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METHODOLOGY

SOARinG to New Heights Through a Structured Medical Student Research Program

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Introduction: Since the US Medical Licensing Examination (USMLE) Step 1 became Pass/Fall in 2022, medical students competing for residency spots must distinguish themselves with alternative criteria. Research experiences and output offer valuable skill development and objective metrics to support competitive residency applications.

Objective: We describe the methodological development of a structured program to support, enhance, and track medical student research efforts at the University of South Carolina School of Medicine Greenville, explain the implementation of the program, and summarize initial program outcomes.

Methods: The Student Opportunities for Academic Achievement Through Research in Greenville (SOARinG) Program was established to serve as a centralized hub for rising second year medical student research. The program matched medical students with mentored research projects scheduled during the summer following first-year coursework. The program included a required weekly seminar series on research basics and current biomedical literature. SOARinG culminated with a student research symposium for which students submitted abstracts and presented a poster or a talk. Quantitative and qualitative program outcomes of student and mentor satisfaction with the program were measured through surveys.

Results and Discussion: The program was successfully implemented in summers 2021 and 2022. Most students (80–95%) in each class engaged in mentored summer research projects. Students reported overall satisfaction with research projects and mentor support. Overall, 69% of students rated their overall research experience in the program as extremely good or very good. Each student submitted an abstract and presented at the program's symposium or alternate research venue. Overall, 97% of research mentors reported that students were adequately prepared for summer research and suggested that students would benefit from additional skills-specific research training.

Conclusion: The SOARinG Program provided a formalized process for tracking and showcasing medical student research and allowed for increased student participation in research. Additionally, each participating student produced objective research output, thus enhancing future residency applications.

Keywords: medical student summer research, student research deliverables, student research output

Introduction

Research has long been an important aspect of medical education. Although medical students are taught to interpret research findings and exposed to limited research methodology, only some medical students actively engage in research. Participating in research teaches students to critically evaluate the medical literature, enhances future ability to practice evidence-based medicine, and develops objective research output.[1]

Research participation will be even more important since the US Medical Licensing Examination (USMLE) Step 1 is now pass/fail, as competitive residency applications will increase the emphasis on extracurricular activities.[2,3] The Electronic Residency Application Service (ERAS) application allows students to report objective research output such as

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peer-reviewed manuscripts and abstracts, poster presentations, and oral presentations. Thus, since medical students can enhance their residency applications by including objective research output on their ERAS applications, such deliverables will be increasingly important for medical students. Multiple schools throughout the United States incorporate research within the medical education curriculum. Some, such as Duke University School of Medicine and Stanford University School of Medicine, integrate research as a requirement, while others offer elective research opportunities. Duke University School of Medicine devotes its entire third year to scholarly research. At Stanford University School of Medicine, students develop scholarly concentrations via mentored scholarly study; this curricular requirement includes coursework and scholarly output such as a scientific paper.[4] At The University of Texas Medical Branch at Galveston, students may electively participate in an 8-week summer research experience for credit.[5] Months before the research elective, the program directors identify potential research mentors, who provide research abstracts that students review to select mentors. At the conclusion of the program, students present research posters.[5] At Mount Sinai School of Medicine, research opportunities are available throughout the four-year curriculum, and may include summer research after the first year or a scholarly leave following the second or third year.[6]

Such programs enhance student skills, career development, and competitive residency applications. The scholarly experiences nurtured by such programs grow critical thinking and analytical skills that better prepare students for residency.[7,8] Through research, students learn how to work in teams, communicate complicated information clearly and concisely, and manage time effectively.[8] Research opportunities also support scholarly output such as publications and presentations, which then develop student resumes and ERAS applications. In 2022, before the change from numerical to pass/fail USMLE Step 1 scores, the average fourth-year medical student had participated in 4 research experiences and had 8.1 abstracts, presentations, or publications.[9] We anticipate that the average number of such deliverables will increase as students enhance competitive residency applications in the context of the pass/fail Step 1 examination. Similarly, as residency programs adjust applicant evaluation criteria in the absence of numerical USMLE Step 1 scores, their evaluation criteria can expand to reflect extracurricular student achievements such as research experience and output.[10] Such scholarly activity was important even before the transition to a pass/fail USMLE Step 1, as many residency interviewers discuss research experiences with students.[11]

