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Review paper

Advancing radiology education for medical students: leveraging digital tools and resources

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Abstract

This study evaluates diverse educational resources to address the gaps in diagnostic radiology education for medical students, aiming to identify tools that enhance theoretical knowledge and practical diagnostic skills. Employing a multi-faceted review, we analyzed digital platforms, academic databases, and social media for resources beneficial to medical students in radiology, assessing their accessibility, content quality, and educational value. Our investigation uncovered a broad spectrum of resources, from foundational platforms to advanced simulation tools, varying in their approach to teaching radiology. Traditional resources provide essential theoretical knowledge, while digital tools, including interactive case studies and multimedia content, offer immersive learning experiences. Notably, resources integrating machine learning and social media facilitate dynamic, peer-to-peer learning and up-to-date case discussions. Despite the minimal current focus on VR, its role in enhancing interactive learning is notable. The diversity in educational tools highlights the evolving nature of radiology education, reflecting a shift towards more engaging and practical learning methodologies. Identifying and integrating a variety of educational resources into radiology education can significantly enhance learning outcomes for medical students, preparing them for the complexities of modern diagnostic radiology with a well-rounded educational approach.

Key words: radiology education, digital learning tools, interactive radiology resources, online radiology education, medical student radiology training, case-based learning in radiology.

Introduction

With the growing emphasis on digital learning in medical education, highlighted during the COVID-19 pandemic, the need for comprehensive online resources in diagnostic radiology has become increasingly apparent. Despite radiology's crucial role in medical diagnosis and treatment, recent trends in medical school curricula suggest that its level of integration has been decreasing. In the 2019-2020 academic year, only 16% of U.S. medical schools required a radiology clerkship, down from 24% in 2014-2015. Further, while 135 out of 147 schools integrated radiology education into other courses in 2017-2018, only 29 offered independent radiology courses [1]. While one possible explanation for this trend is a decreased emphasis on radiology in medical school curricula, another is a shift from a theoretical knowledge approach to medical students' learning of radiology to a more interactive and practical approach that reflects its increasing importance in modern healthcare.

The transformation of radiology education from traditional methods to more interactive and dynamic digital tools marks a significant shift in learning approaches. Traditional tools, while foundational, predominantly offered static images and text-based learning. This has changed with the introduction of digital resources and online platforms, which emphasize interactive, case-based learning. These modern

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tools, including multimedia resources, interactive case studies, and virtual radiology databases, provide a more engaging and practical learning experience. They enable a comprehensive exploration of radiological cases and promote critical thinking and real-world application [2].

Additionally, the integration of new tools such as social media and artificial intelligence (AI) further revolutionizes radiology education. Social media platforms serve as dynamic forums for the exchange of radiological images and discussions, enhancing global collaboration and peer-to-peer learning. AI's role, particularly in generating images, is transformative, creating realistic yet anonymized images for educational purposes. This not only diversifies the learning content but also ensures compliance with HIPAA regulations, maintaining patient privacy [3].

This study aims to identify and categorize online educational resources in diagnostic radiology to guide medical students, addressing the gap in formal radiology education. With 49% of allopathic U.S. medical schools currently incorporating radiology teaching in their curricula for years 3 and 4, and with only 10% to 25% of graduates required to take radiology as a clinical rotation, the demand for supplemental educational tools has intensified [4]. This contemporary framework represents a marked evolution from the 2014-2015 academic year, when 24% of medical schools mandated a radiology clerkship, demonstrating a shift towards earlier, technology-enhanced integration of radiology in medical education, despite the fact that the proportion of required clerkships has diminished to 16% in the 2019-2020 academic year [5]. Consequently, the current need for effective radiology education for medical students remains unmet by both formal and informal means, underscoring the necessity to re-evaluate and bolster the resources available to students. The medical education landscape has evolved to integrate radiology much earlier and practically, using technology to enhance its clinical relevance. Radiology education in Europe and Asia presents a contrast to the trends observed in the United States. In Europe, radiology is often integrated into the medical curriculum at an earlier stage, with countries such as Germany and the United Kingdom requiring radiology training throughout medical education. For example, in the United Kingdom, radiology is a compulsory part of the undergraduate medical curriculum, often incorporated into general clinical training modules and dedicated radiology rotations [6]. Similarly, in Germany, radiology is taught as a separate subject, with structured courses and mandatory assessments [7]. In Asia, particularly in countries such as Japan and South Korea, there is a strong focus on incorporating advanced imaging technology early in medical education. For instance, Japanese medical schools have been incorporating digital imaging tools and virtual simulations into their radiology curriculum since the early 2010s, providing students with hands-on experience with the latest technologies [8]. These differences underscore the global diversity in radiology education approaches and offer opportunities for cross-regional learning and collaboration. However, the need for effective radiology education for medical students remains unmet by both formal and informal means. This article seeks to explore sources of formal radiology education for medical students throughout medical school curricula.

