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Supplemental educational program to heighten the impact of research – an opportunity for OA imaging

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Abstract

Objective: To develop and evaluate a supplementary educational program (“IMPACT”) centered on enabling participants to consider specifically and articulate explicitly the best path for and potential impact of their research.

Design: Participants (trainees) and faculty mentors were from all areas of biomedical research. The group worked longitudinally in small, rotating groups, through a process of developing a written statement (“Impact Statement”), an overview (“Impact Storyline”) and an oral presentation (“Impact Case”) of their work.

Results: One hundred and eighty-seven Fellows enrolled in the program. Of the 179 (96%) Fellows who completed the program, 159 (89%) responded to a post-program survey; 94% indicated that IMPACT was a significant learning experience, 89% indicated that they were more able to identify the long-term potential of their research, 95% felt more able to talk about their work to diverse audiences.

Conclusion: This voluntary educational program was appreciated by the participants and led to increased confidence in their ability to drive their science towards a clear impact and communicating that potential to others. This type of program may aid in redirecting some of the efforts and resources of imaging in OA from the large focus on technical developments to more direct biological and clinical questions which might be resolved with current technology.

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Supplementary materials

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Keywords

Impact; Diversity; Research; Communication

Introduction

Osteoarthritis (OA), a chronic, often debilitating disease, remains poorly understood and has no disease modifying therapies. In the early 1990s, many MRI techniques were proposed for evaluating the structure, function, and molecular composition of cartilage, one of the primary tissues involved in OA [1–10]. However, despite the promise of these technologies, progress in further understanding or treating OA was slow. In 2009, the second Workshop on Imaging Based Measures of Osteoarthritis asked the question “why aren’t we there yet”, with “there” defined as “a situation in which the signs of “pre-clinical” OA were detectable, with recommended lifestyle and/or medical or surgical intervention to prevent the disease from reaching a symptomatic level” [11]. Similarly, in 2019, the European Society of Musculoskeletal Radiology advocated for musculoskeletal imaging research to be directed towards clinical impact, stating that “diagnostic pathways should be assessed not only for the technical and diagnostic performance but also for their impact on medical and social outcome” [12].

Imaging research of OA presents a particularly difficult task for many reasons. OA is a very slowly progressing disease (and thus it is difficult to study changes over time), one of the tissues which was a primary target of OA research for many years (articular cartilage of the knee) is very thin and curved (and thus has challenging imaging criteria), there are no approved disease modifying drugs [13] (and thus it is difficult to test a new imaging protocol with an intervention), and in general the only tissue available for validation of new imaging techniques is from total joint replacement, and thus in the late stages of disease. Animal models are difficult for corresponding reasons (replication of a slow disease process, very thin structures in small animals, and no clear interventions to test).

Perhaps for these reasons, over the past 30 years substantial research has gone into developing imaging technologies for the structural and molecular components of joints. Improved impact might emerge if we build on the technical advances and redirect some of the efforts and resources of imaging in OA from the large focus on technical developments to include more direct biological and clinical questions which might be resolved with current technology.

We recently developed a supplementary educational program which may serve to support this shift in focus. The program is centered on enabling participants to consider specifically and state clearly “why their work matters”. We designed the program so that strong mentor-mentee relationships, communication skills, confidence building, network building, and awareness of career options would occur organically.

The program was intended to challenge participants to articulate what their work is, and more specifically, how it will lead to impact, in a way that is understandable to a group of trainees and professionals who work in diverse fields and sectors within biomedical

research. The participants (trainees) were from all areas of biomedical research, as were the faculty. The group worked longitudinally with 11 meetings over the course of 5 months. During this time, they worked in small, rotating groups, through a process of developing a written overview and an oral presentation of their work.

The innovation in this program was to combine several important features: Melding of research and career considerations, a context where the mentors have no direct or indirect supervisory relationship to the trainees, group mentoring involving professionals from diverse fields and multiple biomedical sectors on equal footing, participation on a voluntary basis by both trainees and mentors, and an in-depth longitudinal experience over several months. As a mentoring program, we focus on identifying and clarifying the content and potential impact of a given research project (rather than the importance of a given field), and group individuals with others outside their field and sector. This is unlike other mentoring initiatives in our institutions, which generally focus on the mechanics of writing proposals or papers, and/or the phrasing and presentation of the work, and generally pairs a trainee with a mentor who is familiar with the field.

