

Future of Radiation Oncology Education: Transforming Scholarly Teaching Into Medical Education Scholarship

Description

Medical education must develop and adapt through robust education scholarship, applying novel teaching with evidence-based best practices to optimally convey new concepts. Continued growth in undergraduate, graduate and continuing medical education as well as in diversity, equity, and inclusion efforts, are critical for the future of radiation oncology. This review article explores how education scholarship can facilitate these advances in areas from artificial intelligence to technology-oriented teaching.

Learning Objectives

Upon completing this activity:

- Clinicians will be able to identify at least one opportunity for educational innovation at the undergraduate, graduate, and continuing medical education level.
- Clinicians will understand how scholarship in medical education has led to advancement in critical topics in radiation oncology.
- Clinicians will be able to apply Glassick's criteria to transform scholarly activity in radiation oncology into education scholarship.

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Target Audience

- Radiation Oncologists
- Related Oncology Professionals

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Abstract

Medical education is vital in preparing radiation oncologists to care for patients in an ever-changing landscape of new treatments and technologies. Medical education must develop and adapt through robust education scholarship, utilizing novel teaching with evidence-based best practices to optimally teach new concepts. Education scholarship has led to significant advances in several areas of radiation oncology education, spanning undergraduate medical education (UME); graduate medical education (GME); continuing medical education (CME); and diversity, equity, and inclusion (DEI). Continued growth in these domains are critical for the future of our field, and education scholarship can facilitate these advances.

Due to technical advances and changing treatment paradigms, the knowledge required to practice radiation oncology continues to evolve, necessitating a comprehensive and ever-changing set of educational tools to train a spectrum of learners. Over the past two decades, academic medicine, and specifically the field of radiation oncology, has seen an increasing focus on medical education.¹ This is likely multifactorial and attributable in part to an increase in learner's needs, such as the need for high-

yield teaching due to time limitations in educational settings, desire for more flexible learning options, and a generally higher standard of education exposure/expectations from a systemically more mature educational community. Increasing attention to vulnerable populations and the importance of diversity, equity, and inclusion (DEI) in health care and medical training has also fueled educational interventions and innovations.²⁻⁴ In response to this increasing focus on the value of medical education, many US

institutions now consider medical education scholarship when evaluating academic faculty for promotion.⁵ Here we describe differences between scholarly teaching and the scholarship of teaching before focusing on impactful areas of current and future medical education scholarship within radiation oncology, with a focus on undergraduate medical education (UME); graduate medical education (GME); and continuing medical education (CME); and diversity, equity, and inclusion (DEI). With educational innovation and educational scholarship, the future of radiation oncology education is bright.

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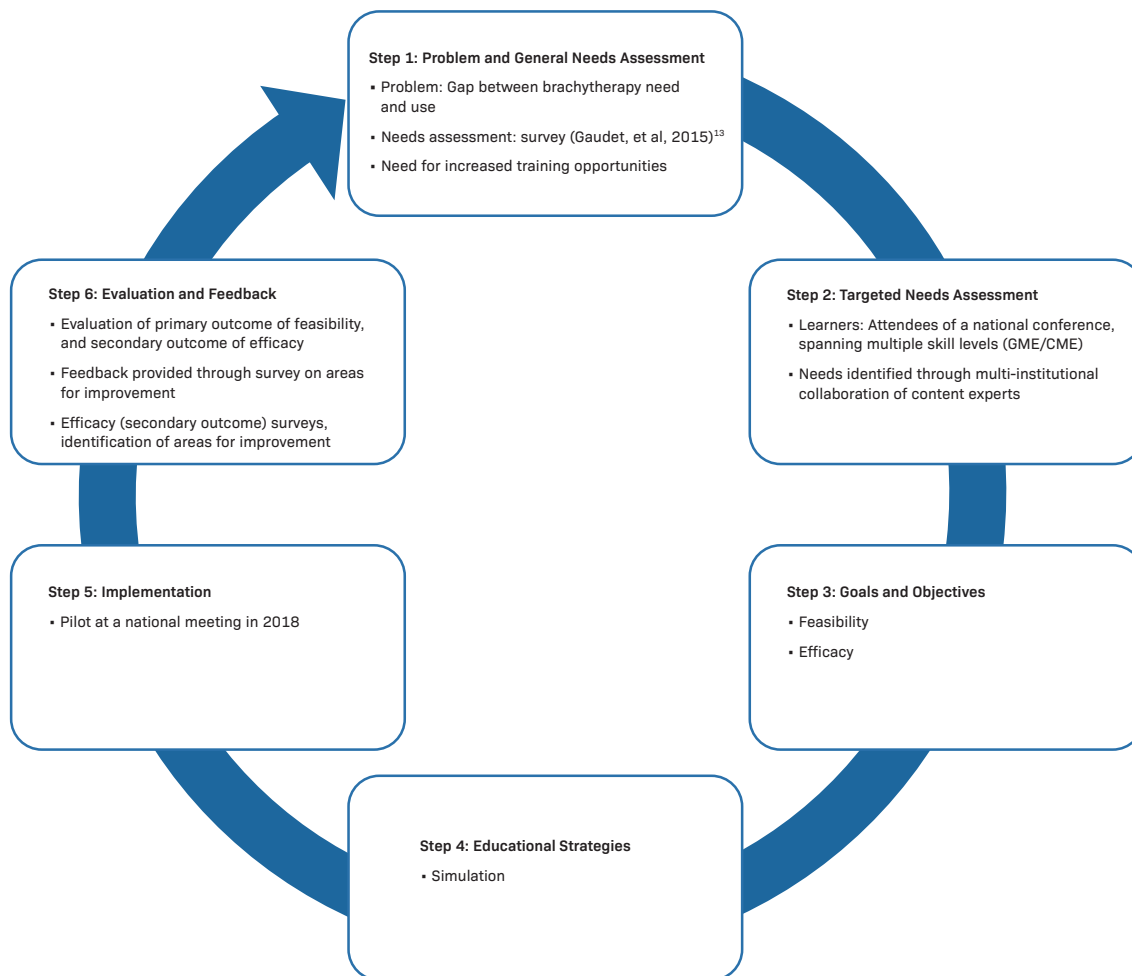
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Defining Medical Education Scholarship

