

The Radiology Scholars Certificate Program: A Medical Education Learning Tool

Natalie K. Domeisen, MD, Jordan E. Forte, BS, Victor K. Agwu, MD, MS, Samuel C. Allen, BS, Nikki A. Mehran, BS, Tebianne Abubaker, BA, Nishk P. Patel, BS, Niobra M. Keah, MD, MS, MA, Yolanda Shaw, MD, MS, Frederick S. Jones, MD, Carol P. Geer, MD, Kevin D. Hiatt, MD

Rationale and Objectives: The Radiology Scholars Certificate Program (RSCP) is an extracurricular program created for preclinical medical students to address disparities in radiology education and exposure during medical school.

Materials and Methods: The RSCP was designed as a year-long program for first- and second-year medical students. The 4 key components of the RSCP are: Exposure to radiology through shadowing, knowledge acquisition through self-paced case-based learning modules, knowledge application in interactive workshops, and completion of a scholarly project. Students are required to complete at least 3 hours of shadowing, attend at least 3 workshops, complete self-paced online modules, and complete a capstone project on a topic of their choosing. Pre- and post-program surveys were administered to assess trends in participants' perception of the field and imaging-related clinical knowledge.

Results: In the first year of the RSCP, 55% of the matriculating class enrolled and of those, 84% completed the program. Approximately half of participants were female. Participants demonstrated significant improvement in radiology knowledge, with average scores improving from 52.8% to 68.6% ($p < .001$) on the knowledge-related survey questions. Significant improvements were also observed in student-reported confidence with ordering and interpreting imaging studies and in their perceptions of the field.

Conclusion: The RSCP is an effective tool for addressing deficits in radiology education and exposure during medical school. It is designed to be run by senior medical students under radiology resident and attending supervision. With motivated student and radiologist investment, the RSCP should be easily replicable in medical training programs worldwide.

Key Words: Undergraduate medical education; Medical imaging; Diversity; Curriculum.

© 2022 The Association of University Radiologists. Published by Elsevier Inc. All rights reserved.

Abbreviations: RSCP Radiology scholars certificate program

INTRODUCTION

Despite being a core component of patient care, radiology continues to be an afterthought in medical student education. There is rarely room for dedicated radiology rotations in the crowded third-year medical school clinical curricula. As a result, radiology instruction is inhomogeneous, is often informal, and is commonly delivered by non-radiologists. This system fails to impart medical students with a strong foundation in diagnostic imaging and

fails to convey accurate perceptions of radiology as a field and career option (1–4). Misperceptions of radiology are common among medical students, including views that radiologists are isolated, introverted, lacking in patient contact, and merely an ancillary service without an active contribution to medical decision making (5–10).

Fortunately, early exposure to radiology during the pre-clinical years of medical education has been shown to improve students' understanding and valuation of radiology and increase interest in radiology as a career (11–13). Various approaches have been studied in teaching radiology to medical students, with problem-based and interactive sessions found to be particularly effective in teaching correct perceptions of the field and in teaching students radiology skills that they will find valuable in their future careers (14–18). The influence of such programs has been shown to last throughout medical school (19). Even later in practice, heightened radiology exposure during medical school has been linked to improved communication between providers and

Acad Radiol 2022; ■:1–9

From the Wake Forest School of Medicine (N.K.M., J.E.F., V.K.A., S.C.A., N.A.M., T.A., N.P.P., N.M.K., Y.S., F.S.J., C.P.G., K.D.H.), Winston-Salem, North Carolina, USA. Atrium Health Wake Forest Baptist, Department of Radiology (N.K.M., F.S.J., C.P.G., K.D.H.), Medical Center Blvd, Winston-Salem, North Carolina 27157, USA. Received October 6, 2021; revised December 17, 2021; accepted December 22, 2021. **Address correspondence to:** N.K.D. Phone 412-418-5130. e-mail: ndomeise@wakehealth.edu

© 2022 The Association of University Radiologists. Published by Elsevier Inc. All rights reserved.

