

Outcomes and lessons learned while upscaling a successful trauma ultrasound curriculum quality improvement project



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Trauma US: The eFAST¹ exam (extended focused assessment with sonography for trauma) is a well utilized modality for rapidly assessing and determining management of emergent patients.

Background: Despite the modality's ubiquity, as of 2016 only 28% of medical schools in the United States had a formal US curriculum.²

Local problem: New interns described limited experience and confidence with US prior their ER and Trauma rotations.

Intended improvement: Implement a novel eFAST US curriculum.

Study questions:

- To what degree could resident competence and confidence be improved by a novel curriculum?
- How could a successful curriculum be upscaled without losing efficacy?

1. Husain, L. F., Hagopian, L., Wayman, D., Baker, W. E., & Carmody, K. A. (2012). Sonographic diagnosis of pneumothorax. *Journal of Emergencies, Trauma, and Shock*, 5(1), 76.
2. Dinh, Vi Am, et al. "Integration of ultrasound in medical education at United States medical schools: a national survey of directors' experiences." *Journal of Ultrasound in Medicine* 35.2 (2016): 413-419.

Methods



Setting:

Tripler Army Medical Center, a military tertiary care hospital serving 260,000 soldiers, family members and retirees.

- 97 resident learners included, representing a diversity of medical schools including USU, domestic MD/DO programs and international schools.
- Varying specialties were represented:

Transition year (TY) interns	Family medicine	Pediatrics
Internal medicine (IM)	General surgery	Dermatology
OBGYN	Radiology	ENT
OMFS	Orthopedics	Urology
Psychiatry		



Photo: Andy Stenz

Plan:

1. Create a quality improvement (QI) project of resident curriculum covering US basics and trauma topics.
2. Utilize pre and post-tests to assess learning and confidence.
3. Implement **Plan/Do/Study/Act**. Three implementations were completed involving larger groups:
1st with transition year interns, 2nd with a medicine cohort, and 3rd with all new hospital interns from the following year at once.



Methods: Study Design

Curriculum Sequence

1. Pre-test
2. Lecture
3. eFAST Demonstration
4. Hands-on tutorials
5. Post-test

Length: 2 hours

Educational content

US physics, probes, knobology, US imaging planes and anatomic orientation, imaging anatomy, normal versus abnormal findings, and trauma concepts.

Didactic Slide

Ultrasound

<u>1. U/S</u> Physics Probes Enhancement	<u>2. eFAST</u> Overview Images	<u>3. Trauma Survey</u> Primary Secondary Script	<u>4. GCS</u>
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Sound is mechanical energy

Causes things to compress and expand
Propagates as a compressive wave

↑Density \leftrightarrow [Wave travels further]
[More energy needed to create a wave]

Density affects how sound travels



Interfaces cause sound reflection

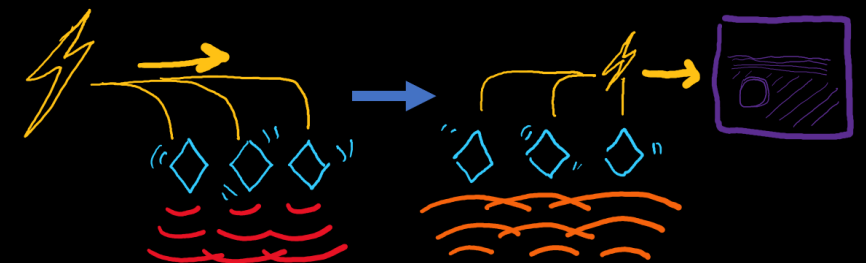


Nomenclature

Reflected energy = "Echo"
↑Reflections = ↑Echos = "Echogenic"

"Squeezing" Crystals

Piezoelectric Crystals
Piezein: Greek, to squeeze or press



Methods: Study Design

Trauma Survey Skills, Post-Assessment

1. List the (5) organs examined during eFAST:

100% confident
 75% confident
 25% confident
 Guessed

1) _____
 2) _____
 3) _____
 4) _____
 5) _____

2. Describe how an ultrasound probe works:

100% confident
 75% confident
 25% confident
 Guessed

3. How does density of an object affect sound?

100% confident
 75% confident
 25% confident
 Guessed

A) ↑Density change across an interface = brighter signal
 B) ↑Density change across an interface = dimmer signal
 C) Denser structures = ↑sound scatter
 D) Less dense structures = ↓sound scatter

