Medical Student Education

Creating an Open-Access Educational Radiology Website for Medical Students: A Guide for Radiology Educators

David M. Mauro, MD, Joshua A. Ellis, BS, John F. Lilly III, MD, Gary L. Beck Dallaghan, PhD, Sheryl G. Jordan, MD

Rationale and objectives: Studies of medical school clerkship websites have reported efficient time management, resource utilization, and hands-on activities. We built a website devoted to medical student education in radiology to address student, educator, and school curricular needs and surveyed students to assess their satisfaction with the site.

Materials and methods: The website was created using an easily-recalled name, no-cost institutional software, and no-cost enterprise-level university hardware. The main menu links to the student formal didactic lecture calendar, custom-built health sciences library e-resources in radiology, American College of Radiology Appropriateness Criteria, each radiology course page, and teaching files. Each course tab includes faculty-curated content from course lectures, supplemental articles and educational modules. At 6, 12, and 24 months, website analytics were assessed. At 12 and 24 months postimplementation, data were evaluated to include student assessment and satisfaction surveys and student course comments. This project was IRB-exempted.

Results: At 6 months, the website had received 5792 views, at 12 months 10,022 views and at 24 months 19,478 views. The website homepage with the formal didactic lecture calendar received 7156 views, the general clerkship page 4233 views, the teaching file page 3884, and thereafter subspecialty pages as follows: breast 1478, body 633, pediatrics 361, neuro 346, cardiothoracic 291, musculoskeletal 249, vascular interventional 178. One hundred fifty-two of 240 (63.3%) of students surveyed replied. Of students who utilized the website on the satisfaction survey, 80 of 97 (82.5%) indicated ratings of "extremely informative" and "very informative" to the question "How would you rate the website?." Students indicated convenience and structure as website strengths in their postcourse evaluations.

Conclusion: The radiology medical student website incorporates demands and needs of today's students, faculty, and our medical school. A radiology clerkship website for medical students centralizes access to course resources and promotes an active learning experience with high satisfaction. Instructions on setting up a website are offered to today's radiology educators, including pearls and pitfalls.

Key Words: Website; Active learning; Medical student education; Clinician educator; Radiology.

INTRODUCTION

Numerous sources cite demand for, and benefit of, students having choices in how they learn (1−4). Medical school-created clerkship website studies report efficient time management, resource utilization, and inclusion of hands-on, manageable activities as advantages (5,6). Specifically, Desai and colleagues point to multiple advantages of a radiology medical student website, including meeting the expectations of medical students to have computer-based learning, minimizing "overload of material," and optimizing the efficiency of information transfer for the clerkship director and coordinator (5).

Websites may also be designed to meet the Liaison Committee on Medical Education (LCME) standards for self-directed and life-long learning. Undergraduate medical education now emphasizes the importance of "self-directed learning experiences with components of self-assessment of learning needs, independent identification, analysis and synthesis of relevant information, and appraisal of the credibility of information sources" (7). Offering a source of vetted

medical resource references in radiology appropriate to learner level in turn offers the opportunity for independent analysis and self-study. Since a radiology clerkship website may be a student's first experience with radiology, a well-organized and well-run educational website may attract students to pursue a career in radiology. For those students pursuing other fields, a well-sourced website may highlight the roles of radiologists as consultants to our clinical colleagues in collaborative patient care delivery; tailoring imaging examinations to specific organs and diseases, diagnosing disease entities in their typical and atypical appearances, and performing procedures are examples of highlighted radiologist consultants' roles.

To date, little has been reported about developing such a resource for medical students interested in radiology. We report our institution's 2-year experience in building, launching, and maintaining a website devoted to medical student education in radiology, focusing on third and fourth year medical students enrolled in radiology courses. Table 1 summarizes terminology relevant to website development, to establish a common language in this manuscript.