<https://doi.org/10.1016/j.acra.2021.12.021>

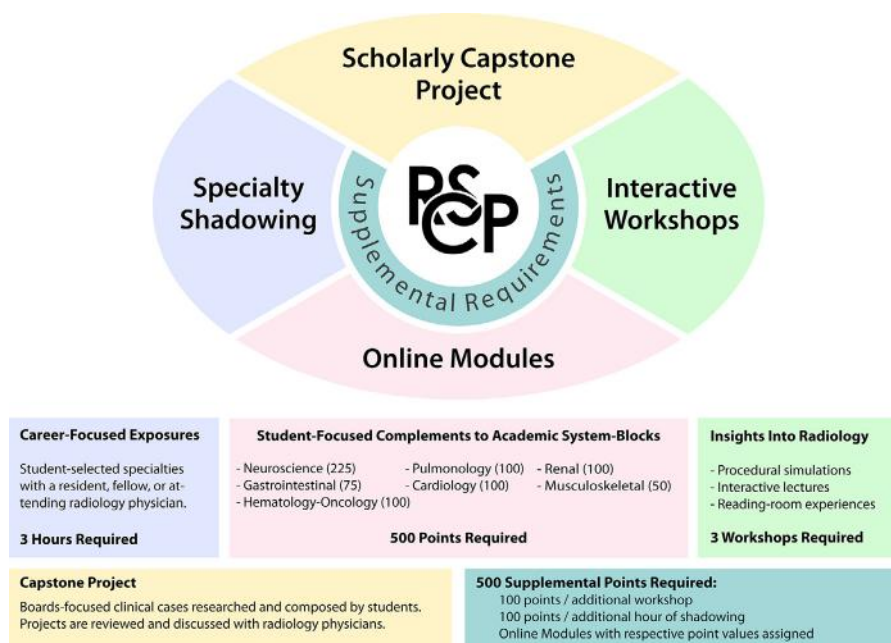


Figure 1. The radiology scholars certificate program (RSCP) is point-based, experiential learning model composed of four key components to optimize the learning experience: specialty shadowing, self-paced online modules, interactive workshops, and a scholarly capstone project. The required Supplemental Requirements allow students flexibility to tailor their certificate program experience to their interests or preferred learning modalities. Requirements and point values for each component are listed within their respective sections. Individual case module point values are indicated within parentheses.

radiologists, more appropriate use of diagnostic imaging, and enhanced overall clinical attitudes toward radiology as a specialty (3,11). While it is imperative that radiologists take an active role in improving radiology education in the medical school curriculum (3), medical student radiology interest groups are also a valuable resource for augmenting the learning experience and providing mentorship opportunities for students (8).

We designed the Radiology Scholars Certificate Program (RSCP) to address disparities in radiology education and exposure during the preclinical years of medical school. The RSCP is an extracurricular program which was created and is operated by our medical school radiology interest group with oversight and support from the radiology department. The aims of the RSCP are to teach basic principles of ordering and interpreting imaging studies and to accurately present radiology as a field and career option. Herein, we report our experience following the first year-long implementation of the RSCP, including an analysis of fundamental knowledge of radiology and student perspectives of the field following program completion. Additionally, we provide a guide to facilitate implementation of the RSCP at other institutions.

MATERIALS AND METHODS

Program Design

The RSCP is a point-based, year-long extracurricular radiology program. Supported by our institution's medical school and department of radiology, the RSCP was designed to

directly supplement the medical school preclinical curriculum and provide students with hands-on exposure to the field of radiology. The curriculum has four key components: exposure to radiology through shadowing, knowledge acquisition through self-paced case-based learning modules, knowledge application in interactive workshops, and completion of a scholarly project (Fig 1).

At our institution, the program begins in November of the first year of medical school, during the preclinical system-based pathophysiology blocks, and concludes in November of the second year, well before students' dedicated United States Medical Licensing Examination (USMLE) Step 1 study block. Approximately 20 – 25 hours over the duration of one year are required to fulfill all certification components. The points-based system is divided into Core Requirements and Supplemental Requirements. Core Requirements are mandatory for all participants and include attendance at 3 workshops over the year-long program, three hours of shadowing in reading rooms, completion of 500 points of case-based modules, and completion of a Capstone Project. Supplemental Requirements consist of an additional required 500 points that must also be attained over the course of the year. While completion of the RSCP requires completion of both the Core and Supplemental Requirements, what differentiates the Supplemental Requirements is their adaptability: they can be earned in any combination suited to the learner, including through the completion of additional workshops, shadowing, and/or case-based modules.

For completion of the shadowing component, students are required to shadow for at least 3 hours in the radiology

department over the course of the program. Participants are responsible for requesting shadowing opportunities in an area of interest and are then paired with a corresponding radiology resident or attending. Completion of a standardized signature-based verification form for each shadowing event is required. Every additional hour spent shadowing beyond the minimum of 3 required earns a participant 100 points toward the 500 point Supplemental Requirement. Due to the suspension of all shadowing opportunities at our institution during the COVID-19 pandemic, the RSCP participants were permitted to attend virtual, multidisciplinary tumor boards in lieu of shadowing for the latter half of the program during the 2020 calendar year. Point values remained equivalent at 100 points per hour of participation.

The second component of the certification is the completion of case-based modules that parallel a preclinical system-based block schedule. Although there are numerous case-based resources available, we chose to use the commercially available website CaseStacks.com for the self-paced learning component of the program, as this resource was already available at our institution. We assign sets of cases from this resource, which are carefully selected and tailored to the level of the learners so they serve as a high-yield, level-appropriate adjunct to the core curriculum. Within each case module, students are instructed to identify, describe, and interpret findings across various imaging modalities. Students can then test their knowledge by reviewing a provided discussion of key findings and relevant learning points. Sets of between 15 and 36 cases are assigned for each system block of the medical school curriculum, and points are only awarded for completion of an entire case set. Ideally, students should complete

each case set during the corresponding block of their medical school curriculum. Completion of 500 points is required to satisfy the Core Requirement component, but 750 total points are possible, allowing students to gain an additional 250 Supplemental Requirement points if they complete all case sets.