The Student Opportunities for Academic Achievement Through Research in Greenville (SOARinG) program offers opportunities for medical students at the University of South Carolina School of Medicine Greenville to develop research experience, skills, and output. This zero-credit summer elective program, which occurs between the first and second years of medical school (MS1 and MS2), allows students to gain research experience without adding additional time to the core curriculum. Students are mentored by faculty, community leaders, and researchers across the Health Sciences Center at Prisma Health (HSC); the HSC is a collaborative research initiative comprised of the University of South Carolina, Clemson University, Furman University, and Prisma Health Upstate. Students conclude their SOARinG elective by presenting poster or oral symposium presentations. These presentations tangibly demonstrate the students' research accomplishments and enhance ERAS residency applications. In this paper, we will describe the development of the SOARinG summer program for medical students, implementation of the program, initial program outcomes, and opportunities for future program development.

Methods

Program Overview

The SOARinG Program serves as a centralized program for University of South Carolina School of Medicine Greenville medical students to gain mentored research experience during the summer after MS1. This zero-credit summer elective was prospectively designed to expand student research opportunities at our young academic medical center. Prior to implementation, the elective was reviewed and approved by the medical school's curriculum committee. Students must meet the school's "Good Standing" academic policy to be eligible for this program. Students in the program participate in 100 or more hours of research with a faculty mentor over 6–8 weeks during the summer between MS1 and MS2. The hours are agreed upon by the student and the mentor based on the expected project timeline and outcomes. The faculty mentor and student mentee sign a SOARinG Mentor-Mentee agreement before the program starts; this agreement

outlines program requirements and defines specific expectations for a given project (see Supplemental Material for Mentor-Mentee agreement). All SOARinG students must submit a research abstract for the school's Annual Medical Student Summer Research Symposium. Students are required to attend a virtual weekly seminar series that supports professional development via journal clubs and workshops; workshops prepare students to prepare scientific abstracts and posters. Table 1 and Figure 1 detail the timeline for the program expectations and deadlines. All SOARinG program information for students is housed within a "course" on Canvas, the school's learning management system.[12]

Program Application

Students interested in the program submit a SOARinG application via the online platform Smartsheet in February of their MS1 year.[13] In the application, students describe their interest in and goals for summer research; they also summarize their research skill sets. Students also indicate their top three areas of interest for a research project. These areas of interest include various clinical specialties, basic science disciplines, and specific research programs affiliated with the school. Students who have already identified a research mentor can also list this information on the application.

Applications are processed during the month of March. All students who apply receive notification of research placement and mentor assignment approximately 1 month after the deadline. The process can be fluid as students might be offered multiple projects and must select one. Thus, email communication and mentor/mentee matches are tracked with Smartsheet.

Research Mentor Recruitment

Since the HSC links research mentors across multiple local academic institutions, we employ multiple methods to recruit research mentors for the SOARinG program. Prisma Health clinical faculty receive information on research mentoring from Academic Vice Chairs, research newsletters, or direct email from the medical school. Full-time medical school

Table 1 SOARinG Timeline

SOARinG Schedule	Date of Occurrence
Student Research Introduction during MS1 Orientation	July of MS1 year
MS2 Student Research Panel to share their research experiences with M1 Class	October of MS1 year
CV Preparation, Introduction to SOARinG Application, and Discussion of ERAS reportable research deliverables	November of MS1 year
MS1 students submit an intent to engage in summer research form	January of MS1 year
MS4 Student Panel to share their research experiences and how research played a role as they applied and interviewed for residency	February of MS1 year
SOARinG Application due	February of MS1 year
Discussion of Mentor-Mentee Agreement and Research Professionalism	March of MS1 year
Competitive Summer Stipend Application due	April of MS1 year
Mentor-Mentee agreements due	May of MS1 year
How to read and present a scientific paper	May of MS1 year
Summer research begins	End of May of MS1 year
Summer Journal Clubs led by students	June and July
Student meetings with research librarians	June and July
How to write a scientific abstract and prepare a research poster	June
Student Research Symposium	July