4. Which of the following is a true statement?

100% confident
 75% confident
 25% confident
 Guessed

A) Phased arrays have crystals that vibrate simultaneously.
 B) Linear probes image deep structures well.
 C) Phased arrays have crystals that vibrate at different times.
 D) Linear probes have crystals that vibrate at different times.

5. Choose the correct statement:

100% confident
 75% confident
 25% confident
 Guessed

A) Linear probes create peripheral image field distortion.

I can perform an eFAST exam:

Disagree Moderately disagree Neutral Moderately agree Agree

I have enough confidence in my eFAST exam to identify a critical injury and tell my attending:

Disagree Moderately disagree Neutral Moderately agree Agree

I can perform a complete Primary and Secondary trauma survey:

Disagree Moderately disagree Neutral Moderately agree Agree

I can correctly describe a patient's GCS status:

Disagree Moderately disagree Neutral Moderately agree Agree

Test

Confidence Survey

Testing

- Assessed 3 domains: Facts, Images, and Confidence.
- Factual questions:** 14 multiple choice, regarding probe characteristics, US generation, eFAST, management of eFAST findings, Glasgow Coma Score, and others.
- Imaging:** 18 questions. Anatomic identification, Normal vs Abnormal exams.
- Confidence:** 10 questions based on a 5-point Likert-style scale.

- Post-tests utilized 87.5% new factual and imaging questions, with all new images provided.
- The remaining repeated questions stressed core competencies.
- Confidence questions remained unchanged pre and post to allow direct comparisons.

Methods: Assessment

Tests

Each learner received a packet consisting of both pre and post-tests.
Each packet represented one data point.

Anonymity

Learners identified their packets by drawing a small unique sketch in the upper corner.

Data input

Each packet was given an identification number, and the entries uploaded to an online web form.
The data was then compiled as a report for analysis.

Statistical analysis

Analysis was completed with SAS software and included descriptive tallies, Wilcoxon and paired t-tests.