Third, a variety of workshops are provided covering different topics and utilizing different teaching strategies to allow learners to tailor their educational experience to their needs and preferences. These workshops include simulation labs, interactive case sessions, and lectures aimed to improve understanding of anatomy and the ordering and interpretation of imaging studies. For the first year of the RSCP, 13 workshops covering 8 unique topics were offered over the course of the program (Fig 2). Students are required to attend three workshops to fulfill the Core Requirement. Additional workshops attended are valued at 100 Supplemental Requirement points each (Fig 1).

Ultrasound skills workshops are offered multiple times during the year based on student demand and are staffed by radiology attendings, residents, and third- and fourth-year medical students. In these sessions, facilitators first instruct groups of 6 students on ultrasound technique. Then, students practice ultrasound technique and ultrasound-guided procedures under supervision from facilitators.

In addition, interactive workshops covering chest radiographs and head CT imaging were developed to teach high-yield concepts using a flipped classroom approach. Short pre-learning videos were created by senior medical students interested in radiology under the supervision of attending radiologists, which are reviewed by participants prior to each

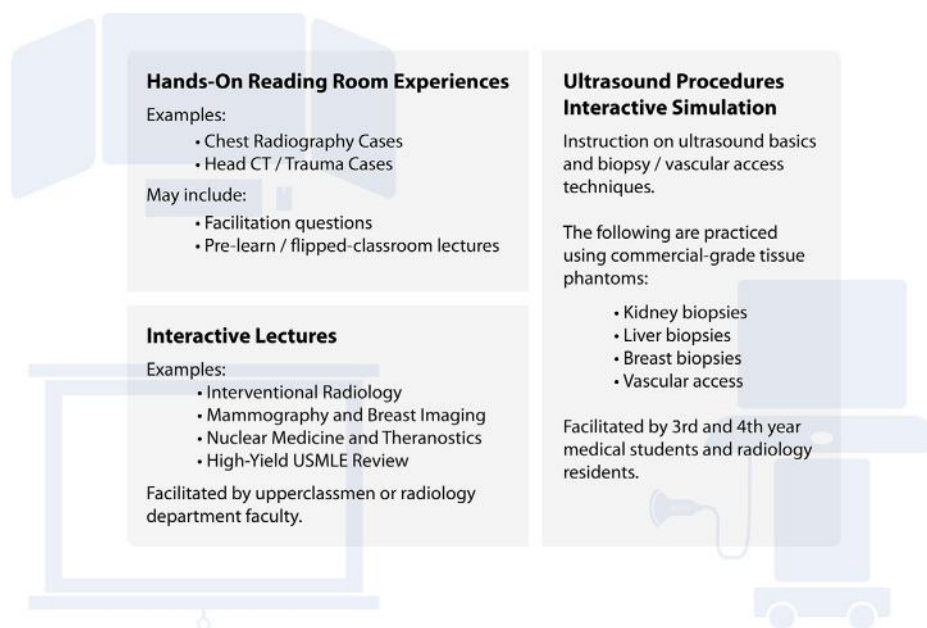


Figure 2. Workshops offered by the radiology scholars certificate program (RSCP) include: facilitated case-based learning exercises in radiology reading rooms, interactive lectures by radiology department faculty or senior medical students, and an ultrasound procedures simulation.

workshop session. During the sessions, students are divided into groups of two and rotate around a radiology reading room where an unknown case is displayed on each reading station. After examining each case independently, students review their findings and interpretations with learning facilitators consisting of radiology attendings, residents, and senior medical students. Each facilitator is responsible for two reading stations. As these workshops can only accommodate 16 students per session, they are offered multiple times during the year to meet student demand. These sessions are strategically offered during the corresponding core curriculum blocks: for example, the chest radiograph session is offered during the cardiology and pulmonology blocks and the head CT imaging session is offered during the neuroscience block.

Finally, lecture workshops are offered covering topics including nuclear medicine and the role of theranostics, interventional radiology, USMLE Step 1 imaging review, and mammography. These lectures can accommodate larger numbers of students and while they inherently offer a more passive learning experience, lecturers are encouraged to promote audience participation. Guest presenters include radiology department faculty and senior medical students who are interested in pursuing radiology as a career.

The fourth component of the RSCP Core Requirements requires students to complete a capstone clinical summary of a disease process and its associated imaging findings, emphasizing relevant knowledge for the USMLE Step 1 Exam. Students select topics for their project from a list of high-yield topics which are associated with imaging buzzwords created by senior medical students utilizing board preparation textbooks as references. Some examples include the “steeple sign” associated with croup on chest radiographs, the “pencil-in-cup” deformity of the distal interphalangeal joints associated with psoriatic arthritis, and the “boot shaped heart” on chest radiographs which the USMLE Step 1 exam associates with Tetralogy of Fallot. Students are encouraged to select topics which are interesting to them. The write-up includes a summary of the disease process, its imaging findings and the Step 1 relevance of the topic. Students are paired with a radiology resident or attending mentor to ensure the quality and accuracy of the case write-up.

