A Blended Learning Approach to Ultrasound Training Using SonoSim®
Clinical Ultrasound

The use of bedside ultrasound in patient care continues to grow at a rapid pace. Correspondingly, bedside ultrasound is assuming a more prominent role in both graduate (GME) and undergraduate medical education (UME) (Bahner 2013 et al., Boulger et al., Steinmetz et al.). Bedside ultrasound is progressively viewed as a highly valuable adjunct to the standard patient history and physical examination (Butter et al.). Fox et al. insightfully built upon the original Stanford 25 physical examination (Kugler and Verghese). Fox and colleagues described ultrasonographic examinations that directly complement standard physical examination techniques and named this augmented patient exam the UCI 30 (Fox et al.).

Medical Student Ultrasound

Clinicians with a mastery of basic physical examination skills, coupled with bedside ultrasound skills, are uniquely empowered to better define patient anatomy and associated pathologic conditions (Afonso et al., Angtuaco et al., Mouratev et al.). As an example, Kobal et al. demonstrated how well a cohort of first-year medical students with 18 hours of ultrasound training compared to a group of seasoned cardiologists using standard physical examination techniques, in detecting cardiovascular abnormalities (Kobal et al.). The medical students correctly identified 75% (180 of 239) of pathologic conditions, while the cardiologists identified only 49% (116 of 239) (p <0.001).

Integration of ultrasound is a proven method of improving medical student understanding of human anatomy, physiology, clinical diagnosis, and patient management (Butter et al., Decara et al., Tshibwabwa et al., Wittich et al.). Introducing bedside ultrasound applications as a supplement to a standard physical examination helps reinforce both approaches. This combined approach enables students to visualize underlying patient anatomy and pathologic findings in real-time (rather than relying upon illustrations).

Bedside ultrasound, or point-of-care ultrasound, refers to the use of portable ultrasonography at a patient’s bedside for diagnostic (e.g., symptom or sign-based examination) and therapeutic (e.g., image-guidance) purposes. Kendall et al. defined the characteristics of point-of-care (emergency) ultrasound (Table 1).

<table>
<thead>
<tr>
<th>Characteristics of Point-of-Care Ultrasound</th>
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<tr>
<td>Exam is for a well-defined purpose linked to improving patient outcomes</td>
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<tr>
<td>Exam is focused and goal-directed</td>
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<td>Exam findings are easily recognizable</td>
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<tr>
<td>Exam is easily learned</td>
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<tr>
<td>Exam is quickly performed</td>
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<tr>
<td>Exam is performed at the patient’s bedside</td>
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Table 1
Implementation Challenges

Bahner et al. 2013 & 2014 and Dinh et al. described commonly encountered challenges to integrating ultrasound into medical education (Table 2). Lack of funding, training resources, and space within existing curricula were major obstacles. Additional cited barriers to ultrasound training during clinical rotations were providing medical students sufficient access to ultrasound machines and ready access to patients with specific pathologic conditions that correlate with didactic instruction. Finally, the resources required to assess competency, track performance, provide feedback, and archive performance metrics should not be underestimated.

<table>
<thead>
<tr>
<th>Barriers to Ultrasound Training</th>
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<tbody>
<tr>
<td>Lack of funding</td>
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<tr>
<td>- Handheld ultrasound machines and associated maintenance costs</td>
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<tr>
<td>- Faculty time requirements to provide training, assessments, feedback</td>
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<tr>
<td>Lack of trained faculty to serve as instructors</td>
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<tr>
<td>Student time constraints</td>
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<tr>
<td>An already overfilled medical school curriculum</td>
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<tr>
<td>Readily accessible ultrasound machines to enable bedside learning</td>
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<tr>
<td>Readily accessible patients with pathologic conditions that correlate with didactic instruction</td>
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<tr>
<td>Lack of trained faculty to assess competency</td>
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<tr>
<td>Lack of resources to performance track and archive performance metrics</td>
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Table 2

Blended Learning Approach to Ultrasound Integration

Blended learning has been defined as a learning paradigm that “combines face-to-face instruction with computer mediated instruction” (Bonk and Graham). A blended learning approach helps medical schools satisfy Liaison Committee on Medical Education (LCME) self-directed learning mandates (Sakai et al.). SonoSim offers a self-directed, blended learning ultrasound training solution that combines didactic courses, hands-on training (simulation), and learning assessment. SonoSim offerings are specifically designed to facilitate meeting LCME educational program content, curricular management, and student assessment accreditation criteria.
SonoSim® Modules

SonoSim’s educational content is structured in a modular format; each SonoSim® Module consists of a didactic course, mastery assessment, and corresponding hands-on scanning cases using the SonoSimulator®. SonoSim’s training programs can be integrated into preclinical (e.g., Anatomy & Physiology, Clinical Skills Courses) or clinical (e.g., Core Clerkships, Subspecialty Rotations) rotations using SonoSim’s versatile curricular mapping features. SonoSim is a cloud-based product that enables a “flipped classroom” approach to learning. Students are empowered to engage in self-directed learning anytime-anywhere and are provided a standardized foundation of ultrasound knowledge and scanning skills. This helps both students and instructors improve the efficiency and maximize the value of live-instructor led ultrasound training sessions. SonoSim has developed proven-effective, easy-to-use, and scalable methods to overcome the aforementioned historical obstacles to UME and GME ultrasound adoption (Table 2).