We define “impact” in a relatively broad but individual way; we ask, “why will this particular project matter”, or “what will be different after this project is complete”. For example, if a project aims to make something faster, or with higher sensitivity, we ask what will be possible with the increased speed or sensitivity that is not currently possible (even if the application is not part of that particular Fellow’s responsibility). This working definition differs from more “standard” definitions of impact which focus on either an individual’s bibliometric or funding metrics (e.g. publications, presentations, grant funding) or societal level metrics (e.g. outcomes, reduction of costs), and is more along the lines of a recent proposal to include impact on other scientists, or of the translational work of delineating new drug targets, prototypes, etc [14].

Here we present the methodology for this supplementary educational program, called the IMPACT program, and the results from 6 years in operation. (Limited findings from the first 2 years have been previously reported in an opinion piece [15]).

Methods

We targeted post-docs, fellows, and advanced graduate and medical students involved in biomedical research through flyers, e-mail lists, and word of mouth. Applicants provided responses to a few short essay questions about their career goals, reasons for interest in IMPACT, and their research project. Most applicants were deemed appropriate for inclusion. Reasons for rejection or deferral were individuals who did not yet have sufficient research experience to discuss a particular project, did not have work that was related to the biomedical field, or would not be able to participate fully. We did not attempt to evaluate the quality of their research project, nor did we restrict participation to those from a single institution. Enrolled trainees were referred to as “IMPACT Fellows.” We recruited trainees twice a year (roughly aligning with the fall and spring semester) with a total of 12 cohorts.

We recruited faculty mentors by invitation, intentionally selecting for a diversity of biomedical field expertise and sectors (academic, clinical, and business), without any attempt to match the specific faculty backgrounds to those of the Fellows. Each semester, we invited a faculty team with a balance of experienced and new faculty with a range of research experience from those in relatively new positions to those with many years of experience. Experience in the IMPACT process per se was obtained through participation in the program. Given that this was a different type of mentoring than standard academic mentoring, the mentors “trained” by participating in the program and getting used to the types of questions and aspects of research that we focused on. Faculty and peer mentors (see below) were given small honoraria to participate, although most would have volunteered even if uncompensated, as their motivation was the opportunity to interact with a talented and diverse group of individuals and to participate in a unique mentoring group process.

Meetings were considered closed. Fellows’ supervisors acknowledged that they were aware of the participation of the Fellow in IMPACT, but the program did not interact directly with their research groups.

IMPACT meetings

The IMPACT program was structured around eleven 3 h in-person evening meetings over the course of a semester. (Due to the COVID pandemic, the sessions of the last 3 cohorts were held remotely, and meeting times were often reduced to 2 h.)

During these sessions, Fellows and faculty met in either large (6–8 Fellows plus 3–4 faculty) or small (3–4 Fellows and 2–3 faculty) working groups. We assigned groups in advance of each session to ensure that everyone had a chance to work with everyone else and to balance the institutions and disciplines of the Fellows. Approximately half the sessions were large group, and half were small group. The large group sessions allowed interaction with more participants and for participants to see one another’s work; the smaller group sessions allowed more personalized and in-depth discussions and for Fellows and mentors to get to know one another.

Three formats were used to describe the Fellows’ projects. At the first meeting, after a general introduction to “impact”, Fellows attempted to write a 1–3 sentence “Impact Statement”. During the remainder of the semester, we iterated between formats of “Impact Storylines”, and “Impact Cases”. An Impact Storyline is a one-page bulleted description of a project that aims to serve as a logically connected scaffold which delineates the project: the problem it addresses, the approach, and the potential impact. The Impact Case is a 5 min slide presentation of the project. Both the storyline and case were developed for a general scientifically literate audience and included an argument for how the work would lead to impact, i.e., explain how the results will matter and to whom. During these sessions, we also encouraged the participants to examine the assumptions embedded in their work.

Stakeholders

As part of developing their storylines and cases, we strongly encouraged Fellows to meet with “stakeholders”, broadly defined as anyone who might be involved or interested in how the results of the studies could move towards impact. For example, these stakeholders might

be researchers who could envision new directions in research from the findings, clinicians who might utilize the results directly, commercial scientists who might incorporate the information into products or product development, politicians interested in public policy development, and/or patients who might be affected by the work or who can shed light on the problem being addressed by the work. We presented a lecture and guide for Fellows on approaching stakeholders and they were encouraged to utilize the IMPACT faculty for connections as needed.

Peer mentors

For each new cohort after the first semester, we invited several alumni of previous cohorts to participate as “peer mentors”. This practice gave additional input to the Fellows, and also gave the peer mentors experience in mentoring.

Self-introductions

We expected the Fellows to introduce themselves before their final presentations (see below) as a means of giving them an opportunity to practice presenting themselves in an interesting and memorable light. To prepare for this, we gave a short presentation on self-introductions and some examples, after which the Fellows worked in groups to come up with several versions of self-introductions to be used for the end of semester presentation (and at other opportunities).