Upon completion of the RSCP, students are presented with paper certificates which are signed by the faculty program director and recognized by our institution’s office of undergraduate medical education.

Survey Collection

Pre- and post-program surveys were administered to all students who registered for the program. A 10-point Likert scale was used to analyze trends in participants’ awareness of, interest in, and perception of the field. Knowledge-based multiple-choice questions were included to assess imaging-related clinical knowledge and were created by senior medical students who had recently completed the USMLE Step 2 exam and core clinical rotations (Fig 3). Optional open-ended

questions to assess gender/ethnic identifications and student feedback of the RSCP were also included in the post-program survey. Our institutional review board approved a waiver of informed consent for participation in this study.

Statistical Analysis

Participants who successfully completed all certificate requirements in addition to the pre- and post-program surveys were included for statistical analysis. A paired, two-tailed Wilcoxon signed rank test was performed to compare the Likert-scale responses from the pre- and post-program surveys, and to compare the aggregate student scores on the knowledge-based questions. Categorical factors and multiple-choice questions were evaluated for temporal associations by comparing the percentages of students selecting each response. McNemar’s test was then used to compare pre- and post-program responses to evaluate statistically significant changes for each knowledge-based question. Finally, comparisons between separate student groups, such as the responses of students who only completed the pre-survey compared to those who completed both, were performed using an unpaired, two-tailed Mann-Whitney *U* test. $p < .05$ was established as the cutoff for significance in all tests.

RESULTS

80 first year medical students at our institution enrolled in the RSCP and 67 students ultimately completed all certificate requirements. These enrollment and completion rates represent 55% and 46% of the matriculated first year class, respectively. 56 students completed both the pre- and post-program surveys, while 24 only completed the pre-program survey.

The self-reported demographic information of students completing both surveys is displayed in Table 1. Slightly more females ($n = 24, 43\%$) compared to males ($n = 21, 38\%$) completed both surveys, with 11 students (20%) preferring not to select a gender identity. These distributions approximate the gender identifications of the matriculating class invited to participate in the RSCP. There was a large non-response rate to the optional ethnic identification question; the majority of participants ($n = 34, 61\%$) identified as Caucasian, with 15 preferring not to provide a response thus limiting interpretability of participant ethnicity. Students’ self-reported time since completion of their undergraduate degrees, past exposures to radiology, and past employment experiences in radiology at the time of the pre-survey are reported in Table 1. No significant associations were demonstrated between these demographic data and student-reported interest in radiology as a career.

Participants demonstrated a statistically significant improvement in their technical radiological knowledge by the end of the RSCP, with students improving from 52.8% to 68.6% correct overall (Fig 3a, $p < .001$). Notably, students scored an average increase of 23.2% correct for questions 2 – 7. However, a 28.6% decrease in accuracy was observed for

