

Evolution of a Plastic Surgery Summer Research Program: Lessons Learned from Programmatic Evaluation and Quality Enhancement

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Background: Early surgical exposure and research fellowships can influence medical students' specialty choice, increase academic productivity, and impact residency match. However, to our knowledge, there is no published guidance on the programmatic evaluation and quality enhancement necessary for the sustainability of formal plastic surgery summer research programs for first year medical students. We present seven years (2013–2020) of institutional experience in an effort to inform program development at other institutions.

Methods: From 2013 to 2016, a sole basic science research arm existed. In 2017, a clinical research arm was introduced, with several supplemental activities, including surgical skills curriculum. A formalized selection process was instituted in 2014. Participant feedback was analyzed annually. Long-term outcomes included continued research commitment, productivity, and residency match.

Results: The applicant pool reached 96 applicants in 2019, with 85% from outside institutions. Acceptance rate reached 7% in 2020. With adherence to a scoring rubric for applicant evaluation, good to excellent interrater reliability was achieved (intraclass correlation coefficient = 0.75). Long-term outcomes showed that on average per year, 28% of participants continued involvement in departmental research and 29% returned for dedicated research. Upon finishing medical school, participants had a mean of 7 ± 4 peer-reviewed publications. In total, 62% of participants matched into a surgical residency program, with 54% in integrated plastic surgery.

Conclusions: A research program designed for first year medical students interested in plastic surgery can achieve academic goals. Students are provided with mentorship, networking opportunities, and tools for self-guided learning and career development. (*Plast Reconstr Surg Glob Open* 2023; 11:e4785; doi: [10.1097/GOX.0000000000004785](https://doi.org/10.1097/GOX.0000000000004785); Published online 17 February 2023.)

INTRODUCTION

The growth of plastic surgery depends on training future generations. Rohrich (2008) highlights the importance of plastic surgery's involvement in all years of medical school and urges program development nationally.¹ Early surgical exposure has been recognized as the most important factor influencing medical students' choice of surgical specialty.^{1–3} In a study

evaluating the impact of surgical exposure on medical students' specialty choice, the implementation of an 8-week surgical research program resulted in interest in surgery, with over half of the participants who applied to residency matching into a surgical specialty.⁴ The need for early exposure to plastic surgery is further evidenced by medical students' lack of understanding of the scope of the field, which can negatively impact future referral patterns.^{5,6}

A research fellowship with a structured curriculum can provide medical students with early exposure to plastic surgery and be highly beneficial for residency applicants. The integrated plastic surgery residency track is among

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the most competitive specialties, with the applicant pool including some of the highest United States Medical Licensing Examination scores and greatest number of Alpha Omega Alpha Honor Medical Society members.^{7–10} A research fellowship provides the opportunity for students to improve their oral presentation experience and publication record, as well as develop a valuable professional network.¹¹ This supports the ability to obtain high-quality letters of recommendation, which was ranked in a national survey of plastic surgery program directors as one of the most important contributors in selecting residents.¹² The contributions of plastic surgery research fellows have historically been important, with published institutional experiences showing significant increase in academic research productivity with the incorporation of formalized research fellowships.^{13,14} Applicants who complete a research fellowship demonstrate significantly higher match rates than those who do not, and research productivity is significantly greater in successful match for reapplicants.^{15–17} Applicants continue to find dedicated research time important when evaluating residency programs.¹⁸

To our knowledge, there is no published guidance on the implementation of formal plastic surgery summer research programs for first year medical students. In this study, we present our institutional experience and process of programmatic evaluation developing a plastic surgery summer research program for first year medical students. Through participant feedback, institutional support, and engagement of senior medical students, post-doctoral research fellows, and department faculty, we were able to establish and continuously refine a successful research program that can herein be used as a model to evaluate and enhance current programs and develop similar programs that foster early, structured research experience in plastic surgery.

METHODS

This study presents an iterative quality enhancement process implementing a plastic surgery summer research program for first year medical students at our institution over 7 years (2013–2020). We designed the program to provide a structured learning experience for first year medical students by utilizing a curriculum and learning objectives that afford students the opportunity to harness critical thinking and fundamental research skills. These include identifying problems, formulating research questions, designing studies, collaborating within diverse teams, and communicating effectively through writing and public speaking. The program is structured to develop leadership and mentorship expertise, in addition to project management skills within a team composed of peers, senior medical students, research fellows, administrators, and faculty. An 8-week program duration complemented established medical school curricular schedules and mirrored reports of prior successful research opportunities.³

Initial Program Development

The first iteration of the summer research program in 2013 filled the gap of limited plastic surgery research

Takeaways

Question: How has a plastic surgery summer research program for first year medical students evolved and impacted career development?

Findings: As demonstrated through a single institution experience, an 8-week research program designed for first year medical students interested in plastic surgery can successfully provide mentorship, networking opportunities, and tools for self-guided learning and career development.