Dissemination of medical education scholarship is needed to synergize efforts across institutions, and to create a foundation upon which future efforts can further advance education.

Figure 1A. Kern's Six Steps provide a framework for curricular development. In this example of efforts to improve brachytherapy education, a single research team did not focus on completing all 6 steps independently. Rather, the needs assessment was addressed through surveys and involved Accreditation Council for Graduate Medical Education (ACGME) guidelines, which were written by different authors than those in the simulation-based education project illustrated in steps 2-6.



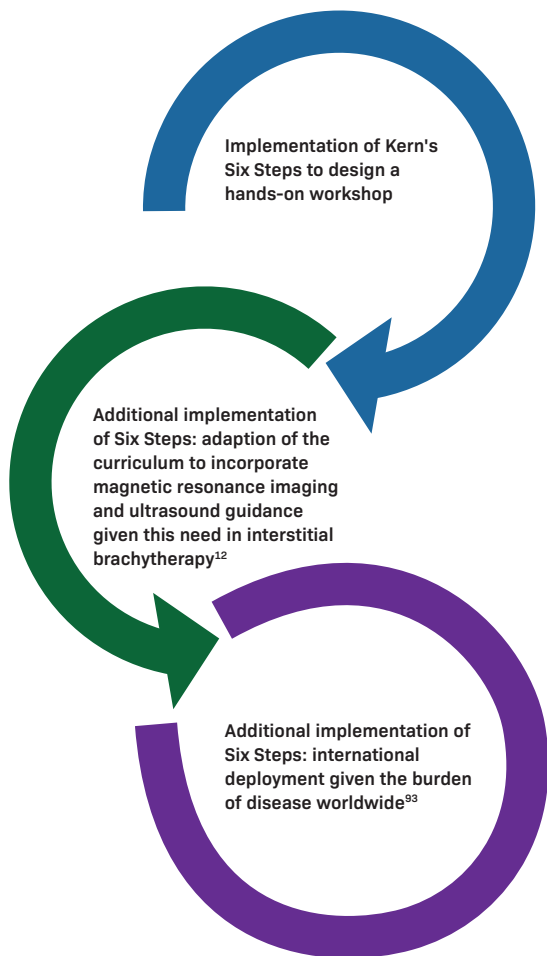
In this discussion, it is important to differentiate teaching methods within medical education (an umbrella term encompassing multiple practices in teaching hospitals) between those that specifically draw on best practices and evidence-based methods, here referred to as *scholarly teaching*, from nonevidence-based teaching methods. Scholarly teaching is similarly distinct from, though may overlap with, *education scholarship*, the process of moving the field of medical education forward by rigorously measuring, assessing, and reporting on the results of scholarly teaching for publication.⁶ These distinctions are important because the advancement of medical education