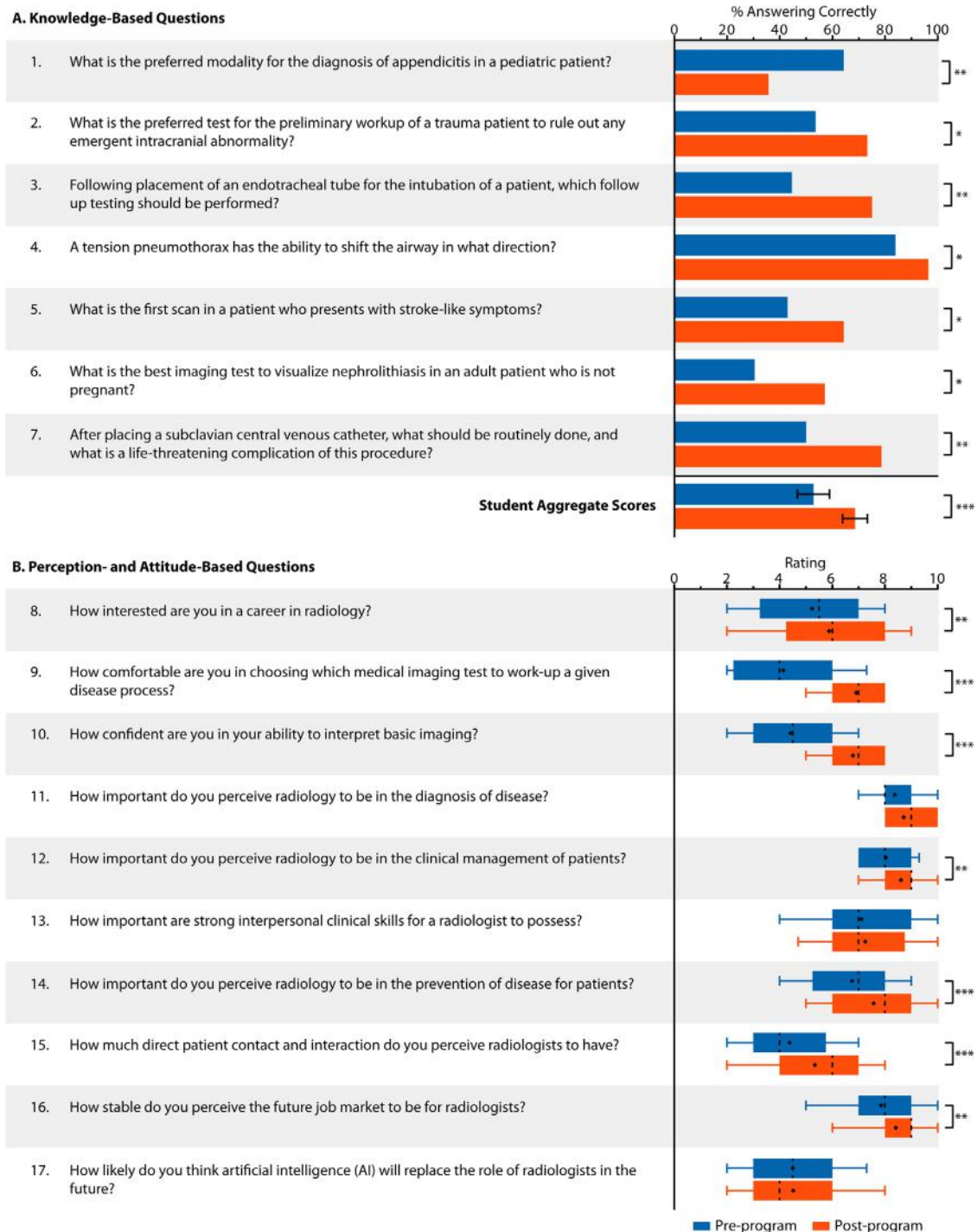


Figure 3. Results of the pre- and post-program surveys administered to all participants. (a) Image-related, knowledge-based questions. (b) Attitude- and perception-based questions toward the field of radiology before and after completion of the RSCP. The whiskers represent the 10-90th percentile of data, the boxes contain the middle 50% of the data, and the dashed lines and plus signs represent the medians and means, respectively. Statistically significant differences determined by McNemar's test or a paired, two-tailed Wilcoxon signed rank test are indicated as * $p < .05$, ** $p < .01$, and *** $p < .001$. Blue: pre-program responses; Orange: post-program responses.

question 1 (What is the preferred modality for the diagnosis of appendicitis in a pediatric patient?) ($p = .006$).

All survey responses assessing participants' attitudes and perceptions toward radiology before and after completion of the RSCP are detailed in (Fig 3b). We observed a significant

increase in students' perceived understanding of the field and the role of radiology and radiologists within clinical management (questions 12, 14, 15; $p = .002$, $p < .001$, and $p < .001$, respectively). Furthermore, participants expressed improved confidence and ability when selecting and interpreting

TABLE 1. Self-Reported Demographic Information of the Radiology Scholars Certificate Program (RSCP) Student Participants 1: RSCP Student Participants

Self-Reported Information	Number	%
Total Students	56	
Female	24	42.9%
Male	21	37.5%
Prefer not to answer	11	19.6%
Years between undergraduate education and medical school matriculation		
0 – 1	32	57.1%
2 – 3	15	26.8%
4 – 5	4	7.1%
>5	5	8.9%
Prior exposure to radiology before medical school		
Yes	18	32.1%
No	38	67.9%
Prior employment in the field of radiology		
Yes	1	1.8%
No	55	98.2%

medical imaging data (questions 9 and 10; $p < .001$). Finally, a career in radiology was viewed more favorably by students at the completion of the program (questions 8 and 16; $p = .009$ and $p = .006$, respectively). Although students did not demonstrate changed perceptions of the role of radiology within the diagnosis of disease or the importance of interpersonal skills within the field, the pre-program survey responses for these questions were already favorable (mean values of 8.38 and 7.11, respectively). Finally, the negative perception that artificial intelligence would replace the roles of radiologists remained unchanged. Although no differences were observed between the groups of survey respondents identifying as female and male, our analysis may have been limited by the sample size of each group.

Program feedback was gathered by formal, informal, and observational manners. Formalized survey-based individual feedback submitted by students completing the program was unanimously positive and most notably applauded the “hands-on” aspect of RSCP workshops as the most engaging feature. Informal verbal feedback provided by students praised the organization and procedural aspects of the program and cited the workshops as a standout component. Observationally, enrollment in workshops capped within minutes of offering student sign-ups and workshops were the most sought-after aspect of the program, continually having waiting lists for participation.

DISCUSSION

The Radiology Scholars Certificate Program (RSCP) is a novel, student-driven program that aims to provide

foundational radiology knowledge and improve student perceptions of the field of radiology. As an extracurricular program, it is spared the struggle of trying to find room in the already crowded medical school curriculum. As a student-run program, it is propelled by student energy and the promise of tangible achievement for students who both run and participate in the program. The RSCP has the potential to mold students’ understanding and perception of radiology, hopefully improving future referral relationships, promoting appropriate utilization of imaging studies, and recruiting talented and diverse students to the field.