Meaning: A research program designed for first year medical students interested in plastic and reconstructive surgery can achieve academic goals and be used as a model for early structured research experience in the field.

experience for students, but was unstructured without clearly defined curricular objectives or mentorship roles. Early feedback allowed recognition of an opportunity to delineate expectations and goals of the program. By evolving an 8-week research curriculum, we hypothesized that students who participated in the program would enter their fields better equipped to incorporate research into their clinical practice. In the short-term, this early, formal exposure could spark interest in pursuing research activities throughout medical school and residency.

We placed additional focus on maximizing mentor and mentee productivity within an eight-week period. From 2013 to 2016, a sole basic science research arm existed. In 2014, we introduced a formal application process, with established start and end dates. We chose to reduce the number of informal volunteers in favor of an application-based selection process. The smaller group allowed mentees to work in closer proximity to research staff and receive individualized attention.

Over the next 4 years, the programming team gathered data to present to the department to support funding avenues and attract a larger applicant pool. This program has since been funded by the department, including student stipends and full time research staff. Each year, we incorporated specific feedback from participants in order to improve communication and tailor management and programming. In 2017, we introduced a clinical research arm. Supplemental activities incorporated with this phase of the program included weekly journal clubs, laboratory meetings, and surgical skills sessions. Participants attended weekly departmental grand rounds and participated in research day, which evolved into presenting their work in front of the department. The incorporation of this additional programming is also supported by survey data of what trainees desire from their teachers in order to improve their educational experiences.¹⁶ Program expansion allowed for one-to-one mentorship from senior research fellows, with a ratio of two to three students to every faculty member. A general calendar of events for participants is outlined in Supplemental Digital Content 1. (See table, Supplemental Digital Content 1, which displays

the general calendar of events for the 8-week summer research program. <http://links.lww.com/PRSGO/C368>.)

Yearly Planning

Figure 1 delineates the most up-to-date yearly planning timeline. Execution of each category of tasks requires input from multiple groups within our programming team. Success is achieved through the cohesive efforts of financial administrators, pre- and postdoctoral research fellows including residents, senior medical students, and faculty. A central project manager role is necessary for coordination and timely execution of all steps. This organizational model functions as a multi-level tiered training system, which provides a mutual mentorship experience for all involved. It has also established a sustainable framework for yearly program implementation.

Information Session

Recruitment through the online platform¹⁹ is supplemented by face-to-face efforts. In coordination with the Office of Student Affairs at NYU Grossman School of Medicine, the programming team and program alumni participate in a town hall-style information session followed by a summer program fair. Program alumni serve a critical role as their perspective is highly valued by prospective students. A printed flyer containing program highlights supplements the information shared with students. (See document, **Supplemental Digital Content 2**, which displays the information session program flyer example from the 2020 application cycle. <http://links.lww.com/PRSGO/C369>.) Team members address follow-up questions via email and/or phone.

Application and Student Selection Process

Only online applications are accepted. Table 1 demonstrates the application questions. In order to review upwards of 100 applications, we assign each application to two evaluators using a randomized assignment generator.²⁰ For the most recent application cycle, we developed a scoring rubric (Fig. 2) to grade applications according to seven criteria. The rubric is adapted from online educational resources and instruction literature.^{21,22} A heterogeneous panel of evaluators from the research team are responsible for assessing the applicant pool. Most recently, this panel consisted of two senior medical students in predoctoral research fellow roles, three residents in full-time postdoctoral research fellow roles, and one basic science faculty member.

For each application, readers assign scores of one (lowest) through five (highest) per criteria based on the rubric, and then assign an overall impression score out of five. During a meeting between all evaluators, overall impression scores are combined to generate a composite score out of 10. If impression scores are found to be discrepant, a group discussion is conducted to reach consensus and designate a composite score. Each member of the selection committee has an equal vote. In the data presented, we assessed interrater reliability retroactively by determination of intraclass correlation coefficient.²³

In-person or web-based 10-minute, semistructured interviews are granted to up to 20 applicants, depending on application year and applicant pool. Semi-structured interviews provide an opportunity to interact with prospective students and assess communication skills, while also exploring several predetermined themes such as interest in plastic surgery, curiosity in research topics, and prior experience working within a team. All application evaluators are present