relies on both the development of scholarly teaching methods and the robust assessment and dissemination of the results of these interventions. To ensure that scholarly efforts in medical education qualify as rigorous education scholarship, scholars may look to Glassick's 6 standards for educational scholarship: 1) clear goals, 2) adequate preparation, 3) appropriate methods, 4) significant results, 5) effective presentation, and 6) reflective critique.⁷ While interventional studies and prospective trials are a common form of clinical research, impactful educational scholarship can focus on innovative teaching methods, novel educational materials, qualitative survey and focus

group assessment, and curriculum design, among other examples.

One of the most common types of medical education scholarship in radiation oncology is curriculum development,⁸⁻¹⁰ for which an established framework is Kern's Six Steps (**Figure 1A**).¹¹ These steps help ensure that Glassick's criteria are met using a structured approach to curriculum development. For example, **Figure 1A** illustrates a needs assessment of a simulation-based educational workshop for GME and CME learners.^{12,13} Evaluation of this workshop led to curriculum adjustments and additional implementations of Kern's Six Step Approach (**Figure 1B**),¹⁴ which is

Figure 1B. In Figure 1A, the sixth step of evaluating the curriculum led to multiple new directions and implementation of all of the steps, resulting in multiple scholarly educational efforts. Ongoing assessment motivates educational innovation in multiple directions, but all projects share an overarching goal to improve brachytherapy education. As shown in this example, a single cycle of Kern's Six Steps led to multiple cycles of Kern's Six Steps with additional projects listed in Figure 1B.



cyclical and can be used for continuous educational innovation. Overall, it is important to be methodical and intentional to transform scholarly activity to scholarship.

Undergraduate Medical Education

In the UME setting, medical education can be used to increase exposure to radiation oncology, which is critical for maintaining a workforce as well as preparing those in other specialties to understand when to consult radiation oncology. For students rotating in radiation oncology, an evidence-based national UME curriculum in radiation

oncology is also critical given that the field is rapidly evolving, with new technology and management indications growing from year to year. It is documented that UME rarely incorporates information about radiation oncology, while exposure increases medical student interest and affinity for the specialty.^{9,15,16}

In UME, most school curricula do not include a dedicated radiation oncology didactic session in their preclinical curricula¹⁷ and some students may not gain exposure to any aspect of radiation oncology throughout their medical school education.^{9,18,19} Novel methods of incorporating radiation oncology

into the medical school curriculum can include collaborating with pre-clinical course leaders or integrating radiation oncology into a clinical rotation.^{20,21} Radiation oncology can also be incorporated into a general oncology educational curriculum. One example of this is the Scholars in Oncology-Associated Research (SOAR) cancer research education program, a summer research experience for first-year medical students at the University of Chicago, which includes a formalized interdisciplinary and interprofessional oncology curriculum, such as 10 2-hour lectures, tumor board attendance, and half-day shadowing with a pharmacist, therapist, or palliative care advanced practice nurse.²² This program has demonstrated that preclinical students had an increased understanding of the multidisciplinary nature of oncology, including radiation oncology, after completion of the program.

In the preclinical setting, a single lecture on radiation oncology has been shown to significantly increase medical student knowledge of the field, as well as increase desire to learn more about the field.^{23,24} In the clinical setting, the introduction of an optional radiation oncology rotation during a core surgery clerkship for third-year medical students was shown to significantly improve radiation oncology knowledge and usefulness of the knowledge in their careers.²⁰ Furthermore, a structured didactic curriculum in radiation oncology significantly improved knowledge and clinical competency, suggesting that structured didactics are important to a well-designed clerkship.²⁵⁻²⁷

In addition to novel educational programs in medical school, mentorship initiatives can also promote student interest and engagement in the field of radiation oncology. A large, formalized mentorship program described by Hirsch et al, with both clinical and research tracks,

demonstrated that mentorship significantly impacts specialty selection and productivity in the field.^{28,29} This mentorship initiative was associated with high mentee satisfaction and improved confidence in the residency application process.³⁰ Similar results have been reported from other mentorship pilot programs in recent years.^{31,32}