SURVEY ANALYSIS

In its first year, the RSCP gathered strong interest, with 55% of the class enrolling in the course and 46% completing the full course. The popularity of this program is likely multifactorial. We designed this program for first year medical students knowing their enthusiasm for learning and extracurricular involvement. Additionally, the promised recognition associated with program completion was crucial for its popularity. Extrinsic motivation is often an impetus for engagement in many academic environments; we capitalized on this and subsequently sought to engender intrinsic motivation throughout the curriculum by stressing the universal applicability of radiology education. There were no predisposing features amongst the participants that predicted likelihood of enrollment, and interestingly only 32% of students enrolled in our program reported exposure to radiology prior to medical school. Regardless of student motivating factors, this program provided valuable opportunities for improving students’ perceptions of radiology and fundamental knowledge for ordering and interpreting imaging studies.

Ensuring high quality radiology education and exposure during medical school requires buy-in from radiology, as this goal is not likely to be achieved by non-radiologists (2,3,7,18,20). Radiology-driven educational programs must instruct students on the fundamentals of interpretation and utilization of imaging studies while dispelling misperceptions of the field of radiology. In addition to improving patient care, such programs may have significant financial and resource impacts. For example, interns and junior team members order the majority of imaging studies at academic institutions (21,22) and represent a potentially high-yield group of clinicians to educate to reduce unnecessary or incorrect imaging ordering practices.

The RSCP accomplishes these goals by first teaching basic image interpretation skills geared toward the future non-radiologist clinician and emphasizing an understanding of appropriate imaging utilization. Notably, participants who completed the RSCP demonstrated improved technical knowledge of radiology concepts when comparing pre- and post-program survey results. Certainly, this improvement in knowledge may reflect their overall educational progression through medical school in addition to knowledge gained through the RSCP.

The one noticeable item in the post-test that did not demonstrate improved understanding was with regard to pediatric ultrasound. There was a statistically significant decrease in the percent of correct responses for the question asking the preferred modality to diagnose appendicitis in a pediatric patient. Many students changed their response from “Ultrasound” to “CT Scan” between pre- and post-program surveys. The reasons for this change are unclear and likely multifactorial. First, students may receive misinformation within their curriculum that stresses the importance of CT imaging as a diagnostic cornerstone for emergent pathologies. Misinformation could have also originated from senior medical student and resident RSCP leaders, but we think this is less likely given the close radiology attending oversight of each educational activity in the program. Second, the preclinical ultrasound curriculum at our institution is not taught by radiologists. Third, this finding may indicate that pediatric imaging was not sufficiently emphasized in either the RSCP curriculum or the school curriculum.

Second, the RSCP aims to present radiology as a career option to attract talented and diverse students to the field. In this program, participants are challenged to assume the role of a diagnostician and better understand the intellectual demand of radiology as a specialty. Matalon et al. reported that radiologists who chose the field for its intellectual or imaging properties reported better job satisfaction than those who chose the field for other properties including quality of life (23). Furthermore, immersion in the field has been lauded as essential for students who have selected radiology as a career (24), with active participation in imaging interpretation shown to be more effective in fostering student interest than observation alone (25). Therefore, introducing radiology to medical students as a viable career option should include immersion in imaging studies and active participation in the diagnostic process.

Approximately half of participants in the RSCP identified as female. In contrast, only about one-quarter of all practicing radiologists and radiology residents are women – this percentage has remained relatively stable over time and is persistently lower than the percentage of female physicians graduating medical school (26). Increasing medical student exposure to radiology may help improve interest in and perceptions of the field among female students (6,8,10). Encouragingly, we found significant increases in student-reported interest in radiology as a career following completion of the program, with increases found in both women and men when stratified by self-reported gender. Female attendings, residents, and senior medical students are integral to the execution of the RSCP, which improves the visibility of female role models to students considering radiology as a career.

Finally, the RSCP seeks to improve future clinicians’ perceptions and understandings of the field. Following participation in the RSCP, we identified significant improvements in student perceptions of patient contact within radiology and the value of radiology in clinical decision making and disease prevention. These findings may be explained by the program’s emphasis on aspects of radiology that are not regularly

taught in medical education. For example, through lecture-based workshops, we presented topics ranging from nuclear medicine and theranostics to the applications of interventional radiology, including oncologic and palliative treatments. Educating the future generation of physicians to understand the broad purview of radiology will allow our field to thrive and be utilized to its fullest capacity. We hope that knowledge gained in this program will help optimize referral relationships between radiology and referring clinician colleagues.

HOW TO IMPLEMENT THE RSCP

The structure of the RSCP should be easily replicable and adaptable in medical training programs worldwide. The 4 key components of this program are: exposure to radiology through shadowing, knowledge acquisition through self-paced case-based modules, knowledge application through interactive workshops, and completion of a capstone scholarly project. Strategies we found particularly effective include appointing a resident liaison to coordinate shadowing opportunities and offering a variety of workshop styles and topics to cater to the diverse learning styles and interests of medical students.

