Medical Student Satisfaction and Performance Using an Innovative Radiology Education Laboratory

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BACKGROUND

Imaging plays a critical role in the practice of modern medicine, yet it remains underrepresented in undergraduate medical education (UME) [1]. Many graduating physicians feel insufficiently trained in core radiology interpretation and utilization skills, and only 10% to 25% of US medical schools require dedicated radiology clerkships [1,2]. Challenges in imaging education include competition for time in crowded UME curricula, lack of innovative educational methods that meet the needs of millennial learners, and the integration of digital resources and technology into the educational experience [3].

Underscoring these national trends, University of Colorado School of Medicine (CUSOM) students have consistently rated the quality of their experience in radiology education lower than the national average on the Association of American Medical Colleges graduating survey. At our institution, this gap in learner satisfaction reflected an outdated curriculum that was overly reliant on passive learning in the form of didactic lectures and an observational experience gained from shadowing radiologists in the reading room. Millennial learners prefer collaborative learning and expect integrated digital resources and technologically savvy instructors [4]. Therefore, addressing this curricular gap required significant restructuring of our UME program in radiology.

The ACR task force on medical student education and the Alliance of Medical Student Educators in Radiology, recently published a study on the status of radiology in UME [2]. Key task force recommendations included (1) increasing the availability of digital imaging resources for students, (2) exposing students to radiology earlier in the medical school curriculum, and (3) supporting faculty dedicated to UME [2].

In this article we present the program implemented as our department's response to key task force recommendations. Our program evaluation suggests that incorporating these guidelines into UME in radiology results in a well-received and effective educational program.

INTERVENTION

The Physical Space and Technology

The Department of Radiology at CUSOM received internal grant funding to support restructuring of the radiology UME curriculum in October 2014. This curricular redesign included the development of a dedicated space for UME in radiology. The Beginning to Advanced Radiology Laboratory (BAR Lab) was completed in August 2015. Innovative features of the space include a design that facilitates active learning methods and embraces technology and digital resources for radiology education. Additionally, the BAR Lab was designed to reflect the millennial generation's core work values, including small group learning, collaboration, interaction, problem solving, creativity, and facile use of technology [4].

The design of the laboratory is centered on a 34-foot-long learning "bar" that provides workspace to accommodate 15 learners (Fig. 1). There are five bar workstations, each accommodating one to three students. Each workstation is equipped with a wireless keyboard that interacts with a hidden, local area network–connected Apple Mac Mini computer and a wall-embedded 32-inch monitor. The computers host a simulation teaching PACS and provide Internet access to educational websites and online material. Each workstation is also equipped with an Apple iPad 2.

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Fig 1. Beginning to Advanced Radiology Laboratory design featuring five individual and small-group workstations.

The iPads provide second screens for viewing curricular content and serve as conduits for the integration of web-based mobile tablet applications into the curriculum.

On the wall opposite the learning bar are three 72-inch monitors powered by an Apple Mac Mini that allow conversion of the small-group environment at the bar into a larger group learning experience. Apple TV devices connected to the 72-inch monitors use Bluetooth technology to mirror the screen of a student's or facilitator's iPad for display to the group. Screen mirroring facilitates instructor mobility and, combined with mobile tablet whiteboard applications, allows students to engage with images and the larger group in an interactive manner.

Lounge areas at both ends of the room have built-in casual seating and additional iPads for up to eight students with electric outlets and secure areas to store the iPads.

The fleet of iPads in the BAR Lab is managed by the CUSOM Department of Radiology using the Apple Deployment Program. Each iPad is equipped with educational applications, including iTunes University, 2-Screens, and Explain Everything. These applications integrate digital resources, facilitate active learning, and promote student creativity.

Integrated Curriculum

The BAR LAB pilot curriculum is a required component of the third-year internal medicine and surgery rotations. The curriculum combines independent prework e-learning assignments combined with flipped classroom and team-based learning (TBL) methods. The e-learning components are select MedU CORE modules [5]. The MedU CORE modules are peer-reviewed cases with learning objectives appropriate for third- and fourth-year medical students [5]. TBL is a type of collaborative learning that has been shown to be effective in medical education [6], with a modified version used during the BAR Lab sessions.

CUSOM students complete MedU CORE modules 5 ("GI: Colon and Small Bowel") and 6 ("GI: Hepatobiliary and Pancreas") during their surgery rotations and CORE modules 1 ("Chest: Infection") and 4 ("Chest: Vascular and COPD") during their internal medicine rotations. Integrating radiology topics directly related to the specific clinical rotation a medical student is rotating through is consistent with best practices in adult-centered learning [7].

Students are assigned to work in teams of three during the modified TBL curriculum and complete tasks requiring the use of digital resources and applications on the iPad. Each group is asked to interpret images viewed on the UCD-TPACS, a dedicated web-based teaching PACS. The UCD-TPACS was created through a partnership with Philips and archives 25 cases that link to MedU CORE module content. Cases have been deidentified, with DICOM data removed. New fictional medical records are created, and imaging studies are organized according to the related MedU CORE module content.

Students follow a syllabus on the iPads using iTunes University to guide case review on the UCD-TPACS. Teams are asked to interpret imaging in addition to answering a series of synthesis questions focusing on pathophysiology, the use of imaging, and patient safety. Students can use an iTunes University report template with voice recognition to dictate a radiology report and present an "impression" to the larger group. Additionally, synthesis questions are presented to and discussed with the larger group through the use of screen mirroring with the iPad and Apple TV device.

PROGRAM EVALUATION

A survey regarding students' satisfaction with their radiology experience during medical school was sent through the CUSOM office of evaluations to 105 students at the end of the second year of medical school, before the BAR Lab intervention, and to the same 105 students the end of the third year, after they had completed four BAR Lab modules.