Results: 1st Iteration with Transition Year Interns

Details

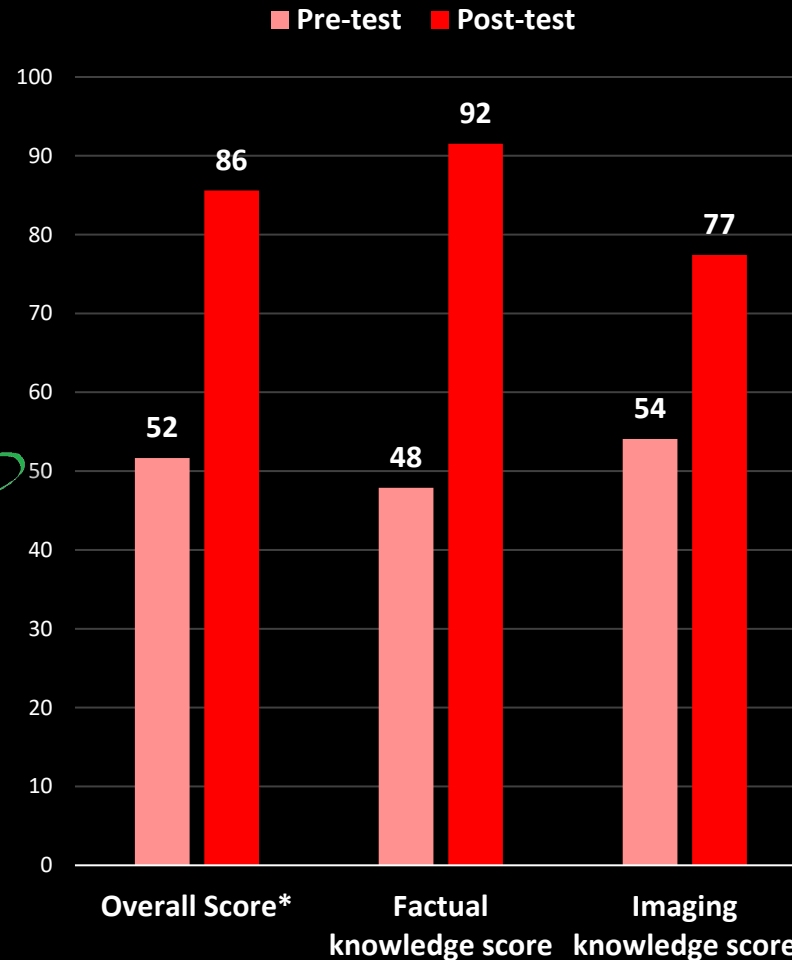
- Single instructor
- 15 learners

Lessons Learned[†]

15 learners is the maximum per demonstration station to ensure decreased wait time.

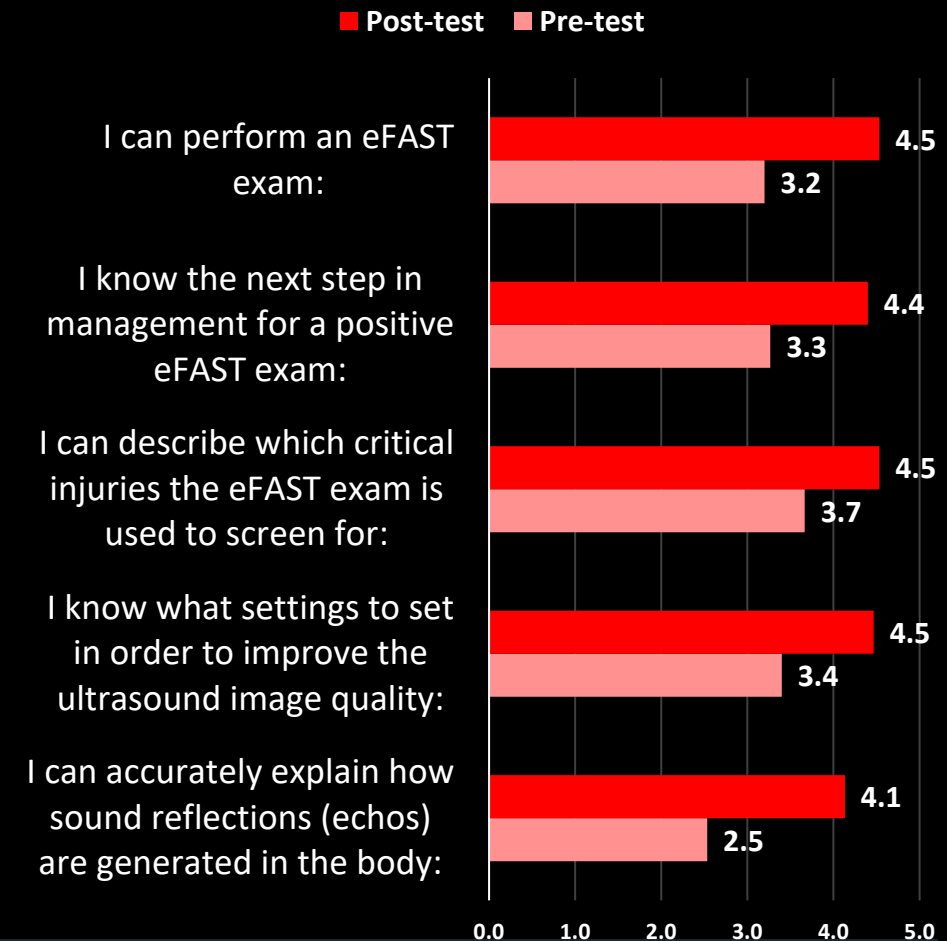
[†]These were conclusions based on experience, and were not studied in isolation nor specifically measured for significance.

Percent Correct of Pre and Post-tests for TY Learners



*Overall Score includes other tested subjects beyond factual and imaging knowledge scores.