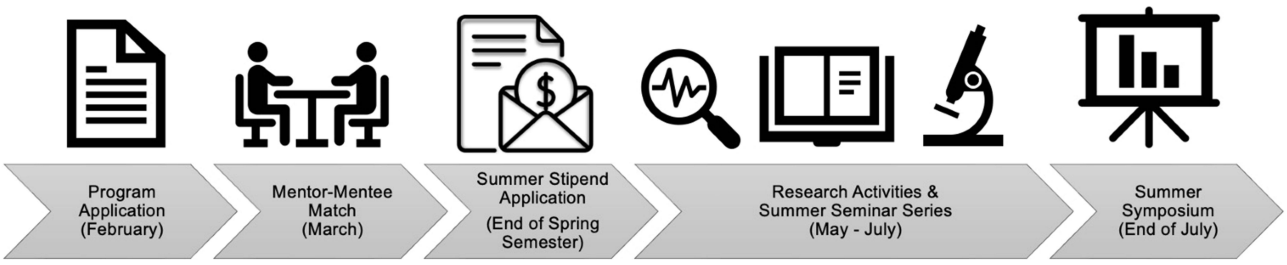

Figure 1 This timeline highlights the start to end of the SOARinG program including the application, mentor-mentee match, stipend disbursement, research and summer research activities and the summer symposium where students get to present their poster or oral presentations.

faculty receive program information from medical school department chairpersons. Program information is also distributed to partnering institutions and mentors by Prisma Health Sciences Center meetings, emails, and newsletters.

Mentor-Mentee Agreement

Once student mentees are matched to faculty mentors, they are required to review, discuss, and personalize the SOARinG Mentor-Mentee Agreement. This agreement explicitly defines the expectations for project goals, timelines, responsibilities, and deliverables. The agreement addresses key research requirements and professional expectations, including the following: the planned research must meet regulatory requirements (ie, is approved by the hospital or university IRB); mentors and mentees must schedule regular meetings to discuss project progress and must set deadlines to write, review, and revise the end-of-summer abstract; and mentors and mentees must document all research activities. The agreement also addresses common logistical challenges to ensure ongoing communication between student and mentor throughout the summer. Both parties then sign this agreement and are held to the items contained in the agreement.

Stipends for Research

The University of South Carolina School of Medicine Greenville offers a competitive summer research stipend program for students who participate in SOARinG. Once students are matched to a research mentor, they can then apply for a student stipend and associated research supply funds. Student applications include a short essay describing their motivation for participating in the research project, a short research proposal for the summer research project, and, if needed, a research supply budget of up to $500 with justification. In the research proposal, students outline the project aims, goals, timeline, methods, and anticipated dissemination of findings. Applications and requested budgets are reviewed by a committee at the medical school. Award winners receive a $1500 stipend plus up to $500 for project supply money. The number of stipends awarded by the university varies from year to year based on available funds and additional philanthropic donations.

In addition, individual clinical departments at Prisma Health provide summer stipends to students, funded from the departmental budget. Several faculty mentors within the medical school and Prisma Health pay student stipends using funds from faculty research grants.

Summer Research Activities

In addition to engaging in actual research activities in the summer months, the students are required to attend a summer virtual seminar series, journal club sessions, and individual educational sessions with the science librarians (Table 1). The seminars cover key topics and prepare students for success across the SOARinG timeline. The first session occurs during medical school orientation and is delivered by the Director of Medical Student Research and Research Program Coordinator. This session introduces new students to SOARinG and educates students on school research policies such as conference travel and research eligibility. The second and third sessions are peer-based panel discussions moderated by the Director of Medical Student research. In the second session, second-year students share their summer research experiences from the summer between their first and second years of medical school. In the third session, which occurs in the spring, fourth-year medical students share the experiences of discussing research during their residency

interviews. The seminars are mainly taught by medical school biomedical sciences faculty, but staff from Student Affairs have also helped deliver the session on preparing a CV and the discussion on the Electronic Residency Application Service (ERAS). Just prior to the start of summer research, biomedical sciences faculty teach students how to present a journal club; faculty also provide a presentation outline with examples. About halfway through the summer, faculty host another seminar that reviews the process of writing a scientific abstract and preparing a scientific poster. This session is extremely helpful as all students in the program are required to submit an abstract detailing their summer research progress for the end of summer Research Symposium. This session provides step-by-step directions, outlines, examples, and templates for the students. Students who are awarded summer stipends are required to present one journal club during the summer elective. Students are placed in small groups to prepare a journal club presentation of a recent article from the primary scientific literature and present to all SOARinG students during the summer. These journal club sessions are run virtually. Additionally, students are also required to meet one-on-one with one of the science librarians (employed by the university or hospital system) to review how to identify and locate scholarly resources for their specific summer research project. The librarians teach the students how to use PubMed to locate credible resources and give them a brief overview of the available reference management software.