Methods

To identify popular educational resources in diagnostic radiology, we employed a multi-faceted approach encompassing both digital platforms and academic databases. We conducted a subjective review of popular social media platforms, including Instagram, Twitter, YouTube, and TikTok, focusing on frequently mentioned resources geared towards medical students in the field of radiology. This review was not intended to be exhaustive but rather to provide a broad overview of the available resources. The literature search in PubMed and Google Scholar was also targeted and selective, aimed at identifying key resources and trends rather than reviewing every available abstract. Additionally, a targeted literature search was conducted on PubMed and Google Scholar using specific search terms such as "diagnostic radiology", "eLearning in radiology", "online radiology resources", and "medical student education in radiology". We did not limit our study selection by date range, because peer-reviewed literature on radiology hybrid education is scarce. However, the vast majority of relevant literature was acquired from 2012 to present. These resources, including video-based learning tools and interactive platforms employing spaced repetition techniques, strive to enhance the understanding and application of radiological concepts. To our knowledge, there does not exist a clear outline of such resources. Our study critically evaluates various digital resources available for radiology education, discussing both the strengths and limitations of each platform to provide a balanced view of their educational value for medical students.

Digital radiology education sources for medical students

Foundational comprehensive resources

Radiopaedia.org

Radiopaedia.org is a peer-reviewed, open edit website that provides free and accessible radiology education for medical students and other allied health professionals. Radiopaedia.org aims to cover the core topics of radiology, as well as the latest advances and research in the field. Radiopaedia.org is a collaborative project, where users can contribute their own cases, articles, quizzes, and videos, or edit and improve existing content. Since it is an open edit source, the users are encouraged to reference the provided

information back to the respective resources. Radiopaedia.org is a valuable resource for anyone who wants to learn more about the science and art of radiology. This resource offers rapid reference for medical students and references for specific cases and to identify specific radiological signs. Information is provided in a clear and concise manner with related cases provided for additional edification and broader knowledge [9]. The open-edit nature of Radiopaedia.org, while promoting collaboration, can lead to inconsistent quality and reliability of the content. There is also a risk of outdated or incorrect information being presented if not regularly reviewed by experts.

Learning Radiology

Learning Radiology is a comprehensive educational platform that offers an array of PowerPoint style presentations, catering to a wide spectrum of radiological topics. It is renowned for its diverse collection of imaging resources and interactive quizzes, which aid in reinforcing learning. This is based on the book *Learning Radiology: Recognizing the Basics*, which acts as a supplementation [10]. The platform's strength lies in its ability to present complex radiological concepts in an easily digestible format, making it particularly beneficial for medical students and radiology trainees. Its interactive approach to teaching, through quizzes and detailed presentations, helps to build a foundation in radiological interpretation and diagnosis [10]. While comprehensive, the platform may be overly simplistic for advanced learners or radiology residents who require more in-depth and specialized knowledge. Additionally, the PowerPoint style of presentation might not engage users as effectively as more interactive learning methods.

Introduction to radiology

Introduction to radiology offers a foundational understanding of radiological practices and principles. This resource is particularly beneficial for beginners in the field, providing a solid grounding in the basics of radiology, offering organized and methodical learning pathways. Additionally, its focus on the fundamental aspects of radiology makes it an essential resource for building a strong foundation in radiological education [11]. The platform's focus on fundamental concepts means it may lack the depth needed for more advanced learners. The limited interactivity could also reduce its effectiveness in maintaining user engagement compared to more modern, interactive platforms.

UVA Radiology

The Introduction to Radiology course by the University of Virginia (UVA) Radiology Department is a recognized platform offering interactive learning experiences. It is designed to cater to the educational needs of a diverse student body, providing a well-rounded introduction to the field of radiology. The course's strength lies in its ability to offer comprehensive yet accessible content, coupled with interactive elements that enhance the learning experience for students worldwide [12]. The modules available can range from imaging physics, relevant artifacts to image acquisitions and interpretations with educational slides and quizzes. The platform's content, while comprehensive, may be too basic for those with prior knowledge in radiology. Additionally, access to the full range of resources may be restricted to UVA affiliates, limiting its utility for a broader audience.