In the COVID era, there has been a new emphasis on creating virtual mentorship and educational opportunities, which allows for expanded access to the field, even for those who attend a school without an associated radiation oncology residency program. The Radiation Oncology Virtual Education Rotation (ROVER) is one example of a novel virtual experience that implemented educational panels and case-based learning, which significantly improved medical student understanding of the role of radiation oncology in a number of disease sites.³³ Other published experiences with virtual clinic, tumor boards, and didactics in the medical student population have yielded similar results with high satisfaction rates.³⁴ The Radiation Oncology Intensive Shadowing Experience (RISE), a virtual educational and mentorship initiative for under-represented medical students, was recently implemented to help reduce the disparities in access and exposure to radiation oncology during the COVID-19 pandemic; this added to the literature questions on optimal implementation of scholarly teaching for URM students in a virtual environment, as well as reported on experiences of both mentees and mentors in this understudied educational environment.³⁵ Of the 14 URM students participating in RISE, 100% completed pre- and post-surveys with the majority agreeing strongly that they planned to utilize what they learned for their future practice (93%). This unique program centering equity and inclusion within medical education was not only feasible but

desired and highly rated by participants.³⁶ The above initiatives differ in size and scope, but all provide pathways to drive medical student interest in the field. Future directions should focus on optimizing the design, development, implementation, evaluation, and ongoing sustainability of these educational and mentorship programs as an integral part in the formation of the next generation of radiation oncologists.

Graduate Medical Education

The national requirements for radiation oncology residency training involve Accreditation Council for Graduate Medical Education (ACGME) case log requirements, American Board of Radiology (ABR) written and oral certification exams, and American College of Radiology (ACR) in-training written exams. However, the overall curriculum is left to individual residency and fellowship training programs. To provide guidance to US training programs with regard to GME curriculum, the Radiation Oncology Education Collaborative Study Group (ROECSG) formed a Core Curriculum Leadership Committee utilizing the Delphi method to identify and develop content domains (CDs) and entrustable professional activities (EPAs) to formalize a curricular framework for radiation oncology GME in the United States.³⁷ A strength of this process is the inclusion of numerous radiation oncology GME stakeholders, including academic and private practice physicians, residents, physicists, dosimetrists, nurses, therapists, and others to ensure a well-balanced curriculum.

Novel educational initiatives that leverage technology to facilitate learning in residency also have the potential to improve medical education. Recent work on web-based educational tools for residents focusing on anatomy and contouring guidelines has improved resident confidence

and competence in these areas.^{38,39} A case bank learning tool on radiation treatment plan evaluation from Princess Margaret Cancer Centre has also been shown to improve resident competency, with a pilot study demonstrating that a high-fidelity simulation platform was associated with increased learning and competency attainment.⁴⁰ A common limitation in these studies utilizing web-based or technology-oriented teaching is the reproduction of these tools outside of the institution, whether due to intellectual property concerns or resource concerns (ie, when an institution may not have the same software available to their learners). Another concern was the need for continuous information technology upkeep and maintenance that may require funding and resources. Finally, specialty curricula in radiation oncology residency have been developed in several niche areas such as global oncology⁴¹ and quality and safety,⁴² among others, with the intent that more robust education will increase career interest and progress in areas of critical need. With the increasing field complexity and growing knowledge required to be a radiation oncologist, work on innovative learning tools should be prioritized.

Future GME efforts can also focus on transition to practice. Although residency is ultimately intended to prepare physicians for independent practice, the transition from resident to attending physician is often challenging, especially in areas of limited exposure during training. Within radiation oncology, multiple surveys, editorials, and focus groups have described the encountered or anticipated obstacles involved in adjusting to unsupervised clinical care during transition to independent practice.⁴³⁻⁴⁷ Commonly cited issues include inadequate exposure to certain clinical competencies, such as treatment plan review and image verification, and limited guidance about nonclinical responsibilities, including leadership,^{48,49}

mentorship,³¹ and education.⁵⁰ Currently, there are few widely available resources to develop proficiencies in plan review^{51,52} or image verification, while resources provided by individual programs can vary significantly, or more often are lacking altogether.⁵³ Scholarship of simulation-based teaching has shown substantial impact in acquisition of practical skills and, to date in radiation oncology, simulation-based teaching has been created for plan review⁴⁰ and image verification,⁵⁴ although it has broad applicability for other radiation oncology skills, including treatment planning and toxicity management. As part of a collective effort through ROECSG, a series of workshops to structure the teaching of the basic components of plan evaluation – called the Radiation Oncology Plan Evaluation School (ROPES) – is in progress.⁵⁵ This project draws on expert consensus from multiple institutions to develop a practical educational tool to evaluate several acceptable plans in the same patient scenario. Likewise, select programs are aimed at enhancing leadership⁵⁶⁻⁵⁸ and teaching⁵⁹ skills to utilize best practices in individual environments. Another ongoing ROECSG effort is the Teaching Mentoring in Radiation Oncology (TEAMRO) program designed to develop mentoring talents among residents,⁶⁰ with a multi-institutional pilot program underway investigating whether formalized mentoring of students by residents can impact a resident's mentorship relations and education overall.