Selected Pre and Post intervention Confidence Results of TY Learners



All results are statistically significant with P-values <0.05.

Results: 2nd Iteration w/Internal Medicine Residents

Details

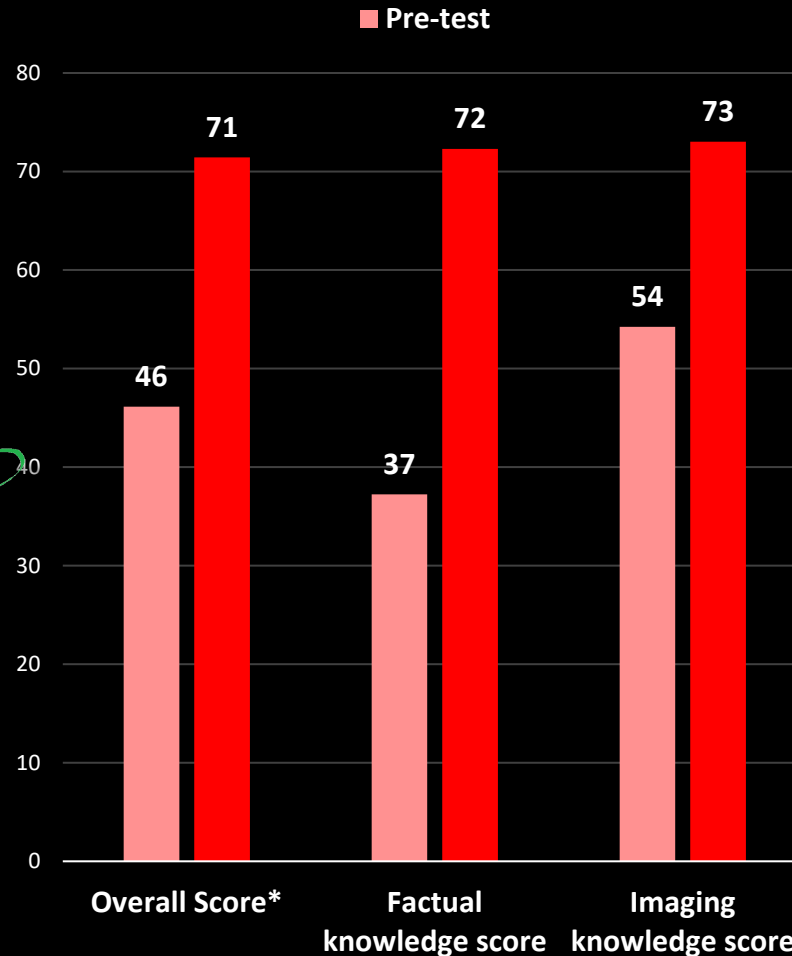
- 2 instructors
- 22 learners

Lessons Learned[†]

Learner engagement was increased by utilizing simple descriptions and stressing anatomic relationships.