Our institution offers 4-week general radiology, subspecialty, and research elective course to third and fourth year medical students. Typically, in each block one general radiology, six subspecialty, and one research elective are offered. Course size varies per elective and per block; maximum capacity is 8 (10 in select blocks upon course director's approval) students for the general elective and most commonly 2 students for all other electives. Daily educational structure (including the relative percentages of faculty-directed versus student-directed study) differs by course, though daily formal didactic lectures, clinical activities, and independent learning time are offered to all students. Before the course start date, each student receives orientation materials including website information. Website resources are utilized by course directors and faculty in varying manner; examples include reading assignments prior to formal didactic lectures and daily clinical activities, postlecture reading assignments to cement knowledge, and contemporaneous review during live teaching sessions.

MATERIALS AND METHODS

Building a cost-effective website

Initially conceived by our director of undergraduate medical education, the platform was driven by our institution's web publishing service. In February 2018, we initiated build of a medical student–centric radiology website with limited-access cloud upload capability (Fig 1). An easily recalled short name for the website "msrads" was intentionally selected to precede the domain designation required by the institution.

Using no-cost institutional web publishing services on a platform hosted on enterprise-level hardware, the site is supported by the institution's information technology digital services (ITS). Specifically, the web publishing service selected allows anyone affiliated with our institution to create their own website at no charge. The service runs on the WordPress platform (Automattic, San Francisco, California), making it easy to use with features and functionality. This platform was chosen by ITS because its interface is easy for all on campus to use for their webpages. WordPress includes over 50 plugins that add functionality. The themes, or layouts, are built to be supported on mobile devices. A new site can be created de novo, live and ready for content input within minutes. Hence the majority of faculty time to be focused on developing radiology content rather than website infrastructure. Of note, most academic institutions' ITS offices provide support for website creation and management.

Home and subspecialty rotation pages were created. Individual course page content was predominately created by course directors under the guidance of the director of graduate medical education. Students assisted in the website design and creation in advisory roles, and content they created during rotations joined faculty content posted to the site. Website monitoring and upkeep is a shared responsibility of the

TABLE 1. Common Website Terminology (11).

Term	Explanation
Bounce rate	Metric quantifying percent of visits to page with no interaction (left site without clicking to another page)
Domain name	Identifying portion of the URL (for www.google.com, "google" is the domain)
Fixed header	Bar at the top of a website that remains visible when a user scrolls down
Landing (home) page	Site page that a user accesses first
Mobile devices	Portable computing device (ie smartphone or tablet)
Navigation	Process of accessing information on a website (ie links, buttons)
Open access	Nonrestricted access
Open source	Distributed computer software with available modifiable source code
Pages	Individual viewable documents that together comprise a website
Pageviews	Number of visits to a web page
Plugin	Program installed into a site for additional functionality (Flash, Adobe Reader)
Software	Program or instruction for a computer to complete a task or function
URL	Uniform Resource Locator, also called web address
User interface	How a user interacts or controls a software application or website

Figure 1.   Example of our institution's radiology medical student home page, including course tabs.

radiology course directors, director of undergraduate medical education, and the institution's ITS.

Students have access to the educational content on this open source host site for prestudy, in-clinic education and post-teaching reference. The main menu provides links to the following pages: student formal didactic lecture calendar (Fig 1), custom-built health sciences library e-resources in radiology, American College of Radiology Appropriateness Criteria, each radiology course materials, and student teaching files (8). Each course tab includes faculty-curated content from course lectures, supplemental articles and educational modules. Faculty course directors choose high-yield subspecialty specific resources applicable to medical students bound for both radiology and nonradiology specialties as career choices. The custom-built health sciences library e-resource link, a collaborative effort of the radiology department medical student educators and a designated librarian champion, includes a treasure trove of vetted resources, including PubMed, e-Anatomy, UpToDate, and individual radiology course director-selected reference textbooks. Student-created

teaching files were selected for publication after peer review and acceptance (10).