SonoSim Products & Services

Utilizing SonoSim for blended learning is a highly effective method to deliver in-depth, standardized ultrasound training across institutions. SonoSim can be seamlessly integrated into traditional faculty-led or peer-to-peer ultrasound instruction paradigms (Celebi et al., Fox et al.), and supports both anatomic-based and/or problem-based learning approaches. SonoSim LiveScan® is a perfect tool that facilitates objective structured clinical examinations (OSCE)(King et al., Tshibwabwa et al.). SonoSim provides UME educators an ecosystem of training, assessment, and program management tools.
designed to overcome historical barriers to ultrasound training and assessment. SonoSim products and services include:

- SonoSim® Personal Solution
- SonoSim LiveScan® featuring SonoSim® CaseBuilder
- SonoSim® CaseBuilder
- SonoSim® Performance Tracker
- SonoSim Support Services

The SonoSim® Personal Solution converts your personal computer into your own ultrasound training solution. It comes with a SonoSim® Probe and SonoSim® Drive. It is ideal for UME as it provides each individual medical student 24/7 access to ultrasound education and training. SonoSim® Personal Solution user performance is tracked via SonoSim® Performance Tracker (detailed below). SonoSim is easily scalable and readily supports medical schools with annual enrollments ranging from 400 to 1,000+ students per year.
SonoSim LiveScan® instantly transforms live volunteers and mannequins into ultrasound training cases with real pathologic conditions. Some of the benefits of SonoSim LiveScan® are described below:

**Seamless Integration**- Apply SonoSim LiveScan® Tags to designated anatomic locations on either human volunteers or mannequins. Use the SonoSim LiveScan® Probe to scan designated ultrasound windows. A variety of normal and pathologic ultrasound findings that correspond to hand-held SonoSim LiveScan® Probe movements are displayed in real-time within the SonoSimulator®.

**Enhance Bedside Training**- SonoSim LiveScan® allows you to assess how well trainees identify key anatomical landmarks, image artifacts, and pathologies, and apply this information towards medical decision-making.

**Improve High-Stakes Simulation**- SonoSim LiveScan® improves your simulation training scenarios techniques and OSCEs by integrating real-patient ultrasound cases.

**SonoSim LiveScan® Packages**- The SonoSim® Content Library contains the largest collection of hands-on training cases in the world. New training cases are added on a regular basis.
SonoSim® CaseBuilder allows you to create customized ultrasound training cases. This groundbreaking technology unleashes the creativity of ultrasound educators worldwide and allows them to apply their knowledge. SonoSim® CaseBuilder is a SonoSim LiveScan® add-on feature and further extends its ultrasound simulation capabilities.
SonoSim® Performance Tracker

SonoSim® Performance Tracker enables you to take control of your ultrasound classroom. Track, monitor, and assess student performance metrics using SonoSim® Performance Tracker. Specifically designed for “flipped classrooms,” or remote learning environments, SonoSim® Performance Tracker helps manage and track course completion and test scores of multiple students using an intuitive visual dashboard. Both online course performance and images saved during SonoSimulator® hands-on scanning sessions are stored for feedback and review by course instructors.

SonoSim® Performance Tracker provides instructors and system administrators complete control of student account management. Add and remove student users, create groups and subgroups, and archive performance metrics with ease. Access real-time performance data, and customize views with sophisticated analytic filters. Create useful views of performance metrics using the interactive SonoSim® Performance Tracker dashboard.
The SonoSim support staff is committed to helping you successfully implement ultrasound training at your institution. Examples of ways that SonoSim supports ultrasound educators and institutional clients include:

**SonoSim Support Days**

SonoSim Support Days are one- or two-day organized sessions that provide individualized, on-campus technical support and product in-servicing for all students preparing to use SonoSim in the upcoming academic year. Our dedicated staff will ensure that all students have successfully installed the SonoSim® software on their personal laptops and provide a brief product overview to the students.

**SonoSim Curriculum Integration**

SonoSim ultrasound curriculum experts can assist with drafting lesson plans and assignments, identifying SonoSim cases that best meet the requirements of the educators and students, and sharing best practices from other medical institutions nationwide that are integrating ultrasound into their curriculum using SonoSim. Optional services include detailed SonoSim product overview presentations, as well as individualized training for faculty and/or IT staff responsible for ultrasound integration.

**Student Ultrasound Workshops**

SonoSim staff will work with ultrasound educators to help implement the highly acclaimed SonoSim LiveScan® and SonoSim® CaseBuilder products into student ultrasound workshops. These workshops expose students to a variety of pathologic ultrasound training cases, and will demonstrate how ultrasound findings are integrated into medical decision-making, in a fun, exciting, and challenging format.
Summary

SonoSim is dedicated to improving and transforming medical care by serving as a global leader in ultrasound education and training. The SonoSim® Ultrasound Training Solution is a computer-based ultrasound-learning platform that overcomes traditional barriers to ultrasound education with asynchronous learning, self-assessment, and performance tracking. The SonoSim® Content Library provides an easy-to-implement, scalable solution that seamlessly integrates ultrasound education into any four-year medical school curriculum. The SonoSim® Ultrasound Training Solution is currently installed at more than 300 medical schools, academic centers, and simulation centers in the United States and has been utilized for both UME and GME applications by over 15,000 users. We look forward to the opportunity to help you successfully implement, maintain, and grow ultrasound training at your institution.
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