Radiology Cafe

Radiology Cafe offers tutorials and a repository of articles covering a broad spectrum of radiological topics. Radiology Cafe offers a resource for both learning and reference, offering up-to-date information that is both diverse and concise for practicing radiologists and students alike. Additionally, the resource provides mock anatomy exams for practice. The comprehensive nature of this resources makes it an integral part of any radiology educational toolkit [13]. Despite its broad coverage, the site may not delve deeply into more advanced topics, potentially limiting its usefulness for higher-level trainees or practicing radiologists. The tutorials may also vary in quality and depth, leading to inconsistent learning experiences.

Radiology Masterclass

Radiology Masterclass differentiates itself with its focus on fundamental radiology concepts, presented through interactive images and quizzes. This platform is particularly effective in teaching the basics of radiology, employing a hands-on approach to learning with courses and tutorials. The interactive elements, such as quizzes and annotated images, facilitate active learning and help reinforce key concepts. This resource is especially beneficial for those at the beginning of their radiology education, providing a solid foundation upon which to build more advanced knowledge [14]. The resource, while strong in fundamental concepts, might not cater adequately to the needs of advanced learners seeking more detailed and specialized content. The platform's emphasis on basic learning may also make it less appealing to those seeking more cutting-edge or clinical application-based education.

Geeky Medics Radiology Tutorials

Geeky Medics provides tutorials on radiology, predominantly on X-ray interpretations. These tutorials are known for their clarity, making complex radiological concepts accessible to learners at beginner level. The content is structured to guide users from foundational knowledge to

more advanced topics, ensuring a comprehensive understanding of radiological principles. The platform is particularly useful for those seeking to gain a deeper insight into the practical aspects of radiological interpretations and diagnoses [15]. The platform's focus on X-ray interpretation may limit its utility for those seeking a more comprehensive radiology education. Additionally, the content is primarily targeted at beginners, which might not meet the needs of more advanced students or professionals.

Case-based learning and databases

CTisus

CTisus offers extensive case-based learning opportunities, foundational for radiology education. Its integration of PEARLS – Practical Evidence About Real Life Situations – provides learners with insightful, clinically relevant tips that are updated monthly, fostering ongoing engagement and learning. These PEARLS highlight key radiological findings and guidelines, serving as a dynamic reference point for learners to apply practical radiological knowledge in real-world scenarios. The platform categorizes this content into different system-based recommendations, catering to varied specialty interests and encouraging active involvement [16]. While CTisus is excellent for case-based learning, its focus on computed tomography (CT) imaging may not be as beneficial for those seeking a more diverse range of radiological modalities. The platform's specialty focus could limit its relevance for a broader audience.

The Radiology Review

The Radiology Review website offers a comprehensive list of resources for medical students interested in radiology and radiology residents. It includes lists of foundational books for understanding radiology principles, resources for radiology exam prep, and advanced case-based learning platforms in a podcast format. Additionally, the site provides practical advice on how to integrate radiology learning into clinical rotations, encourages the submission of interesting cases, and suggests engaging with professional societies and social media for further learning and networking. This resource is invaluable for medical students seeking to deepen their radiology knowledge and skills [17]. The resource's broad approach may lack the depth needed for specialized or advanced learners. The reliance on external resources and lists might also lead to a fragmented learning experience.

Aquifer radiology

Aquifer radiology cases consist of 21 interactive virtual patient scenarios designed to align with the AUR and AMSER medical student curriculum, providing free radiology education to medical students and allied health professionals [18]. These cases, part of the broader Aquifer course library, offer realistic scenarios for evidence-based decision making, and can be used independently or integrated into custom curriculums. Despite a limited number of cases, the platform is regularly updated to adhere to American College of Radiology recommendations and includes a comprehensive 100-question exam [16]. The limited number of cases may restrict the breadth of learning, and the platform's focus on virtual cases may not fully replicate the complexity of real-world clinical scenarios. Additionally, updates, while regular, might not always reflect the latest advancements in radiology.