End of Summer Student Research Symposium

At the end of the summer, The University of South Carolina School of Medicine Greenville hosts an annual Student Research Symposium to showcase the work of all the medical students involved in the SOARinG program; high school and undergraduate students who have conducted research at the medical school are also eligible to participate in the symposium. All SOARinG students are required to submit an abstract detailing their research progress from the summer for presentation as a poster or oral talk. Abstracts are reviewed by a faculty panel to determine the awarding of oral presentations. All submitted abstracts are published in an abstract book housed on the school's website. The symposium typically includes at least two poster sessions and at least one oral presentation session. Several research awards are also presented at the symposium. Students who cannot attend the event are required to submit an abstract to the annual research symposium held at Prisma Health or to the annual University of South Carolina research day event.

Surveys and Data Analysis

In the weeks after the Student Research Symposium, all students and faculty mentors who participated in SOARinG receive surveys via Smartsheet. Survey data collected in summer 2021 and 2022 was recorded and de-identified for analysis. Data was compiled into one spreadsheet for student-specific responses and one for research mentor responses. Preliminary analysis was performed using Microsoft Excel data analytic functions. No responses from initial data collection were excluded from analysis, unless "N/A" was recorded for an individual question.

Results

SOARinG is an initiative that facilitates formalized, mentored research opportunities for first-year medical students at the University of South Carolina School of Medicine Greenville. Since the program's inception 3 years ago, this program has engaged 253 medical students in clinical, translational, and basic science research (69 students in summer 2020, 90 students in summer 2021, and 94 students in summer 2022). A portion of the students were also paid a summer research stipend either from the university's stipend program or from departmental or research grant funding. In summer 2020, 23 students were paid a summer stipend; this number increased to 48 students in summer 2021 and to 69 students in summer 2022. These stipends were paid by medical school funds, clinical department funds, research grants, or philanthropic donations to the school.

One objective measure of student research productivity is the total number of abstracts presented as posters or oral presentations at the end of summer Student Research Symposium. The summer 2021 Student Research Symposium included 65 poster presentations and 16 oral presentations delivered by SOARinG medical students; this increased to 72 poster presentations and 10 oral presentations in 2022. End-of-summer survey results were collected from 2021 to 2022 summer cohorts to assess the overall quality of and satisfaction with SOARING. Overall, 62 survey responses were

collected from student participants, and 39 responses were collected from participating research mentors who served as mentors for students in SOARinG in summer 2021 and 2022.

Student Research Experience and Satisfaction

Student survey results (Figure 2) revealed that 29% of participants found their overall SOARinG experience to be extremely good, 40% reported a very good experience, 15% had a moderately good experience, 8% had a slightly good experience, and 5% did not have a good experience. Students conducted research in a variety of clinical departments, one basic science department, and other affiliated universities and research centers. Subsequently, 39% of student participants rated the quality and interest of their research to be extremely interesting, 42% very interesting, 15% moderately interesting, and 5% slightly interesting. Students reported spending between 100 and 140 hours conducting research over 6–8 weeks during the summers of 2021 or 2022.

Quality of mentorship was an influential factor in student experience. Students were asked a free-response question based on their experience working with their research mentor and were asked to provide positive and/or negative comments. The responses were grouped into one of two categories for qualities of a "good mentor" or a "poor mentor." Students reported that a "good mentor" excelled at communication and was attentive, helpful, flexible, enthusiastic, and knowledgeable; good mentors set attainable goals and provided feedback. Students reported that a "poor mentor" was unresponsive or difficult to contact, overcommitted, and busy. Students were then asked to rate the quality of their mentor regarding helpfulness. The majority, 52%, found their mentor extremely helpful, 23% very helpful, 16% moderately helpful, 6% slightly helpful, and 3% not helpful. Overall, 94% of students (in 2021 and 2022) reported that they completed sufficient work on their research project to prepare a poster or oral presentation for the end of summer Research Symposium or for a fall or spring conference presentation.