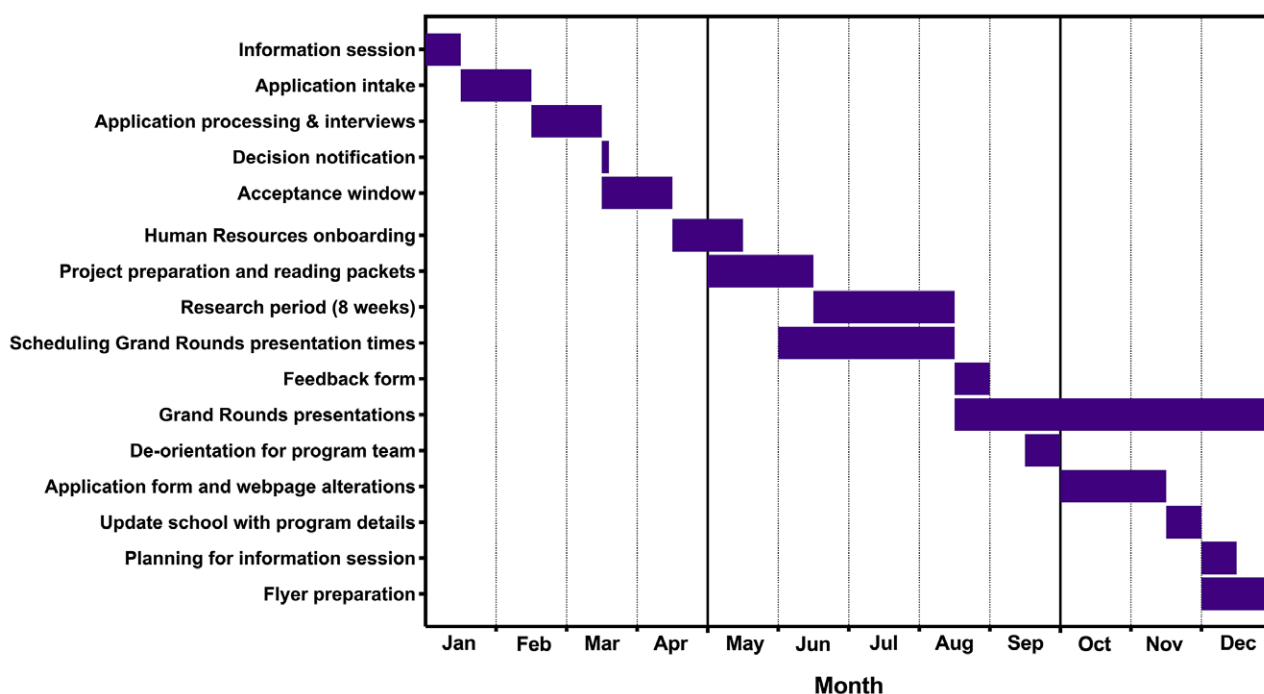


Fig. 1. Yearly planning timeline.

Table 1. Application Requirements and Questions

Summer Program Application	
Personal information	
Name	
E-mail	
School and year	
Please indicate your research interest	
Clinical	
Basic science	
Both	
Please briefly describe any previous research experience	
Statement of purpose	
Please describe why you are interested in this research opportunity (in 300 words).	
Please upload your resume (not CV).	

for the interviews and may refer to each interviewee's application, resume, and composite score. We then rank all interviewees and subgroup based on their expressed interest in clinical research or basic research, or both. We offer positions to the top three students per group and generate one combined waitlist in the event an applicant declines the offer. The timeline from application submission deadline to acceptance notification typically spans 1 month.

Program Evaluation

In the last week of the program, mentors conduct individual exit interviews with each participant. We provide

tailored feedback for each student and explain future research opportunities. Within 1 week of program conclusion, we distribute an online feedback form (Table 2) that rates the program on multiple parameters using a five-point Likert scale. The responses are pooled by the director of the program, anonymized, and shared with the program team. On the administrative side, we take into account the feedback from students and staff to refine timeframes for administrative tasks, and discuss funds and operational dates for the following year. On the mentoring side, we conduct a de-orientation based on responses and discuss which feedback to incorporate into the following year's program. Individual mentors receive feedback as well. We save all proposed changes for the following year in written form.

Long-term program evaluation included analysis of continued research commitment and productivity. We defined research commitment as students who continued to perform research after program completion or returned to the department for dedicated time as a research fellow outside the medical school curriculum. Productivity is measured by number of peer-reviewed articles published and searchable on PubMed after program completion and before medical school graduation. This is calculated as mean \pm standard deviation. Residency match rate is based on students who have since graduated medical school and reported as a match percentage. Of those who matched, we calculated the proportion matching into

Summer application scoring rubric

Please score all categories, from 1 to 5, with 1 being poor and 5 being excellent