Medical student radiology electives and the website

During the 2-year study time frame, information regarding the website was first relayed to students during course introductory electronic communication, and was frequently referenced thereafter in lecture, direct, and email communications during each block. While direct interaction with the website was not mandatory, students were often directed to the website by course directors for updated scheduling information and access to self-study educational resources. The website provided the centralized location for the radiology formal didactic lecture calendar per block, displayed on the home page.

Website analytics and survey evaluations

Website analytics provided by Google Analytics (Google, Mountain View, CA) were analyzed at 6, 12, and 24 months

following website inception. At 12 and 24 months, student satisfaction surveys were administered during senior medical student formal lecture time (aggregated for their Transition to Residency course)with student survey participation voluntary and anonymous. . The student surveys were administered in paper copy in 2019 and via an online poll in 2020. Three survey questions were asked of all students: 1. Did you take a RADY elective this year? Yes/No 2. Have you visited our radiology website for students www.msrads.web.unc.edu? Yes/No 3. If yes, how would you rate the website? Not informative, Slightly informative, Moderately informative, Very informative, Extremely informative. Additionally, the institution administered per-rotation medical student evaluations using one45 (one45, Vancouver, British Columbia), and student evaluations from March 2018 to February 2020 were reported by the medical school in aggregated annual reports. These include narrative comments of students' perspective of their experiences, with positive comments and suggestions for improvement.

RESULTS

Students began accessing the website during the first block following website build, in March 2018. At 6 months, the website had received 5792 views, at 12 months 10,022 views and at 24 months 19,478 views (Fig 2). The comprehensive data indicated the following: the website homepage with the formal didactic lecture calendar received 7156 views, the general clerkship 4233 views, and the teaching file tab 3884 views. Radiology subspecialty page views were also frequently viewed as indicated in Table 2.

Student satisfaction survey results were as follows: 80 of 120 students (66.7%) chose to complete the paper survey on March 26, 2019 and 72 of 120 students (60.0%) completed the online poll on March 10, 2020. Of the aggregate 152 students completing the surveys, 97 students (63.8%) were enrolled in a radiology elective. Student satisfaction surveys indicated 80 of 97 (82.5%) ratings of "extremely informative"
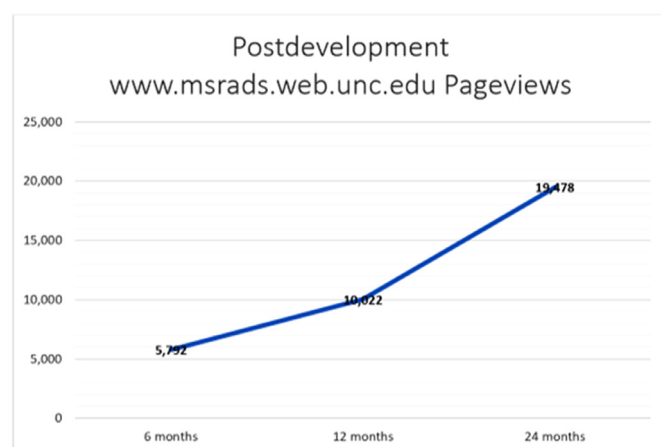
TABLE 2. Webpage Traffic Data Provided by Google Analytics March 25, 2018-February 25, 2020.

Radiology Medical Student Educational Website Traffic at Twenty-four Months

Page	Pageviews
Home	7156
General	4233
Teaching File	3884
Breast	1478
Body	633
Pediatrics	361
Neuro	346
Cardiothoracic	291
Musculoskeletal	249
Vascular interventional	178

and "very informative" to the question "How would you rate the website?."

Review of one45 annual reports indicated that students volunteered website convenience and structure as rotation strengths.

DISCUSSION

In order to optimize educational experiences, educators must understand their learners' preferences. Multi-generational teachers can struggle with the expectations and learning style of contemporary students. Given their propensity for self-directed and web-based learning, Generations Y (born 1982−1995) and Z (1996-2012) prefer customizable options for learning and current medical students extensively utilize digital resources for their learning (1,2). Traditional textbooks have fallen out of favor with the rise of self-directed learning utilizing digital material. Previous research has supported e-learning with high participant satisfaction; students are eager to use online resources and often seek them out from other institutions (2,6).