Research Mentor Experience and Satisfaction

A total of 39 survey responses were collected from research mentors that mentored SOARinG students during the summers of 2021 or 2022. Faculty research mentors typically mentored one or two medical students per summer session, although some research mentors guided more than 2 students each summer. While each medical student was required to pursue a unique focused research question, students working with one mentor often collected, shared, and analyzed data together. The mentor survey asked whether research mentors wished students had additional skills or training prior to the start of the SOARinG research elective. Overall, 32% reported no additional skills were needed, while 26% indicated a need for RedCap training, 13% statistical software, 10% EPIC, 10% scientific writing, 6% qualitative data analysis, and

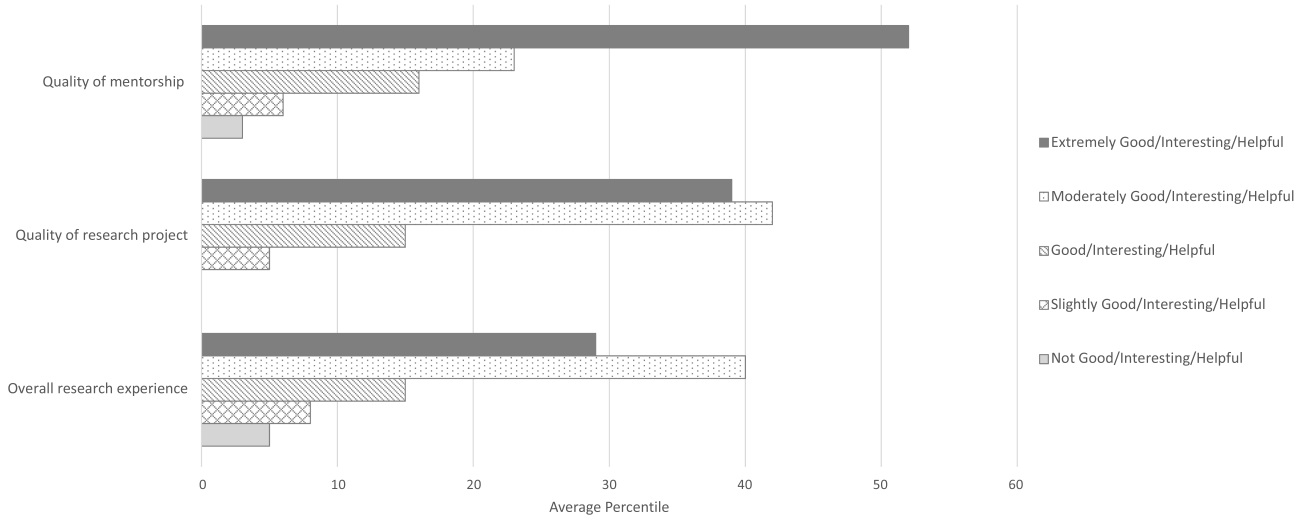

Figure 2 Student's ratings of SOARinG Program in 2021 and 2022. At the conclusion of the summer, students in the program were asked to rate the quality of mentorship, their research project and their overall research experience using a Likert scale (62 total student responses).