	5	4	3	2	1
Work/job experience	<ul style="list-style-type: none"> Jobs in food service, labs, etc. Position requiring accountability Lists specific responsibilities and outcomes 	<ul style="list-style-type: none"> Part/full time Internship No mention of specific learning experiences/achievements 	<ul style="list-style-type: none"> Part-time experiences Shadowing 	<ul style="list-style-type: none"> A few extracurricular activities 	<ul style="list-style-type: none"> Essentially no engagements outside of schoolwork
Research experience	<ul style="list-style-type: none"> 6 months to 1 year minimum Presented as first author (or Masters thesis) Published abstract/paper 	<ul style="list-style-type: none"> Helped senior researcher with data Some innovation involved Some difficulty stating research question 	<ul style="list-style-type: none"> Performed tasks set by senior researcher only Cannot identify research questions, focused on methods only 	<ul style="list-style-type: none"> Able to comprehend primary literature Literature-based thesis in college 	<ul style="list-style-type: none"> Pre-medicine or post-baccalaureate classes and labs only
Written skills, based on Statement of Purpose	<ul style="list-style-type: none"> Logical flow Uses topic sentences Articulate and effective writing style 	<ul style="list-style-type: none"> Well organized Conveys thoughts clearly 	<ul style="list-style-type: none"> Somewhat disorganized Lacks structure Expresses some points well 	<ul style="list-style-type: none"> Disorganized/ lacks structure Attempts to, but does not express points well 	<ul style="list-style-type: none"> Run-on sentences Spelling and grammatical errors Difficult to read/understand
Statement of purpose	<ul style="list-style-type: none"> Has knowledge of Plastic Surgery research topics available at NYU States goals and expectations of self and mentors 	<ul style="list-style-type: none"> Shows interest in the scope of the field Clear dedication to learning Eager to be humble and learn 	<ul style="list-style-type: none"> Minimal idea of Plastic Surgery research Uses trite phrases, such as "Plastic surgery is the only discipline where art and science come together" 	<ul style="list-style-type: none"> Lack of focus on reason for this program No statement of goals 	<ul style="list-style-type: none"> Generic No evidence of even internet research about Plastic Surgery as department or discipline
Teamwork/ collaboration	<ul style="list-style-type: none"> Led a team Volunteered in group Played team sports Appreciates collective goals 	<ul style="list-style-type: none"> Shows leadership and collaborative qualities Receptive to mentorship in past experiences 	<ul style="list-style-type: none"> Shows potential to assume a team and/or leadership role 	<ul style="list-style-type: none"> Seems self-important Takes full credit for work performed by a team 	<ul style="list-style-type: none"> No evidence of collaborative projects/work
Resume (not CV)	<ul style="list-style-type: none"> Genuine (not overstated) Appreciates difference between CV and resume Appealing spatial formatting 	<ul style="list-style-type: none"> Few relevant accomplishments listed Legibly and professionally formatted 	<ul style="list-style-type: none"> Legibly formatted Generic No relevant accomplishments or experiences listed 	<ul style="list-style-type: none"> Spelling or grammatical errors Poor formatting, making reading difficult 	<ul style="list-style-type: none"> Inflated publication list, with respect to schooling and work years CV: Lists educational activities too far back chronologically
Overall Impression (subjective)	Can consider as a contributing, productive member of the team	Has clear potential to be a productive member of the team, shows great promise	May need some support but seems teachable and focused	May need extensive "hand-holding" for minimal productivity	Apprehensive about having on team

Fig. 2. Scoring rubric.

RESULTS

Table 2. Program Evaluation

Program Evaluation	
General information	
Which research program were you in?	
How did you hear about our research fellowship?	
Why did you choose this program?	
Application process and information session	
Rate the application process on a five-point Likert scale	
Please provide comments about the application process.	
Rate the information session on a five-point Likert scale	
Please provide comments about the program information session.	
Please suggest any improvements for the application and information session.	
Program aspects	
Rate the overall program experience on a five-point Likert scale	
Were the program's objectives for your experience outlined clearly? (yes/no/other, explain)	
Did your experience achieve those objectives? (yes/no/other, explain)	
Rate your satisfaction with quality of instruction on a five-point Likert scale	
Rate the research environment on a five-point Likert scale	
Rate your satisfaction with mentorship from your immediate supervisor on a five-point Likert scale	
Rate your satisfaction with mentorship from your group PI on a five-point Likert scale	
Skill sets	
Did you have prior research experience? (yes/no)	
Please describe your prior experience	
Did you have prior suture skills? (yes/no)	
Please describe your prior experience.	
Rate the helpfulness of the program to enhance your laboratory and/or data interpretation skills on a five-point Likert scale	
Rate the helpfulness of the program to enhance your critical reading and writing skills on a five-point Likert scale	
Rate the helpfulness of the program to enhance your suture skills on a five-point Likert scale	
Rate the helpfulness of the program to enhance your public speaking and presentation skills on a five-point Likert scale	
If you mentored another research student, rate your leadership experience on a five-point Likert scale	
If you worked with another research fellow/staff, rate experience on a five-point Likert scale	
Future plans	
Rate how likely you are to pursue academic research in the future on a five-point Likert scale	
Rate how certain you are to pursue a plastic surgery residency on a five-point Likert scale	
Administrative	
Rate your satisfaction with administrative support from the department for your research experience on a five-point Likert scale	
Rate your satisfaction with your interactions with nondepartmental administration (HR, etc) on a five-point Likert scale	
Please suggest any improvements/helpful tips for administrative support.	
Suggestions and comments	
Please share any suggestions that would improve the research program experience for future students.	
Please share any other comments that will help us structure the program further.	
Please share any other comments about the program.	

PI, principal investigator; hr, human resources.

nonsurgical and surgical specialties. We further stratified to identify the proportion matching into integrated plastic surgery. We used GraphPad Prism 8.0.2 (GraphPad Software, La Jolla, Calif.) for figures.

Applicant and Participant Composition

A total of 43 students (58% female students, 67% NYU students) participated in the summer research program from 2013 to 2020. In 2013, this program started with seven students. When applications were instituted in 2014, 14 students applied and five participants enrolled. Program capacity has remained stable between three and eight participants per year. Over time, this has resulted in an increasingly selective acceptance rate starting at 36% in 2014 and 7% in 2020. **Figure 3** depicts the composition of applicants from our institution compared with outside institutions, and shows the relative increase in program popularity over the last three years. This timeline aligns with more recent efforts to formalize applications and programming. **Figure 4** shows more participants from outside institutions in recent years.