Panel presentations

In the final session, each Fellow gave a 5 min presentation of their research case to a panel of diverse faculty who were not in IMPACT during the semester. The objective was to cement the Fellows’ confidence, provide new networking opportunities, and allow them to celebrate their accomplishments and developed camaraderie.

An overview of a typical semester schedule and materials regarding the content described above is available as Supplemental Material. However, we note that as this program is inherently one of interactions between individuals within groups, there is little direct guidance needed. The naivete of the participants relative to each other’s fields drives the questions and discussions towards clarifications. The methodology is designed to “force” participants to explain logically how their work will have impact to people who are not directly in their field. The program has several aims: to establish a culture within the experience where people actively ask questions of one another, where everyone should feel they understand everyone, be cohort-based (allows for bonding, networking, and diversity of thought) and longitudinal (these learnings take time), involve a professionally-diverse set of mentors who are not the supervisors of the Fellows (to prevent it from seeming like an oral exam), and focus on the why, not the how, and the specific path, not the general importance of the field.

Professional development advisors (PDA)

Career advice happened informally with faculty mentors, and more formally by assigning each Fellow with one or two Professional Development Advisors (PDAs) outside of IMPACT. These assignments were based on the specific career interests of each Fellow.

Before meeting with the PDA, we suggested that Fellows produce an Independent Development Plan (IDP) through <http://myidp.sciencecareers.org>.

Career session

A career session was also held each semester with professionals who were not participating in the regular IMPACT program that semester. The Fellows met in small groups to discuss a wide range of topics related to careers. All current and former Fellows were invited to these sessions.

Informal networking

Finally, we held informal networking events each semester for all current and former Fellows and mentors, providing networking time, as well as connecting current Fellows with alumni of the program.

Outcomes

The outcomes were assessed both anecdotally and through a prospective survey-based study conducted by an assessment expert, Dr. Rudolph Mitchell of MIT's Teaching + Learning Laboratory. The study was approved as an exempt study by the local IRB Board (MIT COUHES approval number 511,298,089). All those who completed the semester program were sent an email that explained the process and included a link to the confidential survey. Participants were considered as consented when/if they clicked on the survey. Survey data were under control of one author (RM). Participants were informed at the beginning of the semester that a survey would be done at the end; this was not a requirement, but rather a means to evaluate and improve the program.

Results

Over the 12 cohorts, 187 Fellows were enrolled, including 119 female (64%) and 44 (24%) underrepresented minorities; 80 were graduate students and 107 were post-graduate fellows. A range of academic and medical centers were represented, including Beth Israel Deaconess Medical Center, Boston University, Boston University Medical Center, Brigham and Women's Hospital, Broad Institute, Brandeis University, City College of New York, Dana Farber Cancer Institute, Harvard University, Harvard Medical School, Johns Hopkins University, Massachusetts Eye and Ear Infirmary, Massachusetts General Hospital, Massachusetts Institute of Technology, McLean Hospital, Northeastern University, Tufts Medical School, Tufts University, Tufts School of Nutrition, University of California San Diego, University of Massachusetts Amherst, University of Massachusetts Boston, and University of Massachusetts Medical Center. (Note that some initial findings from early cohorts have been previously reported [15].)

We had an average of 16 Fellows in each semester, with a maximum of 23 in any given semester. Empirically, this size seemed to allow everyone to get to know everyone else, it allowed for a single plenary session at the end when Fellows made their final presentation, and it allowed for good mixing during small group sessions.

A total of 47 faculty mentors participated from 27 institutions and companies, with a breakdown of 14 academically, 12 clinically, and 21 commercially oriented. The fellow-faculty mentor ratio for each cohort was approximately 2:1.

One hundred and seventy-nine (96%) of those enrolled completed the program. Of those who completed the program, 159 (89%) responded to the survey. The results and a subset of comments are given in Tables 1 and 2, respectively.

The results from the survey indicate that we achieved the core goals of the program: The affirmation by 94% of respondents that the participants found the program to be an impactful learning experience were well illustrated by the comments, e.g. “The IMPACT program has truly been a transformative experience”, and “they taught me how to think outside the box. It is difficult to think that way when you are surrounded by people that in a way understand your research.”

The vast majority of respondents indicated that the experience influenced their science and their scientific thinking. That influence included being better able to identify the long-term potential of their work and to identifying conceptual gaps and assumptions. Importantly, many Fellows (77%) said the experience caused them to rethink the direction of their work – which that highlights that this experience is not just about communication per se, but rather about critically exploring and evaluating the direction of their work. Again, corresponding comments support the numbers: “This has led me to propose a different set of future experiments, which I think will be more interesting and useful than those I was planning previously.”