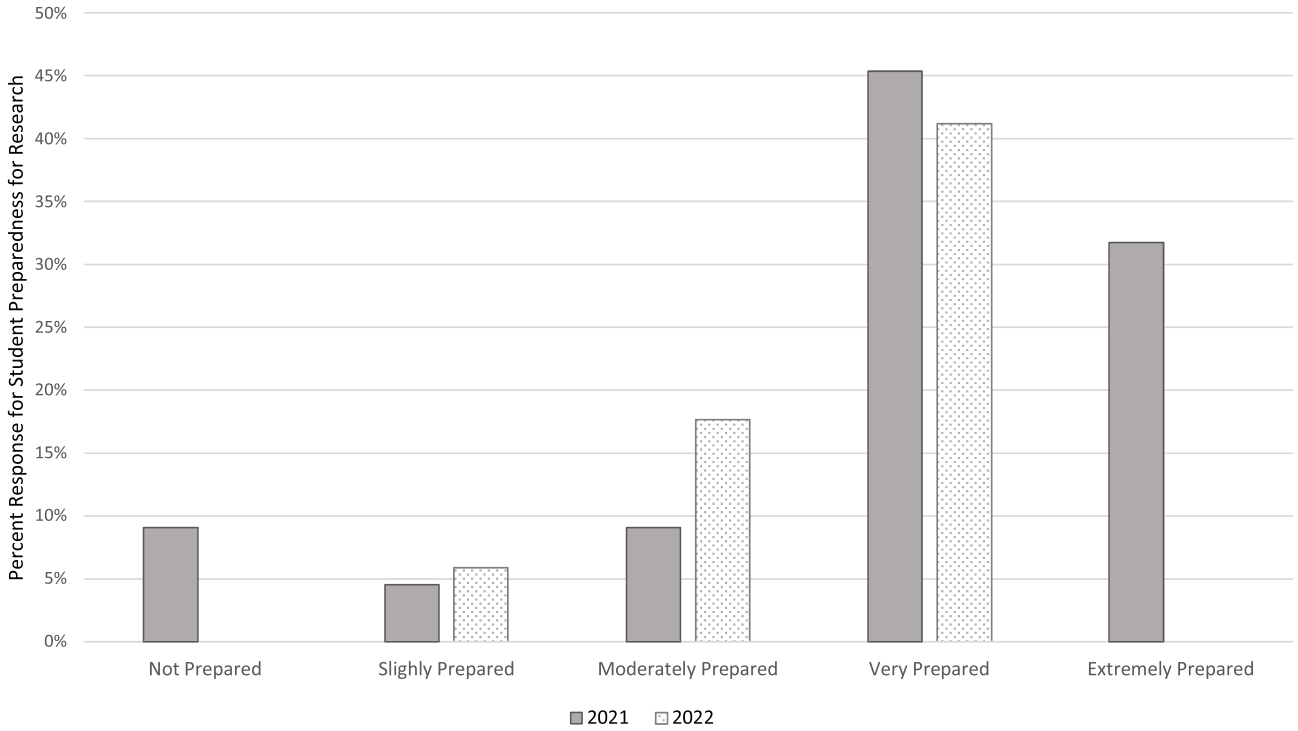

Figure 3 Mentor's ratings of the level of preparation of their students for the summer research activities. At the conclusion of the summer, mentors were asked to rate the student's level of preparation for engaging in summer research on a Likert scale (39 total mentor responses).

3% clinical experience. Mentors also answered binary yes/no questions about their experience and satisfaction with SOARinG. Overall, 97% of mentors felt their medical student was adequately prepared to participate in research (Figure 3). Overall, 85% of mentors felt their expectations for student outcomes were clearly communicated by the medical school. Thirty-six of 39 (92%) mentors reported that having an established mentor-mentee agreement was beneficial for developing expectations for the students. Thirty-eight of 39 (97%) mentors were satisfied with the outcome of the student's project, and 37 (95%) mentors stated they would mentor again after their experience with SOARinG.

Discussion

Since the landscape for medical education is constantly evolving, medical students, faculty, and staff must adapt to accommodate these new changes. In this constantly changing landscape, the scientific method remains a foundational driver of advancement across medicine; understanding the scientific research process is therefore an essential skill for medical student growth. As medical students adjust to the recent loss of a quantitative STEP 1 score, the associated opportunity to supplement medical education and create a holistic, competitive application has led to increased interest in research.[10] The University of South Carolina School of Medicine Greenville has worked to accommodate increasing student interest in research by building a structured summer research experience (SOARinG) that develops research skills with objective output, provides excellent mentorship, and offers summer stipends during the break between MS1 and MS2.

SOARinG pairs students with specific clinical departments and faculty research mentors that align with their students' personal research interests and goals. The overwhelming majority of students in SOARinG successfully presented a poster or oral presentation based on work they completed over the 6–8 weeks SOARinG summer elective. The number of students participating in SOARinG increased over the last 2 years. Several factors supported this growth. First, in response to student feedback, SOARinG leadership streamlined the process and logistics used to match students with research projects. Second, incoming first-year medical students were invited to attend the summer Research Symposium; this early exposure to ongoing research efforts encourages students to pursue future research opportunities. Third,

students understand the importance of extracurricular activities that contribute to a holistic, well-rounded self-presentation for future residency applications.

SOARinG started in 2020; since its inception, student involvement has increased from initial 69 students (2020) to 90 students (2021) to 94 students (2022). Thus, in summer 2020, approximately 61% of the cohort (Class of 2023) participated in SOARinG; in summer 2021 approximately 76% of the cohort (Class of 2024) participated in the program and in summer 2022 87% of the students (Class of 2025) participated in the program. This increasing trend of student participation in the SOARinG program parallels successful research outcomes, as 94% of the students in the program in 2021 and 2022 reported that they completed sufficient work on their research to prepare a poster or oral presentation for the school's Research Symposium.