Reliable Selection Rubric

Of the 87 students evaluated, 60 had two impression scores documented. Reasons for exclusion were those who did not qualify for the program, such as advanced international medical school applicants, students beyond their first year of medical school, or those with a documented score only available from one evaluator due to the retrospective nature of the analysis. There was good to excellent interrater reliability between evaluators (intraclass correlation coefficient, 0.75; 95% confidence interval 0.59–0.85; $P < 0.001$).

Program Evaluation and Outcomes

Response rates for program evaluation questionnaires was 68% overall and 100% in the two most recent available surveys. Questionnaire responses for 2018 were not available because evaluations were retrospectively discovered as not distributed that year. **Figure 5** depicts the trends in student satisfaction and rated influence of program enhancement of skills on a five-point Likert scale (1, poor/unsatisfied; 5, excellent/extremely satisfied). Improvements in public speaking and presentation skills, and suture and clinical skills coincide with additional formal programming of mandatory departmental research presentations and structuring of suturing clinics, respectively. **Table 3** details the curricular evolution and **Figure 6** highlights the timeline of key curricular changes. Starting in 2016, all students presented their work at the department's research symposium and/or grand rounds. Students who participated in the clinical research arm established in 2017 also have on average successfully published one first author peer-reviewed article each in the project(s) they led from start to finish (a total of 11 first author publications across 10 students).

Continuation of Research Productivity

On average per year from 2013 to 2019, 28% of program participants continued to conduct research with the plastic surgery department beyond the official

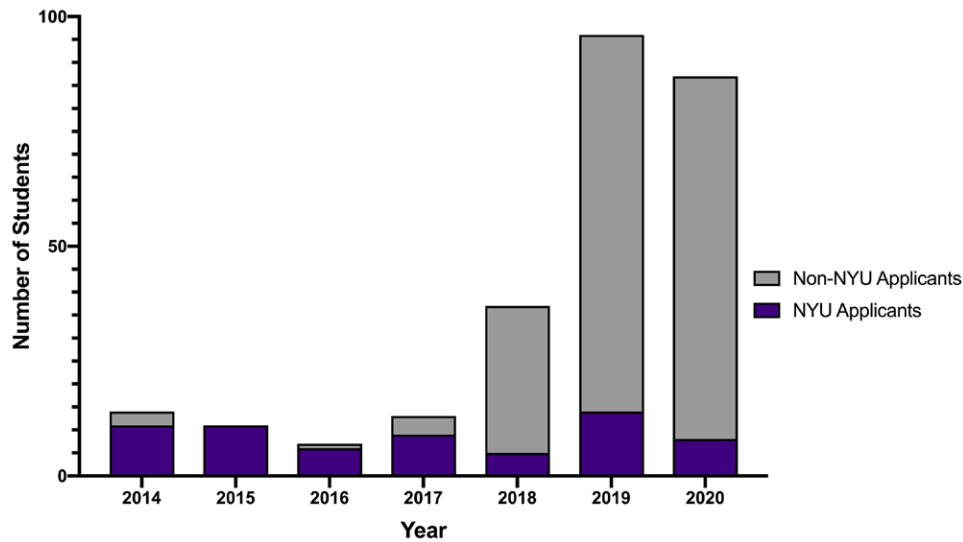


Fig. 3. Applicant composition.

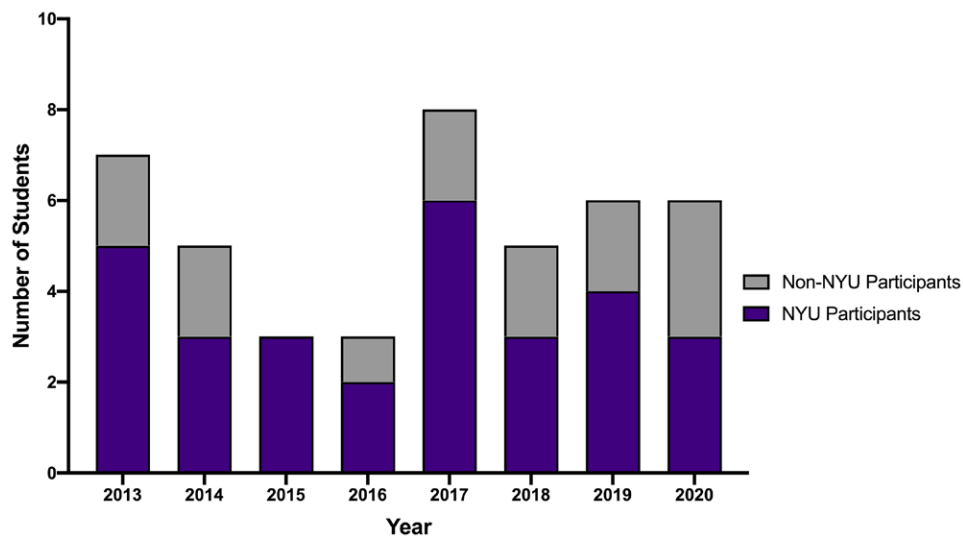


Fig. 4. Participant composition.

program end date. From 2013 to 2018, 29% of program participants returned to the department for a period of dedicated research outside the medical school curriculum. The average number of publications per participant produced by the end of medical school was 7 ± 4 . Of these publications, 7 ± 4 were affiliated with New York University and 5 ± 4 were within the field of plastic surgery.

