" and "max" and make clear what is meant by these terms, and why the decision was made to report data for these 3 terms (median, min, max).
20. Table 2 should be revised to show each item on the pre- and post-surveys along with item means, standard deviations and significance. This should be done in lieu of showing tables 3-6, which will be unnecessary after revising table 2 as recommended.

21. Page 9, lines 15-30: results in 3 different sentences are reported as being "on average." Data should not be reported in this manner. Please provide the actual data/numbers as opposed to stating "on average."

22. Page 9, lines 33-45: it would appear that up to 6 students had previous experience in operating ultrasound equipment. This raises the issue of whether/how the results for those 6 students might have been different, when compared with the remaining students. Did the results of the survey differ for those 6 students, compared to the rest of the students? The authors should address this important question, as it may shed additional light on their results. The final sentence in this section again states that students did not receive any additional training or practice outside of the six learning sessions; but how can the authors know this for certain? For example, could a student who was scheduled to undergo the training during session 4 have done some advanced reading on ultrasound techniques, or even practiced on his/her own ahead of time? This is a potential limitation of the study and should be acknowledged in the discussion section.

23. Pages 9-10, Instructor scoring section: it is unclear exactly what each student was expected to do during their training sessions. I believe that each student was ultimately asked to perform all 11 tasks, but I could not tell for certain. It is stated that four students were scored lower "when attempting 1-2 of the 11 total tasks they were each asked to perform during our training program." Again, the authors should not report data in this imprecise manner. Rather, please state specifically what each student was expected to do, how many failed to achieve a given score level, and on which tasks they were successful and unsuccessful. The final sentence does state that there were 308 tasks attempted collectively by all 28 participants; if we multiply 28 students by 11 tasks, we do indeed get a total of 308. It would also be interesting to know which tasks students had trouble with; please identify the 7 tasks for which students received scores below two.

24. Page 10, discussion section, lines 33-49: two issues here. First, it is stated that the training strategy could accommodate up to 30 students. This number differs from the total of 28 students who were study subjects; suggest removing this mention of 30 students, as it is
unnecessary and may confuse the reader. Second, it is stated that the provided training resulted in medical students "who are competent with the basics of ultrasound use across multiple clinical disciplines." The use of the word "competent" here is problematic. This study was not designed to test actual competence, but rather to determine whether students self-reported an increase in their own confidence levels with ultrasound-associated tasks. The minimal amount of instruction provided, and the minimal amount of actual assessment of student skills, does not support this over-reaching statement about student "competence." To determine their actual competence would require a longitudinal study design featuring more robust methods of assessment.

25. Page 11, line 9: the sentence beginning with "Therefore" and claiming that subjective self-reports by students accurately reflect skill level is not needed, is an unsupported assertion and should be removed. There is a large body of literature on self-reporting of skills that demonstrates the folly of this statement; people are notoriously inaccurate when undertaking self-reporting of both knowledge and skills.

26. Page 11, lines 19-27: here it is stated that "half of the total unsuccessful attempts" were "directly the fault of the participant due to poor tactile technique." To what does this refer? Which attempts? Does this refer to "half" of the 7 ultrasound tasks that students did not perform correctly? Further, stating that the "fault" for these unsuccessful tasks were due to poor student technique seems to be in contradiction to what was stated earlier in the paper about the minimal amount of teaching provided by the instructor. Perhaps no explanation is needed as to why 7 tasks were not completed successfully; this really doesn't add to the findings of the study in any meaningful way.

27. Page 11, lines 38-51: the authors appear to introduce new results here in the discussion section. Data is presented here pertaining to students' agreement with various aspects of the training (e.g., it was enjoyable, beneficial, effectively taught). When were these questions asked of students? They were not part of the questions shown in Table 2. Results should be placed in the results section, with accompanying detail; and not introduced initially in the discussion section.

28. Page 12, lines 14-19: statement is made that the authors "were also able to conclude that first-year medical students already possessed sufficient context to understand the anatomy and basic clinical significance of the target views they attained." The meaning of this
sentence is unclear; what is meant by "sufficient context" here? And, how are the authors able to reach this conclusion? Again, it does not appear to be supported by any data mentioned in the paper. Was the conclusion reached based on themes of students' narrative comments?

29. Page 12, study limitations: the authors correctly point out the issue of selection bias as a limitation. However, there is one further major limitation that the authors do not mention here. The use of a study design featuring pre-test-intervention-immediate post-test is not a particularly strong method of actually determining what a learner gains from a given teaching session. A stronger methodology would involve pre-test-intervention-multiple post-tests over time, so that actual retention of knowledge/skill could be measured. There is a large body of literature available around this design issue. Suffice to say that the study design used here does not lend support to reaching conclusions about whether these students would enter the clinical phase of their medical school training with a strong knowledge base and skill set pertaining to ultrasound. It would have been interesting to test this same group of students again, for example, immediately prior to their entry into their clerkships and see how much of the knowledge and skills they still had as a result of the study intervention which took place during their first year of medical school. If the literature is to be believed, the answer is likely "not much." The authors do state in their "future directions" section on page 13 that they intend to undertake a "skill retention study" along these lines.

30. Page 12, line 51: word should be "program" not "programs."

31. Page 13, conclusion section: again, similar statements made that were previously addressed above. Namely, the use of the term "average of 8 hours per week" is problematic; reference to the cost of the training without sufficient mention of data about cost; mention of the "brevity of each session and convenience of the scheduling system," but without any accompanying explanation of the details of the sessions and how they were actually scheduled.

Are the methods appropriate and well described?
If not, please specify what is required in your comments to the authors.

Yes
Does the work include the necessary controls?
If not, please specify which controls are required in your comments to the authors.
No

Are the conclusions drawn adequately supported by the data shown?
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No

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