The number of awarded summer stipends also increased from 23 to 69 over the same time frame. This financial support expanded the opportunities for students to acquire research experience without expanded financial burden; we note that the financial aid package provided to students over the course of their medical studies does not account for the summer months. Typical financial aid packages only provide students with a budget to cover tuition and estimated living expenses for approximately 10 months. The stipend allows students to focus on their summer research and expand their scientific knowledge. Part of the success of the SOARinG program may be attributed to the awarding of summer stipends for research. Future surveys of the SOARinG program will seek to determine if the stipends were a motivating factor for students to participate and whether the stipend contributed to student satisfaction with the program. In addition, it is important to note that SOARinG is a summer program that allows for dedicated time for students to conduct research when classes are not in session. This is a huge benefit for students but does not necessarily provide an accurate representation of the time they would likely have to conduct research when they are practicing physicians. It is important to note that many of our students continue to conduct part-time research after the SOARinG program ends when they are enrolled in coursework during their second, third, and fourth years of medical school.

One of the key objectives of SOARinG is to teach students how to effectively translate research findings into a presentation format that effectively communicates project goals, results, and broader implications. SOARinG offers a holistic approach to research skill development by providing an immersive research experience during which students generate research questions; collect and analyze qualitative or quantitative data; and prepare and present results, first as a scientific abstract and then via poster or oral presentations. These experiences strategically support students developing a research foundation that will help them appreciate evidence-based medicine and encourage involvement in future research opportunities.

Conclusions

In the span of 6–8 weeks, SOARinG students engaged in research ranging from basic science to clinical research and translated their research findings into a poster or oral presentation. SOARinG is a successful program, with strong positive feedback from mentors and mentees alike, and with measurable objective research outputs. We have progressively expanded the summer stipends that support summer research experiences. In 2022, approximately 73% of SOARinG students received a summer stipend paid by various resources. We believe that all medical students should have the opportunity to conduct research over the summer without incurring additional financial burden. Thus, the program directors are working with the school's philanthropy office to try and offer a summer stipend to every SOARinG student. In parallel, as the medical school encourages students to present their research at local, regional, and national conferences, the school provides travel funds for each student to attend one conference each year to present their research. Presenting research at a national conference is often the culmination of several years of work; we believe that SOARinG provides a foundational opportunity for students to begin fruitful research projects with long-term impact.

The SOARinG program allows students to explore research opportunities when they are not fully engaged in medical school coursework. During the summer elective program, students have time to experience the research process by asking questions, collecting data, analyzing data, and drawing conclusions. Students develop scholarly output during the summer; they can then showcase their research experiences on their ERAS application. The current end-of-summer survey, completed at the very start of MS2, captures data regarding students' participation, level of preparedness, and overall quality of and satisfaction with the research experience. To fully understand the impact of SOARinG, future

evaluations will need to longitudinally track scholarly output following the summer elective. These metrics will require sequential, longitudinal surveys or a database that captures longitudinal student research involvement throughout the 4 years of medical school. The survey should aim to capture students' research output such as poster and oral presentations at regional and national conferences as well as peer-reviewed, published abstracts and manuscripts. Currently, this information is self-reported by students through a static form link available on the school's student research Canvas site. A complete collection of student research experiences across all 4 years of medicine would allow us to ask more questions about the overall student research experience: Does participation in SOARinG after the MS1 year lead to more research productivity in other research projects in later years of medical school? Does the quantity of scholarly output of students at our medical school impact residency placement? Having a complete and accurate dataset of research output will inform the future success and development of the SOARinG program.

Abbreviations

MS1, first year medical school student; MS2, second year medical school student; USMLE®, United States Medical Licensing Exam®; NBME, National Board of Medical Examiners®.

Data Sharing Statement

The datasets generated and analyzed during the current study are not publicly available because this was an internal review of student data at one school but are available from the corresponding author on reasonable request.

Ethical Approval

This study received an exemption from Human Research Subjects on 2/7/2023 by the University of South Carolina Institutional Review Board. The reference number is Pro00126826.

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Author Contributions

RJC and SE initially designed the SOARinG Program. RJC, SE, AD, and SG worked together to implement the SOARinG Program and collect feedback. RJC, SE, and DTN took the lead on drafting the methods. RJC and EW took the lead on analyzing the survey results. RJC, AB, and KR collected the background references for the article. RJC and DTN took the lead in developing figures. AD and SG took the lead on draft revisions to generate the final version. All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests in this work.

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