Successful Residency Match

Among the participants who have now completed medical school ($n = 22$), 95.5% successfully matched into a residency program on first attempt. Of these participants, 62% ($n = 13$) matched into a surgical residency program with 54% ($n = 7$) of these being an integrated plastic surgery residency.

DISCUSSION

The medical student summer research program developed by our department of plastic surgery is built around the institution's academic missions of clinical excellence, education, and commitment to research advancement.²⁴ Initially intended as an introduction to the field of plastic surgery through a research lens, the program has evolved into an incubator for highly dedicated and talented students who have consistently gone on to become productive individuals as evidenced by their academic productivity.

Evidence-based decision making is an integral part of modern medicine, and responsible production, dissemination, and use of scientific evidence is crucial to patient safety and quality of surgical care.²⁵ These elements are important in the fast-paced innovative field of plastic surgery.²⁶ While medical school curricula have

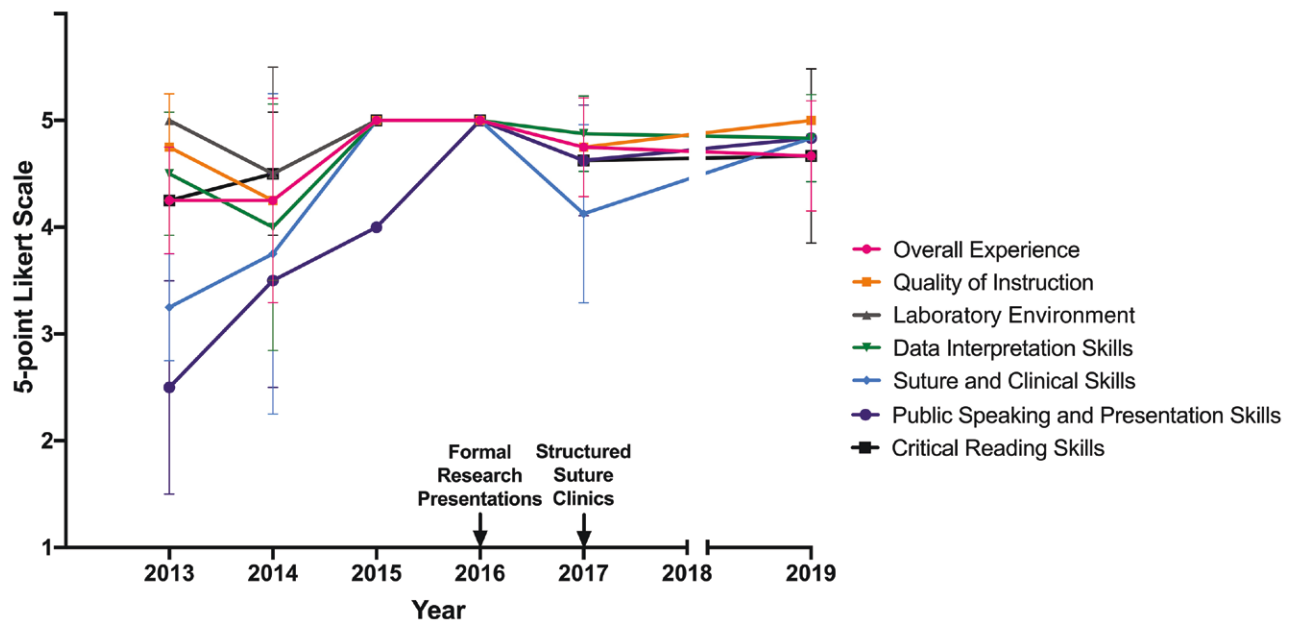


Fig. 5. Program evaluation by students completing the summer research program.

seen substantial reconfigurations in recent years, opportunities for medical students to engage in applied clinical or basic science research within surgical departments are scarce, despite it being cited as an important factor in evaluating medical students for residency candidacy.^{17,27,28} Many medical schools lack affiliation with academic medical centers that have plastic surgery departments hosting residency training programs. When these do exist, the presence of a research infrastructure able to adequately accommodate medical students is rare, and students from medical schools without home programs often seek opportunities at institutions with integrated residency programs.^{29,30} Our experience shows that such an opportunity can be created for a diverse pool of highly competitive applicants across the United States, with reproducible, quantifiable outcomes and a growing educational imprint.

Mentorship

In our experience growing this program, the formalization of a mentor–mentee dynamic, even within the confines of an 8-week program, allows students to complete projects and develop in both leadership and team-based roles. These benefits have been described widely.^{31–35} With the implementation of this model, we have seen students consistently complete the program with first author publications in addition to active involvement in other projects. Residents and fellows have the rewarding experience of providing mentorship to their juniors. We have observed participating students demonstrate autonomy, leadership and inquisitive critical thinking exemplified by their curricular participation, research presentations, and articles they go on to publish. The mentorship relationships built within the program have persisted to become an anchoring force in

students' subsequent path through medical school and beyond.