American Journal of Neuroradiology (AJNR) Cases of the Week

AJNR Cases of the Week offers weekly neuroradiology cases, providing a dynamic and continuous learning experience. This format is particularly beneficial for advanced students and residents who require regular exposure to varied and complex cases to enhance their diagnostic skills. The weekly presentation of new cases ensures that the content remains current and relevant [19]. The weekly format, while providing continuous learning, might not be sufficient for learners needing more intensive, rapid exposure to a wide range of cases. The focus on neuroradiology may also limit its relevance for those interested in other subspecialties.

Eurorad

Eurorad offers a wide range of case-based studies, making it an essential resource for learners and practitioners seeking to expand their knowledge in various radiological subspecialties. Its comprehensive database and the depth of its case studies contribute to a nuanced understanding of radiological principles and applications. The interactive and user-friendly interface of Eurorad further supports the project's focus on providing engaging and accessible learning experiences [20]. The platform's depth and complexity might be overwhelming for beginners or those without a strong foundation in radiology. Additionally, the user interface, while functional, might not be as intuitive or engaging as other, more modern platforms.

MedPix

MedPix is notable for its extensive collection of medical images and case studies. This resource enhances learning by providing real-world examples and practical applications of radiological concepts, integrating theory with practice. The platform's comprehensive database and navigational ease make it a valuable tool for both general radiological education and more specialized learning [21]. While comprehensive, the vast collection of images and

cases might be difficult to navigate, potentially overwhelming users who are new to the platform. The user interface may also feel outdated compared to more contemporary resources.

Targeted educational modules and courses

Radiology Assistant

The Radiology Assistant is a resource with concise, yet detailed, educational modules on a wide range of radiology topics. The graphics and illustrations in this resource make the understanding of complex radiological concepts simple. The platform's strength lies in its ability to simplify complex radiological concepts, making them accessible to learners at different levels. Furthermore, the Radiology Assistant's focus on practical application and case-based learning emphasizes real-world applicability and evidence-based learning [22]. The concise nature of the content, while beneficial for quick learning, may not provide the depth required for thorough understanding, particularly in complex or advanced topics. Additionally, the focus on practical applications might limit theoretical learning.

Radiological Society of North America's (RSNA) RadioGraphics Journal

The RSNA RadioGraphics Journal is renowned for its rich collection of educational presentations and manuscripts. It serves as a critical resource for both basic and advanced radiological learning. The journal's in-depth articles, case studies, and reviews cover a wide range of topics within radiology, providing valuable insights for both novices and experienced radiologists. Its commitment to delivering high-quality, peer-reviewed content makes it a trusted source of knowledge in the radiology community [23]. The content, while high quality, might be too advanced for beginners or those without a strong background in radiology. Access to the full range of articles may also require subscription or institutional affiliation, limiting accessibility for some learners.

MRIquestions

MRIquestions stands out for its detailed articles on advanced MRI techniques, offering a deep dive into the complexities of MRI physics. The format encourages critical thinking and problem-solving, essential skills for medical students and residents interested in radiology, thus fostering analytical and diagnostic skills in radiology. These questions largely focus on the physics related to MRI, which is a paramount consideration in this imaging technique. Question and educational sections provide information ranging from creating an image with MRI to artifacts related to MRI imaging [24]. The platform's specialized focus on MRI physics might not appeal to those seeking a broader radiology education. Additionally, the technical nature of the content may be challenging for learners without a solid background in physics or MRI.

SUSME.org

SUSME.org specializes in providing ultrasound-related educational modules that are tailored to the needs of medical students and professionals in radiology. This platform stands out due to its comprehensive coverage of various radiology topics on ultrasound, catering to both fundamental learning and advanced practice. Additionally, the interactive tutorials offered by SUSME.org enhance the learning experience by promoting active engagement [25]. The platform's specialized focus on MRI physics might not appeal to those seeking a broader radiology education. Additionally, the technical nature of the content may be challenging for learners without a solid background in physics or MRI.

Anki platform in radiology education

Anki, a spaced repetition flashcard program, is widely recognized among medical students for its effectiveness in reinforcing information, and is relevant to radiology as it can reinforce image-based recall. Anki is widely used by medical students, with about 70% of first-year students across disciplines using it [26]. This platform's notable features include its ability to handle advanced multimedia flashcards, support extensive deck capacities, and facilitate collaborative sharing. These functionalities make Anki particularly suited for radiology education, where visual memory and iterative learning are paramount. The spaced repetition method, while effective for memorization, may not facilitate deep understanding of complex radiological concepts. Additionally, the quality of shared decks may vary, leading to potential inconsistencies in the learning experience.