The RSCP requires buy-in from the radiology department, including a proactive faculty advisor and many willing faculty and resident participants. Although financial support and protected time for radiology attendings and residents are not currently provided at our institution to sustain this program, we have found many eager to participate, motivated by opportunities to educate and mentor students and to promote the field of radiology. In fact, we prefer a system supported by intrinsic motivation rather than external gain because this helps ensure that those who do participate are committed to education and are invested in the program’s success.

The secret to the success of the RSCP is that it is run by senior medical students with support from radiology residents and attendings. We think that senior medical students, particularly those considering radiology as a career, are the ideal leaders of this program because they are attuned to the perceptions of and knowledge about radiology typical for pre-clinical students, they are motivated to improve their curriculum, they understand the nuances of scheduling events and communicating with fellow students, and they are approachable and relatable peer mentors. Peer mentorship benefits both the mentors and mentees (27) and, in our experience, the senior student volunteers have been more reflective of the gender and ethnic makeup of the medical school class than radiology residents or attendings. Relatable role models are invaluable to students considering radiology as a career option, and although diverse student mentors do not obviate the need for diverse radiology resident and attending mentors, mentorship at any level is essential for attracting talent and diversity to the field (6,8,10,28-29). Student turnover is inevitable, and the continued success of the RSCP requires maintaining strong, motivated student leadership. We accomplish this by requiring the leadership board of the RSCP to

include students from each year of medical school training. Senior medical student board members select first and second year student applicants who have demonstrated a commitment to the program and who they think possess the required leadership abilities.

While we utilized many workshop strategies, we found the flipped classroom format the most productive. Pre-learning material was designed by senior medical students and tailored to teach a few key learning points in a brief, picture-rich format. Cases were then selected for each workshop to reinforce the key pre-learning points. As students rotated around the reading room, we observed noticeable gains in confidence as they were able to make correct imaging findings and interpretations applying their newfound knowledge. Our experience supports other research indicating that the flipped classroom module and other blended learning tools help students engage in the learning process and retain what they have learned (14–15). We also found that students appreciated when sessions were scheduled to coincide with their core curriculum, which has previously been proposed as an effective strategy for encouraging retention of radiology knowledge (3). The COVID-19 global pandemic required a switch to virtual education, which we were able to accomplish by making workshops virtual and substituting shadowing requirements with virtual opportunities such as multidisciplinary tumor boards. The virtual opportunities we were able to offer allowed the program to continue uninterrupted, but may have negatively impacted chances for one-on-one teaching and mentoring. We have since explored platforms for one-on-one virtual shadowing that will be valuable if future necessity arises. Driven in part by necessity, virtual radiology education is gaining tremendous support and value, particularly in situations where health-related, socioeconomic, or geographic boundaries preclude in-person education (30–32).

Finally, the capstone project is an important opportunity for students to culminate their year of extracurricular radiology education by authoring a case write up, allowing them to meaningfully explore differential diagnoses for imaging findings beyond the rote memorization typical for standardized test preparation. While the capstone project can be tailored to the resources and expertise available at an institution, it should encourage students to explore a topic of interest to aid in their preparation for boards and to prepare for future practice. The capstone project is also an excellent opportunity to pair students with radiology resident and attending mentors. Ultimately, this exercise is intended to allow students to complete the program by applying and feeling pride for the knowledge they have gained.

FUTURE DIRECTIONS

In its second year, the RSCP continues to be a strong success at our institution, driven by motivated members of the medical school radiology interest group and supportive radiology residents and faculty. While the major components of the program remain unchanged, the capstone project has been

modified to consist of a formal case poster presentation and competition. Future directions will include expanding the curriculum to broaden radiology exposure, education, and learning application for preclinical medical students, addressing the role of machine learning in our field, and maintaining a diverse set of mentors in the radiology interest group and participating radiology residents and faculty. We plan to investigate the effect of the program on women and under-represented minorities through future pre- and post-program survey data and by longitudinally following the first cohort of students using surveys to track their perceptions of the radiology and specialty choices as they complete medical school.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

F.S. Jones and K.D. Hiatt are cofounders and owners of CaseStacks.com, which was utilized for self-directed online learning modules in this course.

CONFLICT OF INTEREST

The remaining authors report no conflicts of interest.