Research Project Management

The program's structure revolves around common goals, clear planning timeline (Fig. 1), and an outcomes-driven, personalized system for evaluating progress and discussing achievements and challenges. Participating students join a team of research fellows and faculty. This offers an immersive experience, with tailored feedback, team discussions, and progress updates where each student leads their own project. Under supervision, students learn to manage their projects by developing time management, delegation, and leadership skills. By program completion in recent years, every student has led their project's literature review, study design and/or institutional review board protocol development if needed, data collection, analysis, interpretation, table and figure design and article writing. For students on the clinical research track, successful completion of the program entails completion of a first draft of an article and oral presentation of their work at departmental grand rounds. For those on the basic science research track, ongoing projects are expanded upon by answering new research questions, which typically culminates in an oral presentation and abstract submission.

Educational Development

Successful participation and completion of research includes abstract submission and presentation at conferences, submission and revision of manuscripts and grand rounds presentations. Students additionally develop knowledge-base by attending weekly didactic sessions alongside residents and faculty and engaging in weekly journal clubs. This is supported by the good to excellent

Table 3. Evolution of Curricular Objectives and Activities Built Upon Yearly Lessons Learned

Year	Planned Activities (Cumulative)	Educational Objectives	Lessons Learned
2014	• Reading packet distributed 4 weeks before start date	• Familiarization with active project topics and background material	• Beneficial for students for comprehension of study scopes, generating curiosity, and formulating research questions
	• Journal club	• Practice critical reading skills of both basic and clinical literature	• Essential activity to impart appreciation for level of rigor necessary in scientific investigation
	• Led by postdoctoral mentor with slide presentation format	• Identify research questions	• Students should also lead discussions
	• Group discussions	• Evaluate and discuss study approach	• Encourages peer learning
	• Compare and contrast primary literature through the course of the program	• Appreciate importance of scientific integrity	• Effective to level primary literature reading skills among participants
		• Summarize key findings	
		• Understand criteria for publishing and peer-review	
2015	• Laboratory meeting presentations	• Demonstrate articulation of ideas, active thinking	• At least 2 presentations reinforces need for goal setting
	• Prepare slides to introduce project and background literature, with mentor input	• Construct visual representation to convey information effectively	• Students can recognize their own progress
	• Q&A following presentation	• Process critique/questions	
		• Practice presentation and public speaking	
	• Suture clinic led by resident research fellows once per week	• Practice basic knots and suturing skills	• Facilitates networking among students and mentors
	• Bi-weekly public speaking workshops	• Develop confidence for public presentations	• Ideal opportunity for peer learning and mentorship
		• Practice voice projection and convey enthusiasm about research coping mechanisms for public speaking	• Focused workshop with trained facilitator may yield better outcomes
2016	• Weekly mentor-mentee meeting	• Provide individual assessment	• Identify other activities to incorporate public speaking coaching
		• Provide encouragement and critiques	• Develops mentor-mentee relationship
	• Grand Rounds attendance	• Provide departmental educational opportunities	• Establishes mutual goals
		• Create opportunities to meet residents, fellows and faculty	• Keeps studies on schedule
	• Social activities	• Foster team building and networking	• Encourages student initiative to introduce themselves to department personnel and establish connections
	• Write manuscripts with mentors	• Scientific writing practice	• Strengthens student network and peer-mentorship
		• Familiarize with terminology of the field and story-telling style	• Demonstrates need for clarity for audience
2017	• Individual presentation and interview coaching	• Disseminate student research to department	• Illustrates need for logical arrangement, rigor and integrity of data
	• Presentations at department symposium		• Students respond well to one-on-one coaching
	• Social event with all mentors and research administrative team	• Nurture community and facilitate team building	• Students identify their weaknesses in public speaking and develop tools to overcome inhibitions
	• Structured weekly suture clinic with curriculum that builds on previous weeks led by resident and medical student research fellows	• Practice basic knot-tying and suturing skills	• Allows networking for potential long-term mentor relationships
		• Distinguish among criteria for suture and knot applications	• Facilitates networking environment among students and mentors
	• Grand Rounds individual presentation	• Disseminate student research to department	• Broader range of mentors can offer further range of skills
		• Public speaking exercise	• Standardized teaching approach year to year is critical
2018	• Mentors list available projects	• Increase number of mentors and research subject areas	• Utilization of several research skills: assembling and interpreting data, assess in context of peer-reviewed literature
	• Students rank mentor and project choice		• Communicating results to an audience, public speaking practice
			• Wider knowledge base for students and peer-to-peer learning
			• Broader faculty involvement
	• Resident Q&A mixer with PGY1-3 in a casual setting	• Foster learning environment addressing benefits of research in careers, future research opportunities, residency application process, identification of mentors	• Highly beneficial to first-year students to identify and guide their interests toward a discipline that will serve their curiosity and sustain their careers
	• Basic Science projects: Prepare a specific aims page at initiation of program, describing proposed project and specific questions	• Establish research question and approach	• Future sessions will be recorded
		• Efficient planning and execution within program timeframe	• Sets expectations for both student and mentor
2019			• Practice in scientific and succinct writing

This is a detailed, chronological evolution of the summer research program. Planned activities are cumulative across years and build upon the previous year's lessons learned.