Internet-based resources and didactics are now commonplace in medical student education (5). With resources more easily accessed, over-exposure to educational material is a common challenge to learners. Embracing this new age of learning allows course directors to focus their students and direct learning. A well−organized website facilitates optimal organization and provides convenient access to resources, in turn optimizing learning experiences. Assuring efficient use in an easily manipulated format serves to assure faculty can curate the learning resources, updating the website with new articles, educational modules, and teaching files. Websites also allow an easy format for communicating schedule information, and websites should include the formal educational calendar (5).

Most educators are not experienced in website creation or digital education. Further, current literature offers little instruction on how to optimally structure and create a medical student educational website. We offer insights from our experience to create such a resource.

Ideally, a central radiology organization would work with individual institutions and programs to build a centralized

Figure 2. Domain traffic data provided by Google Analytics at 6, 12, and 24 months.

educational resource, thereby preventing redundancy of work and pool resources and time to build a superior source. Many institutions have produced their own online sites and educational material, however a bulk of the educational documents could be shared. This would allow each institution to only focus on their own individual schedule and assignment pages.

Pearls and pitfalls

Pearl: One-minute preceptor expands to ten-minute learning. Upon familiarizing selves with website content, engaged clinician educators are able to use this curated content as one of their teaching tools. One-minute preceptor teaching sessions are expanded into 5- or 10-minute individualized student learning sessions by referring the student to an online resource that reinforces and expands the teaching points (9,10). For the busy radiology clinician educator, the student's self-study time offers the educator time to intently focus on clinical care (review and dictate cases).

Pearl: Consistency of available educational content. The educational website ensures consistency within the rotation among students, especially crucial when attending faculty schedules change. On the website, one can easily update and disseminate new course resources, and consolidate material from multiple co-educators. Centralizing course material in an electronic format is preferred by today's medical student and offers ease and efficiency in tapping relevant resources.

Pearl: Teaching files promote self-directed learning. Previously reported and notable is the opportunity for the student to author a teaching file and contribute to the website (Fig 3). The student chooses one or more topics of her/his interest and utilizes a template for creating a teaching file with patient clinical presentation, indications for imaging and radiology consultation as well as highlights of key imaging and pathologic findings. This teaching tool is adaptable to individual student specialty interests, encourages peer-to-peer teaching, and meets the AAMC and School of Medicine core competency for lifelong learning. As the data indicate, our students favor these peer-to-peer teaching tools. Further, it requires only that the educator know which specific topics have been posted in her/his subspecialty; being equipped to direct students to an apropos teaching file allows the educator to provide learner-specific, engaging, and thereby sustainable education, while it elongates the learning time.

Pearl: Documentation of involvement. Defining titles for educators involved in creation and upkeep can help encourage involvement in the project and allow faculty to document their time in their curriculum vitae.