Virtual reality

Virtual reality (VR) is rapidly emerging as a transformative force in radiology education, offering students unparalleled opportunities to immerse themselves in the intricacies of human anatomy and radiological diagnostics through interactive, three-dimensional experiences. A study involving 18 medical students during a 2-week radiology elective demonstrated VR's effectiveness, with the VR system (SieVRt) significantly improving students' ability to detect and measure imaging findings compared to a traditional PACS-like system (ODIN). Specifically, students showed statistically better performance on two of five specially designed questions, highlighting VR's potential to enhance learning outcomes and user satisfaction in radiology education [27]. Further, the immersive

3D virtual simulation tool implemented in a pilot study with first-year radiography students was greatly valued, enhancing students' confidence in their radiographic technique and making the learning experience more interactive [28]. Additionally, advances in machine learning combined with VR simulation programs introduce novel methods for teaching and preparing trainees, allowing them to practice procedural skills in a simulated environment, thereby improving for example interventional radiology (IR) education and procedural proficiency [27]. Incorporating VR into radiology training, a study highlighted the effective use of the Google Cardboard app for learning CT angiography of cerebral vasculature and aneurysms [29]. Medical students showed a preference for this engaging educational tool over traditional methods, recognizing VR's potential for future learning applications in complex anatomy and pathology [30]. Virtual reality simulators, offering a spectrum of abdominal ultrasound cases, have been positively received in radiology training, with specialized radiologists noting their utility in enhancing diagnostic skills, particularly due to their realistic simulation and immediate feedback capabilities [31]. This integration of VR into radiology curricula marks a significant step forward in preparing medical students for the demands of contemporary diagnostic radiology, ensuring that they are well versed in both the theoretical knowledge and practical expertise required to navigate the future of medical imaging [32-36]. The high cost and technological requirements of VR may limit accessibility for some learners. Additionally, while immersive, VR might not always replicate the full complexity of real-world clinical environments, potentially leading to an incomplete learning experience.

Discussion

The digital transformation in radiology education, marked by the proliferation of online resources, represents a paradigm shift in how medical education is approached. The findings of this review are contextualized within the broader landscape of radiology education, drawing comparisons with previous reviews to highlight both advancements and ongoing challenges in the field. Notably, previous studies such as Smith *et al.* (2018) have documented the evolution of online radiology resources, emphasizing the growing importance of case-based learning platforms and multimedia resources in medical education. Smith *et al.* identified key resources that were foundational at the time, focusing on the use of static images and text-based tutorials, which were widely adopted for their accessibility and ease of use. However, these resources were often limited by their lack of interactivity and depth, particularly for advanced learners [37,38].

In contrast, our review highlights the significant shift towards more dynamic and interactive digital tools, including the integration of AI and virtual reality (VR) technologies. These advancements have transformed radiology education by offering more immersive and practical learning experiences, allowing students to engage with complex radiological cases in ways that were previously not possible [37]. For example, the introduction of AI-powered platforms enables personalized learning pathways, adapting content based on the learner's progress and providing real-time feedback on diagnostic accuracy. Similarly, VR applications have expanded the scope of practical training by simulating real-world radiological procedures in a controlled environment, thereby enhancing the hands-on experience of medical students and trainees [39-41].

Our review not only builds on the foundations laid by previous reviews but also provides a critical analysis of how these newer technologies address some of the limitations identified in earlier studies. While the adoption of AI and VR in radiology education marks a significant advancement, our review also acknowledges persisting challenges such as the digital divide, which can limit access to these cutting-edge resources in certain regions [42-44]. Moreover, the complexity and cost associated with implementing these technologies raise questions about their scalability and long-term sustainability in medical education programs. By comparing our findings with those of earlier reviews, we offer a comprehensive overview of the current state of digital radiology education, identifying both the progress made and the areas where further improvements are needed (Table 1) [45-47].

These platforms, Radiology Assistant, Learning Radiology, and Radiopaedia.org, cater to a wide spectrum of educational needs, offering both foundational and advanced knowledge in radiology. The global reach of these resources echoes the trends observed in other medical fields, making specialized knowledge more accessible irrespective of geographical constraints. These platforms, by facilitating the sharing and education of interesting cases online, not only navigate the challenges posed by the global pandemic but also democratize medical education across diverse geographical boundaries with contributors around the globe. As medical education adapted on a broader level, so did the sharing and education of interesting cases to adapt to an ever-changing pandemic by moving online [48].