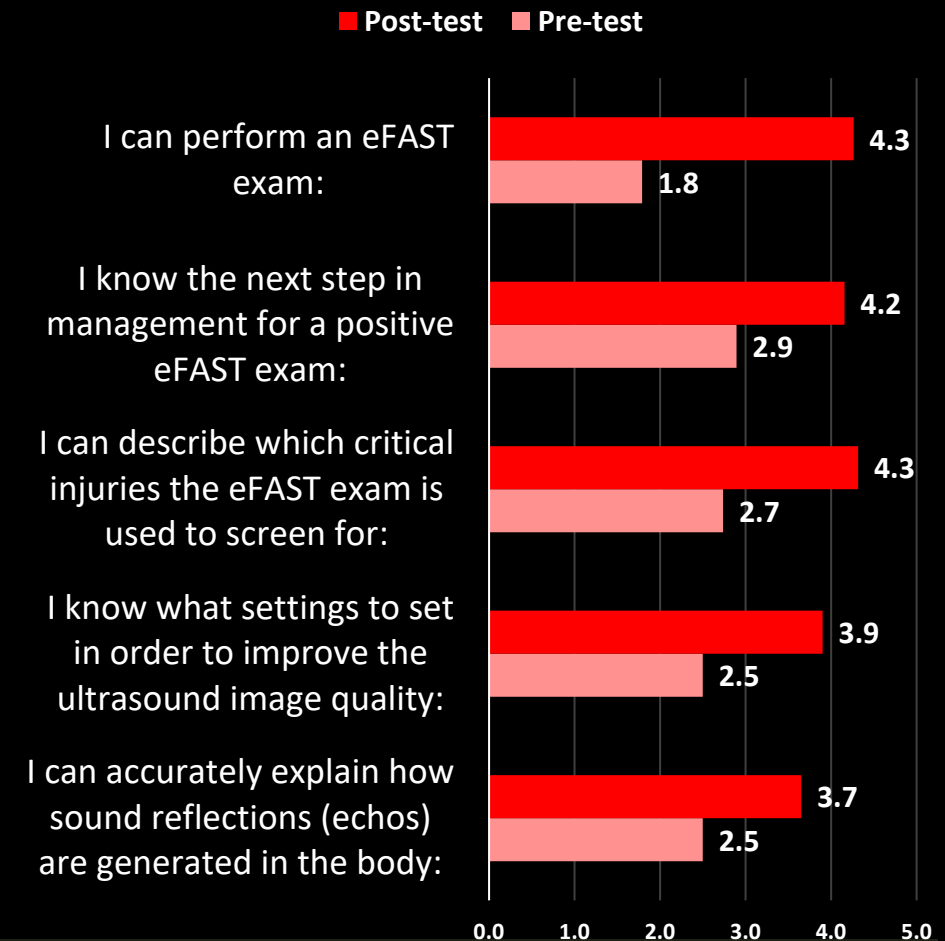
[†]These were conclusions based on experience, and were not studied in isolation nor specifically measured for significance.

Percent Correct of Pre and Post-tests for IM Learners



*Overall Score includes other tested subjects beyond factual and imaging knowledge scores.

Selected Pre and Post intervention Confidence Results of IM Learners



All results are statistically significant with P-values <0.05.

Results: 3rd Iteration w/All New Hospital Interns

Details

- 7 instructors
- 57 learners

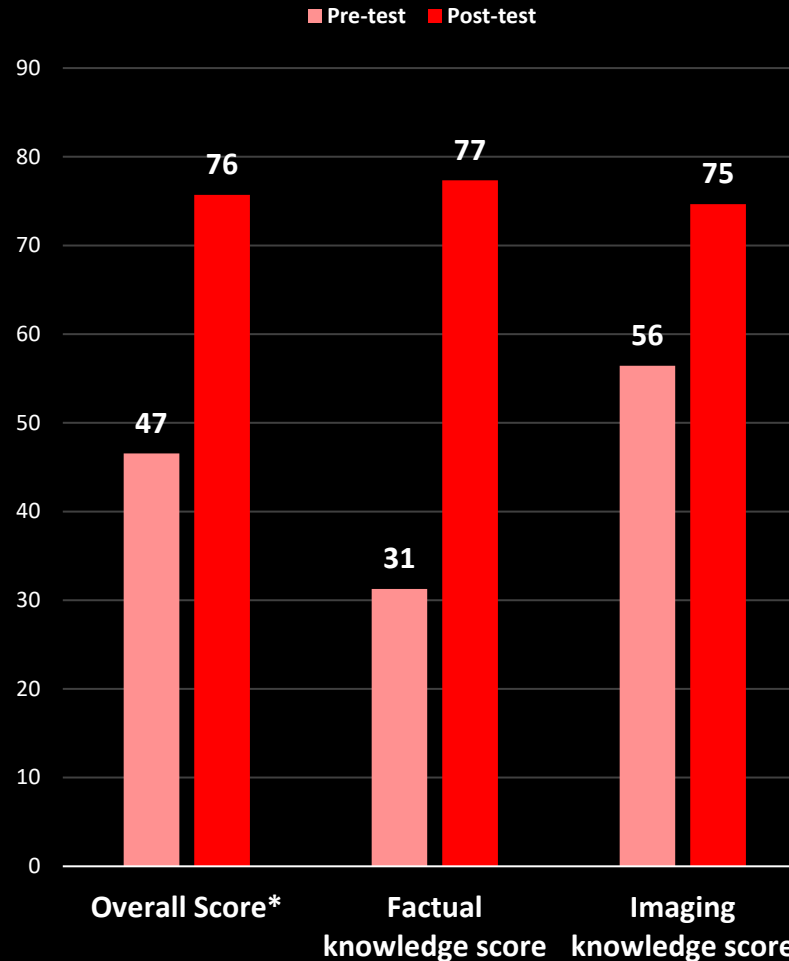
Lessons Learned[†]