Q&A, question and answer; PGY, post-graduate year.

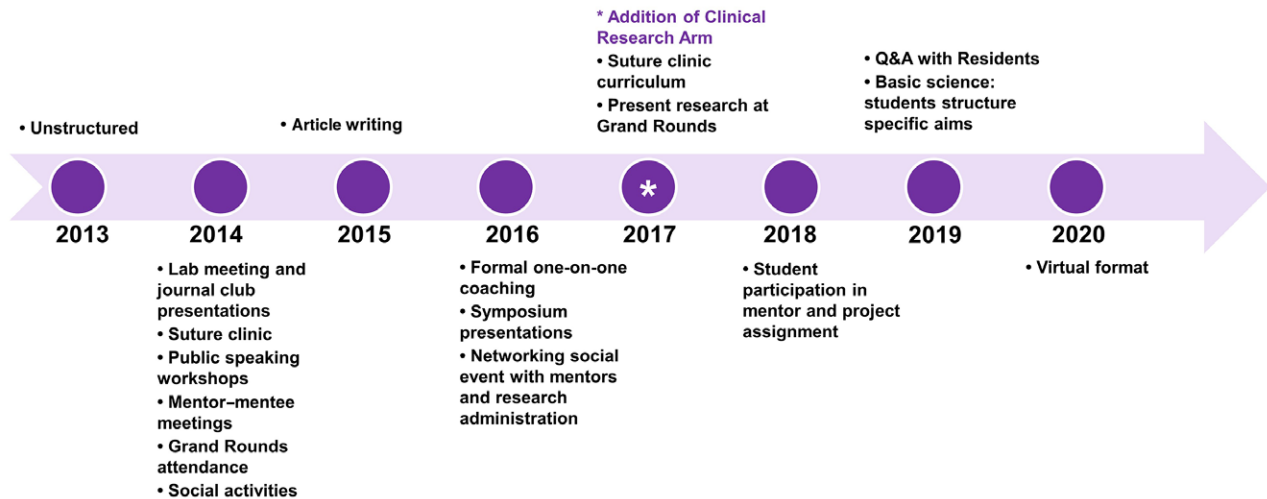


Fig. 6. Timeline of key curricular developments.

rating by students of the helpfulness of the summer program at enhancing their skills in data interpretation, critical reading and writing, public speaking, and presentation. Journal clubs are followed by hands-on surgical skills sessions. Students typically join the program with little to no exposure to surgical technique and complete the program with a basic understanding of instruments and materials and reproducible beginner-level suturing and knot-tying skills as represented by their program evaluation survey responses. When schedules coincide, students are invited to participate in resident cadaver dissection sessions.

Limitations

The evolution of this program is due to our commitment to quality culture and enhancement. The changes observed therefore reflect the identified limitations and proposed solutions. This is a report of the evolution of a summer research program at a research institution in an urban setting with a department of plastic surgery that can formally accommodate approximately six summer research students per year. Although we present the framework for developing your own summer research program, the information presented here should be considered within its context, and subsequently appropriately applied to new settings. The limitations of this study include its retrospective nature that lends to missing survey data in 2018. This is not a controlled study and therefore the long-term outcomes measured cannot be solely attributed to participation in the program, nor is that the intent of the analysis. Holistic application review, student research stipend, and potential for longitudinal mentorship are all factors of the research program that could positively impact diversity and inclusion in the program, and ultimately plastic surgery,³⁶ but the influence of these interventions on the diversity of participants was not within the scope of this study. The scoring rubric would therefore benefit from continued analysis to collect a larger sample size over time, and to assess its ability to achieve an inclusive selection process. We recognize that despite attempts

at reducing bias in the selection process, the program is limited in size and disproportionately supports students from our institution. Although stipends are provided, they are not inclusive of accommodation, which can be cost prohibitive for in-person participation.

Future Directions

Facing the challenges imposed by the evolving COVID-19 pandemic, we implemented remote-learning platforms to enable students to continue to benefit from the summer research program. Participant feedback will continue to play a vital role in the future success of the program. Future investigations will include assessment of the use of remote versus in-person platforms, including transition to virtual journal clubs, suture and knot-tying lessons, and group-based as well as individual feedback sessions. Telementoring has also been shown to be a viable option and one successfully implemented in surgery.³⁷ Ultimately, our hope is to expand the parameters of the program, potentially expanding the application pool to invite international candidates to participate and implement intentional efforts for diversity and inclusion. We anticipate that virtual sessions may have the potential to reach a wider audience and therefore may be adopted and incorporated into the syllabus even as in-person sessions resume.

CONCLUSIONS

A research program designed for first year medical students interested in plastic and reconstructive surgery can reliably achieve academic and educational goals. It also provides students with mentorship opportunities, a professional network, and the tools for self-guided learning and subsequent career development.

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