In addition to individual interventions targeting specific deficiencies, another approach would be to augment resident autonomy overall. For example, continuity clinics and “transition-to-practice” services are experiences designed to position residents as the primary care provider with appropriate supervision. While these are common across the medical field,⁶¹⁻⁶⁴ few programs in radiation oncology have been

described. Of the published experiences, the most comprehensive resident-led rotations include the senior resident rotation at Mayo Clinic⁶⁵ and the Veterans Affairs Medical Center rotation in Duke's radiation oncology residency training program;⁶⁶ however, there is a need for more robust and longitudinal scholarship demonstrating beneficial translation of these experiences into clinical practice. Both programs facilitate autonomy by allowing the resident to assume responsibility for most patient care tasks, including clinical encounters, management recommendations, documentation, directing radiation therapy planning and delivery (ie, simulation, contouring, plan evaluation, image verification), and interdisciplinary communication and collaboration. While there is attending oversight, the attending assumes a consultant role for the trainee, allowing the resident greater independence and responsibility, mimicking independent practice. Another option to promote autonomy is a continuity clinic for follow-up visits, as at the University of Southern California.⁶⁷ These clinics have been reported to improve resident confidence while addressing core issues during early independent practice.⁶⁷ Widespread use of resident-led follow-up clinics may be limited because of institutional and ACGME supervision policies but warrant additional consideration.

Continuing Medical Education

With the continuing technical advances and evidence-based clinical practice shifts in radiation oncology, the need for education does not end after residency training. With practice-changing clinical trials in radiation oncology, medical oncology, and surgery, the standard of care in any disease site continues to evolve. Although states differ in the number and type of CME credits required (for

example AMA category 1, vs AMA category 2, vs self-assessment or SA-CME), CME credits are required for state licensing, American Board of Radiology (ABR) certification and maintenance of certification (MOC). AMA Category 2 credit is self-designated, allowing physicians to claim credit for educational activities such as peer review, provided the activity meets AMA standards. Radiation oncologists may already engage in these activities at their practices. Self-assessment CME (SA-CME) is a subtype of CME that includes content followed by related questions. SA-CME has been historically required for physicians to maintain certification with ABR. Recently, the ABR announced that participation in MOC and online longitudinal assessment (OLA) would fulfill the SA-CME requirement, removing the need to complete additional self-assessment modules to meet ABR requirements.⁶⁸ It is unknown if this change will impact quality or utility of CME. Outside of self-assessment, CME enables radiation oncologists to stay current on treatments, planning techniques, and toxicity management. Annual meetings for radiation oncology professional societies provide CME opportunities. In addition, many institutions offer oncology-specific CME courses. Virtual access to these meetings during the COVID-19 pandemic enabled learning without travel, and continued virtual opportunities may improve future CME access.

Educational needs for practicing radiation oncologists also may be driven by changes in practice throughout a career, such as treating new disease sites, or by a practice acquiring new technology. Web-based contouring tools such as eContour provide a resource for ongoing contouring education for radiation oncologists across the world.^{69,70} On-the-job mentorship in brachytherapy was encouraged through the American Brachytherapy Society #NextGenBrachy initiative.⁷¹

Novel simulation-based workshops in brachytherapy have also been beneficial, and simulation-based education may enhance CME in other areas in the future.^{12,72} Currently, the ACR offers a number of multiday hands-on educational experiences for practicing radiologists focusing on topics such as breast MRI and nuclear medicine. In the future, similar courses for radiation oncologists could facilitate practice transitions or vendor-neutral understanding of new technology in a practice.