Pitfall: E-licenses. Availability of textbooks relies on both the availability of an electronic license for the textbook and its purchase. Closely working with institutional health sciences library or medical school media personnel are important steps to take as keys to cost savings.
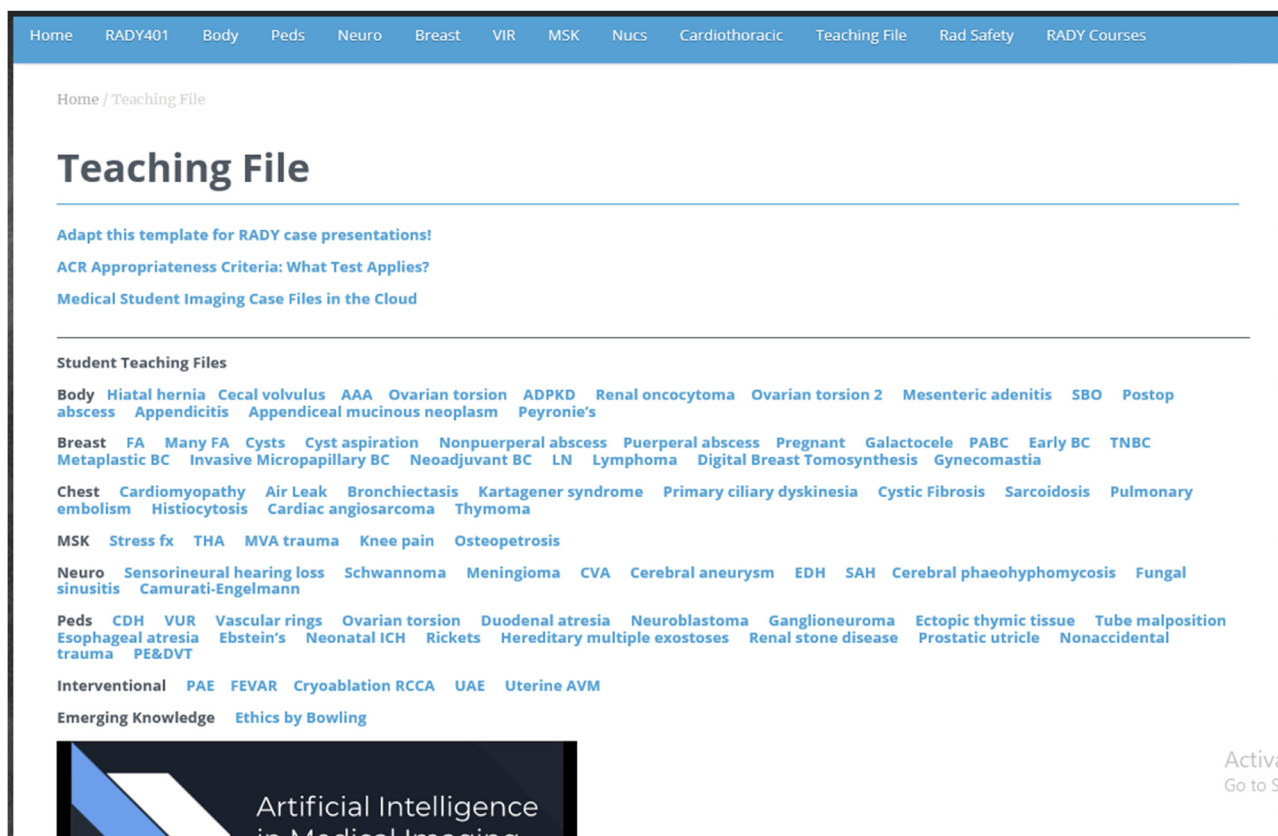

Figure 3. Example of our institution's "Teaching Files" page containing open access electronic files created by students on rotation. Teaching files are presented by the students while on service and peer-reviewed prior to publication on the website.

Pitfall: Technical failures. Broken external links and technical internal software failures are bound to happen over time to any website. Open communication to and from students is key to quickly identify and remedy any issues. It is helpful to have a clearly delineated faculty member or administrator who can serve as a point person of contact.

Pitfall: Outdated information. Site content needs to be curated and reviewed at regular intervals by the individual course director. This should be similar to how learning materials are reviewed prior to use of an online portal.

Pitfall: Copyright infringement. Copyright protections must be heeded, specifically for major refereed journal articles. This is particularly important in the setting of institutional support and oversight that in turn monitor website content and censure noncompliance. Password protection of all or portions of the website is an option, restricting access to those who also have access to the institutional library. Otherwise, strict monitoring of posted material is necessary to prevent unintentional copyright infringement.

While we have demonstrated creating an educational website is easily performed without significant technologic background, further research and published step-by-step instructions for design would be valuable to assure most useful and efficient e-learning websites.

CONCLUSIONS

The radiology medical student website incorporates demands and needs of today's students, faculty, and our medical school.

A dedicated radiology education website for medical students centralizes access to course resources and promotes an active learning experience with high satisfaction.

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