- Maintain pace of demonstration by assigning learners. Don't wait for volunteers.
- Teach a method to localize anatomy by US. Decreases time spent surveying.
- Promote engagement by giving live challenges.



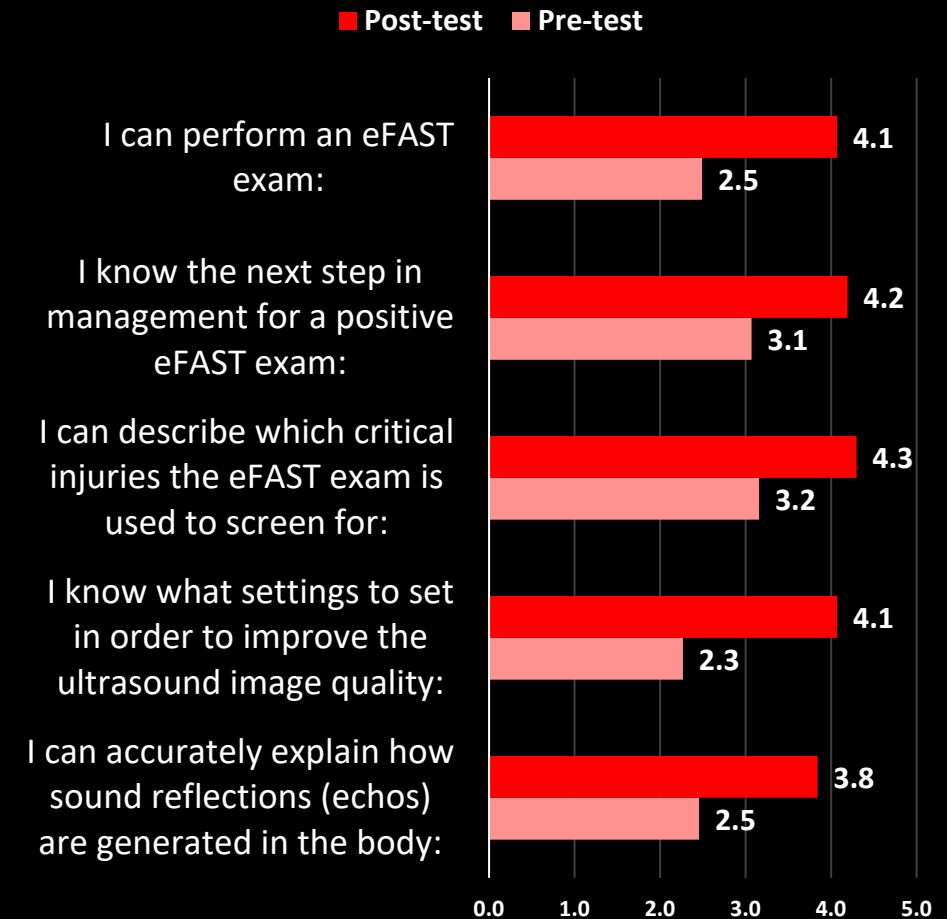
[†]These are conclusions based on experience and were not studied in isolation or specifically measured for significance.

Percent Correct of Pre and Post-tests for All New Interns



*Overall Score includes other tested subjects beyond factual and imaging knowledge scores.