REFERENCES

1. Robinson AE, Voci S. On teaching radiology to medical students: a commentary. *Acad Radiol* 2002; 9:224–225.
2. Rogers LF. Imaging literacy: a laudable goal in the education of medical students. *Am J Roentgenol* 2003; 180:1201.
3. Gunderman RB, Siddiqui AR, Heitkamp DE. The vital role of radiology in the medical school curriculum. *Am J Roentgenol* 2003; 180:1239–1242.
4. Gunderman RB. Medical students are our future. *J Am Coll Radiol* 2005; 2:795–797.
5. Allen BJ, Garg K. Diversity matters in academic radiology: acknowledging and addressing unconscious bias. *J Am Coll Radiol* 2016; 13:1426–1432.
6. Heitkamp DE, Norris CD, Rissing SM. The illusion of choice: gender segregation and the challenge of recruiting women to radiology. *J Am Coll Radiol* 2017; 14:991–994.
7. Sheth MM, Robbins JB, Monawer AH. A call to action: Radiology must seize control of its own narrative. *J Am Coll Radiol* 2019; 16:856–858.
8. Spalluto LB, Arleo EK, Lewis MC. Addressing needs of women radiologists: opportunities for practice leaders to facilitate change. *Radiographics* 2018; 38:1626–1637.
9. Visscher KL, Nassrallah G, Faden L. The exposure dilemma: qualitative study of medical student opinions and perceptions of radiology. *Can Assoc Radiol J* 2015; 66:291–297.
10. Zener R, Lee SY, Visscher KL. Women in radiology: exploring the gender disparity. *J Am Coll Radiol* 2016; 13:344–350.
11. Branstetter IVBF, Faix LE, Humphrey AL. Preclinical medical student training in radiology: the effect of early exposure. *Am J Roentgenol* 2007; 188:W9–W14.
12. Donnelly LF, Racadio JM, Strife JL. Exposure of first-year medical students to a pediatric radiology research program: is there an influence on career choice? *Pediatr Radiol* 2007; 37:876–878.
13. Ghatan CE, Kuo WT, Hofmann LV. Making the case for early medical student education in interventional radiology: a survey of 2nd-year students in a single US institution. *J Vasc Interv Radiol* 2010; 21:549–553.
14. Belfi LM, Bartolotta RJ, Giambone AE. "Flipping" the introductory clerkship in radiology: impact on medical student performance and perceptions. *Acad Radiol* 2015; 22:794–801.
15. O'Connor EE, Fried J, McNulty N. Flipping radiology education right side up. *Acad Radiol* 2016; 23:810–822.

16. Scheiner JD, Noto RB, McCarten KM. Importance of radiology clerkships in teaching medical students life-threatening abnormalities on conventional chest radiographs. *Acad Radiol* 2002; 9:217–220.
17. Wentzell S, Moran L, Dobranowski J. E-learning for chest x-ray interpretation improves medical student skills and confidence levels. *BMC Med Educ* 2018; 18:256.
18. Zwaan L, Kok EM, van der Gijp A. Radiology education: a radiology curriculum for all medical students? *Diagnosis (Berl)* 2017; 26:185–189.
19. Branstetter IVBF, Humphrey AL, Schumann JB. The long-term impact of preclinical education on medical students' opinions about radiology. *Acad Radiol* 2008; 15:1331–1339.
20. Dobre MC, Maley J. Medical student radiology externs: increasing exposure to radiology, improving education, and influencing career choices. *J Am Coll Radiol* 2012; 9:506–509.
21. Iwashyna TJ, Fuld A, Asch DA. The impact of residents, interns, and attendings on inpatient laboratory ordering patterns: a report from one university's hospitalist service. *Acad Med* 2011; 86:139–145.
22. Rudolf JW, Dighe AS, Coley CM. Analysis of daily laboratory orders at a large urban academic center: a multifaceted approach to changing test ordering patterns. *Am J Clin Pathol* 2017; 148:128–135.
23. Matalon SA, Guenette JP, Smith SE. Factors influencing choice of radiology and relationship to resident job satisfaction. *Curr Probl Diagn Radiol* 2019; 48:333–341.
24. Ali S, Vines HD, Lensing SY. Factors influencing the commitment of students to radiology as a career choice during medical school education. *Acad Radiol* 2021; 28:1174–1178.
25. Huang J, Bingham B, Jordanov M. The “look ahead” technique: a novel way to engage medical students in the reading room. *Acad Radiol* 2021; 28:250–254.
26. Ladd LM, Bonaminio DN, Gonda AS. A mentorship and networking group for women in radiology. *J Am Coll Radiol* 2017; 14:987–990.
27. Choudhury N, Khanwalkar A, Kraninger J. Peer mentorship in student-run free clinics: the impact on preclinical education. *Fam Med* 2014; 46:204–208.
28. Hill E, Vaughan S. The only girl in the room: how paradigmatic trajectories deter female students from surgical careers. *Med Educ* 2013; 47:547–556.
29. Kubik-Huch RA, Vilgrain V, Krestin GP. Women in radiology: gender diversity is not a metric—it is a tool for excellence. *Eur Radiol* 2020; 30:1644–1652.
30. Darras KE, Forster BB, Spouge R. Virtual dissection with clinical radiology cases provides educational value to first year medical students. *Acad Radiol* 2020; 27:1633–1640.
31. Dodelzon K, Belfi L, Schweitzer AD. The design and preliminary experience with a virtual diversity visiting student acting internship in radiology for underrepresented minority medical students. *Acad Radiol* 2021. doi:10.1016/j.acra.2021.02.021.
32. Shah N, Nguyen JK, Gupta Y. Engaging medical students in the virtual socially distant era of the covid pandemic: online radiology resources worth exploring. *Acad Radiol* 2021; 28:733–736.