A limitation to this study and general access to diagnostic radiology education is related to the availability of the resources. Most of the resources for radiology education are primarily geared toward resident-based education [49]. Furthermore, radiology education is seldom emphasized, with limited exposure for medical students and even less for other allied health professionals. Despite the limited exposure during training in medical school, medical students are expected to correctly identify structures and critical findings in the United States Medical Licensing Examination (USMLE) and during clinical rotations [50]. Though this may be expected during clerkships, there may be a large variety of exposure of direct

Table 1. Overview of online resources in diagnostic radiology

Resource name	Type	Key features	Specialty content
Radiopaedia.org	Website – case study	Peer-reviewed, wide range of cases	General
Learning Radiology	Educational platform	PowerPoint style presentations, interactive quizzes	General
Introduction to Radiology	Educational resource	Foundational principles	General
Introduction to Radiology (UVA Radiology)	Course	Interactive course	General
Radiology Cafe	Website	Tutorials, articles	General
Radiology Masterclass	Online course	Fundamental concepts, quizzes	General
Geeky Medics Radiology Tutorials	Tutorials	Basic to advanced tutorials	General
CTisus	Educational resource	Practical tips (PEARLS)	CT Imaging
The Radiology Review	Resource list	Case-based platforms	General
Aquifer Radiology	Virtual cases	Virtual patient cases	General
American Journal of Neuroradiology (AJNR) Cases of the Week	Case studies	Weekly neuroradiology cases	Neuroradiology
Eurorad	Case database	Subspecialty case studies	General
MedPix	Image database	Medical images, case studies	General
Radiology Assistant	Educational modules	Practical application modules	General
RSNA RadioGraphics Journal	Journal	Educational presentations and peer-reviewed publications	General
MRIquestions	Educational resource	MRI techniques and physics	MRI
SUSME.org	Educational website	Ultrasound tutorials	Ultrasound
Anki Platform in Radiology Education	Learning tool	Spaced repetition flashcards	General
Virtual Reality	Learning tool	Interactive	General

image interpretation versus dependence on the radiologist reading, resulting in poorly prepared interns.

Future directions and role of generative AI

Radiology education is evolving through the integration of generative AI, which extends beyond the long-established use of 3D imaging in radiology. While 3D models have enhanced anatomical education, the true novelty lies in how AI-driven technologies are poised to transform radiological practice itself. Generative AI, for instance, is now capable of producing synthetic radiological images that maintain realism without compromising patient privacy. These AI-generated images can be used to augment training by simulating rare pathologies, yet their most significant potential lies in their application in clinical practice – where AI can assist in diagnostic processes, improve image quality, and even suggest differential diagnoses. This shift represents not just an enhancement of educational tools but a fundamental change in how radiology will be practiced, offering new avenues for personalized patient care and operational efficiencies in radiology departments [51-53].

Generative AI is transforming radiology education by creating synthetic medical images and 3D models, offering students advanced learning tools without compromising patient privacy. This technology utilizes generative adversarial networks (GANs), variational autoencoders (VAEs), and neural diffusion models to produce diverse, realistic images for educational use, enhancing the learning experience with interactive and immersive visuals. While promising, challenges such as ensuring data quality and managing computational resources highlight the need for careful implementation. This approach not only makes education more engaging but also aligns with modern healthcare's evolving demands [54,55].

This review highlighted the extensive array of digital tools reshaping radiology education. Resources such as Introduction to Radiology, MRIquestions, and RSNA RadioGraphics Journal provide a broad spectrum of learning opportunities, from introductory modules to complex case studies and specialized knowledge. These platforms collectively contribute to a more comprehensive, accessible, and relevant educational framework, significantly influencing the trajectory of learning and skill acquisition for medical students and early stage radiology trainees. As the field continues to evolve, these digital resources will play a pivotal role in defining the standards and practices of radiology education.

Limitations

This review is constrained by several factors. Primarily, it focuses on English-language resources, potentially overlooking valuable non-English content. Additionally, the assessment of the impact of these digital resources on actual learning outcomes and skill acquisition is based on their structural and content offerings, lacking empirical data from extensive investigations. The availability and accessibility of some resources might vary, and the rapidly changing nature of digital content necessitates continuous updates and reevaluations. Further research is required to empirically evaluate the effectiveness of these digital tools in improving learning outcomes in radiology education.

Disclosures

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