Selected Pre and Post intervention Confidence Results of All New Interns



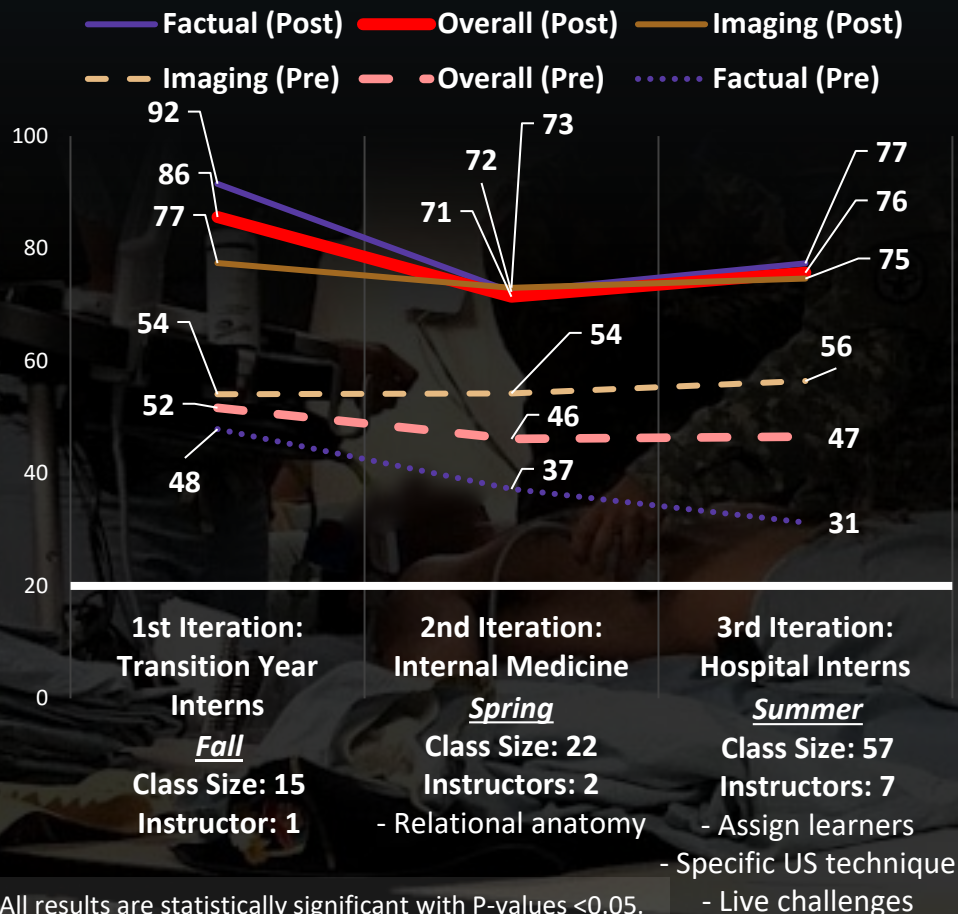
All results are statistically significant with P-values <0.05.

Summary Results

Results for all 97 learners*:

- Overall Scores: 48 → 78%.
- Confidence at performing eFAST: 2.5 → 4.2.

Run Chart of Curriculum Iterations with Class Size, Testing Scores, and Instruction Enhancements*



Conclusion

While not specifically measured for effect, the following principles were learned from implementation:

- **Maintain pace by assigning an order of participation:** 1 instructor could lead 15 learners in a 60-minute hands-on demonstration.
- **Describing relational anatomy increased learner engagement:** “Is there free fluid within Morrison’s pouch?” was not as effective as describing the anatomy, “We expect to see the liver and kidney nearly touching and separated by echogenic pararenal fat. If there’s a dark grey gap between the organs, we must consider hemorrhage.”
- **A specific US technique decreased hesitation with the probe:** Learners told to make large sweeps first, then once the anatomy looks familiar, stop probe motion and make tiny angulations.
- **Spontaneous challenges encouraged problem solving:** Challenges included: 1) Correcting abnormal imaging settings, 2) Probe orientation was flipped, 3) Learners encourage to scan others to observe anatomic variation.

Trauma US is an important modality in the emergent setting, and the results of this project demonstrate that a small group curriculum may be upscaled through iterative improvement, while maintaining efficacy.