Technological advances in radiation oncology will also drive new CME needs, such as with online adaptive planning for external-beam radiation therapy. Both CT- and MR-based systems are now widely available for commercial use, necessitating the development of new physician workflows and education for clinicians unfamiliar with this technology.^{73,74} Future work in the medical education space should also focus on artificial intelligence (AI) in clinical practice, such as AI-based contouring and treatment planning.⁷⁵ As multiple recent studies have demonstrated, auto segmentation with AI and machine learning models can delineate some target volumes and organs at risk while significantly improving efficiency across disease sites.⁷⁶⁻⁸⁰ Multiple recent studies have also shown a potential role for AI-based treatment planning and optimization.⁸¹⁻⁸³ Better understanding of AI could also facilitate radiation oncology research in optimizing clinical workflow, prognosticating patient and personalization of management decisions, and identifying patients at risk of toxicity who require greater clinical attention, among other areas. Finally, AI-based tools may also be introduced into medical education to optimize teaching the next generation of learners.⁸⁴ One example is a study that found deep-learning models could take full videos of surgeons performing surgical techniques for

assessment, categorize them into individual surgical steps, and assess performance levels, suggesting a framework for assessing technical skills that may be difficult to quantify with examinations.⁸⁵ CME scholarship in adaptive radiation therapy, AI, and other areas of growth will facilitate future medical education needs for radiation oncologists in practice.

Advancement of Diversity, Equity, and Inclusion

Integration of diversity, equity and inclusion (DEI) principles and practices throughout all aspects of medical education (UME, GME, and CME) are critical to workforce training. Ultimately, the creation of clinically applicable and sustainable education solutions that advance diversity require strategies that involve all aspects of medical education and include not only underrepresented-in-medicine (UIM) physicians, but also non-UIM physicians, patients, and hospital systems.

In radiation oncology, a virtual away rotation is a medical education initiative that addresses DEI issues in clinical learning environments.^{86,87} RISE is one such example of intentionally targeting opportunities to learn about radiation oncology and UIM medical students.³⁵ The RISE program demonstrates an example of transforming education research in DEI from scholarly teaching to scholarship, as authors utilize pre- and post-surveys to investigate how scholarly teaching impacted both teachers and learners in a novel environment, with results serving to improve future iterations of scholarly teaching in the virtual environment. There are also in-person opportunities, such as in the Department of Radiation Oncology at the Washington University School of Medicine in St. Louis, which offers a 1-month medical student rotation for fourth-year medical students from diverse

backgrounds through the Diversity & Inclusion Clerkship Opportunity for Underrepresented Medical Students (D.I.C.O.M.S.) program. The rotation includes a \$2000 stipend to help offset the cost of travel, housing, Visiting Student Application Service (VSAS), and incidental expenses. National radiation oncology organizations, such as the American Society for Radiation Oncology (ASTRO), also have dedicated opportunities for medical students and early career faculty from underrepresented groups. Two examples are the ASTRO Minority Summer Fellowship Award, which exposes medical students to clinical, basic and translational research questions in radiation oncology, and the ASTRO Leadership Pipeline Program (formerly known as the Pipeline Protégé Program), a career development program aimed at increasing diversity among ASTRO leadership. Overall, as examples of scholarly teaching in DEI for radiation oncology grow, so does the need for medical education scholarship of such initiatives, highlighting the importance of evaluating and reporting on the impact of scholarly teaching on URM students, and radiation oncology trainees and practitioners, to inform and advance the field for our colleagues, patients, communities, and ourselves.

Radiation oncology residents have also addressed the need for DEI training by establishing the Subcommittee on Equity and Inclusion as part of the Association of Residents in Radiation Oncology (ARRO). The goal of the subcommittee is to foster a supportive environment for trainees, systematically assessing and reporting trends in workforce diversity, and initiating and fostering ongoing dialogue on issues of DEI and social justice.⁸⁸ With studies demonstrating ongoing workforce disparities⁸⁹ and the subsequent impact on health equity,⁹⁰ it is critical that we move toward implementation and assessment of these and

other DEI-centered interventions⁹¹ to foster sustainability and reproducibility across specialties.⁹²

Conclusion

Radiation oncology medical education is at an important inflection point where a heightened interest in educational innovation is meeting increased needs for research and innovation in critical topics across UME, GME, CME, and DEI. This article has noted several examples of education scholarship that have increased opportunity for further research into critical areas. Scholarship on mentorship with medical students has improved mentorship practices in other areas of radiation oncology. Curriculum design on special topics such as simulation-based education in brachytherapy at the GME level has led to robust curriculum design of other special topics of critical need in early training and education of other technological advances, including simulation-based training in online adaptive radiation therapy at the CME level. Results in pilot studies investigating educational approaches for UIM students suggest that DEI education can improve training and patient care. Continued efforts in education and educational scholarship can advance best practices and evidence-based approaches for teaching, both of which are essential to train a diverse future workforce in evidence-based cancer treatment.

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