Finally, the vast majority of respondents reported significant gains in their communication skills, self-confidence, and networking abilities. Many reported that the experience increased their confidence in navigating their career path. “I really looked forward to the IMPACT meeting – they helped remind me how interesting and fun science and research can be.”

Discussion

The described educational program ran for 12 semesters, with a 96% retention rate of participants. Confidential surveys, with a similarly high submission rate of 89%, demonstrated the participants’ enthusiasm for the program. The survey results showed changes in how the participants considered their projects, in terms of recognizing gaps in their thinking about the project or where it might lead. These newly recognized gaps are comparable to “not knowing what we didn’t know”.

Improvement in communication was also a clear benefit from the participants’ perspectives. The striking improvement in the clarity of the projects and their presentation was one of the things which the faculty (and participants) commented on, and one of the chief motivators for faculty to return semester after semester.

Although not a goal per se of the program, the excitement and motivation towards their work as they discussed it with a new diverse group of colleagues was palpable.

Finally, given that the vast majority of the projects being discussed were those which were ongoing and vetted by the lab members and at times funding agencies, it was striking how large a percentage of respondents stated that the projects were changed by the IMPACT process. We note, however, that the IMPACT participants self-selected as interested in considering the impact of their work, and thus may be a biased subset of all trainees.

A number of lessons were learned that will be considered in future offerings of IMPACT:

Defining “impact”

Over the years, several misperceptions arose repeatedly. A frequent misperception was that by “impact”, we were referring to work that exits the academy and makes its way to general use (e.g. as a commercial product). Instead, we were focused on clearly delineating the problem/issue being addressed, why and to whom it matters, and then explaining impact in terms of how it might move one closer to addressing the need. This impact could take on many potential forms. It could be a scientific advance that opens up a new area of investigation, provides evidence of feasibility for a new technological solution, a new device prototype, a new/modified clinical method, a policy recommendation, etc.

Related to the above, Fellows also tended to assume that if they worked in a problem domain that is widely seen as important (e.g. cancer, neurodegenerative disease, nanotechnology), then their project must be inherently valuable and have high impact. We challenged them to explore very specifically just how their project would advance the field.

Some Fellows worried that their work might not affect a sufficient number of people. The important question is who will be affected by the research, and how. What will be different because of the results of the research? While the number of people who might be affected is a consideration for potential funding, or for commercial interest, our interest was in demonstrating how the work might have impact in any sphere.

Conceptualization versus communication

A common misconception was that the program aimed to teach them how to best communicate about their projects. We emphasized that the main challenge was to carefully consider specifically and explicitly how the work is headed towards impact, and we further explained that an important way to accomplish this is by challenging each person to describe what they are attempting to do to people who are not in the same field. Doing so forces a better delineation of the essential elements and arguments. In a reciprocal way, thinking through the core aspects of the research with those who are not well versed or vested in the same field pushes the trainee to develop more effective ways to describe their work. Defining the impact and communicating it build upon each other.

Similarly, some were inclined to “sell” their work, and make it sound important. We stressed that we were not asking the Fellows to take what they do and find a way to make it sound impactful. Rather, we were asking the Fellows to take what they do and consider specifically how it will be impactful. We encouraged Fellows to let us know if they were not convinced of whether or in which direction the work will have impact (many having been given their project), and that as a group we would work through it and identify potential paths forward.

Giving and receiving feedback

Because of the nature of these meetings, it can feel like the validity of the work is being questioned. We stressed that we were all in the room to help each other improve the research and find what avenues might lead to impact, and that we were not there to judge or grade. The peer mentors helped to reassure the Fellows that the process would lead to a stronger case in the end.

A complicating factor in the variation of groups from week to week was inconsistent feedback from the diverse individuals in different groups. While this was sometimes frustrating to the Fellows, we saw it as a way of training towards handling “real life” study section and manuscript reviewer disagreements. We encouraged the Fellows to think through the conflicting suggestions and come back to convince the group of their decisions on how to proceed.

Methodology insights

One of the considerations in planning the program was whether small groups should stay together through the semester to have more longitudinal flow and enable more in-depth discussions. In informal surveys of the participants, both Fellows and faculty preferred mixing the groups weekly, so that people had a chance to get to know everyone else. In the framework of several months, this worked well. It also enabled mentor-mentee relationships to form organically, with many relationships continuing independently outside of and after IMPACT.

Initially the semester started with a presentation by each Fellow on their projects, but we found that the barrage of questions that followed were often discouraging. Subsequent semesters switched to beginning the first session with a presentation of impact statements to start the discussion about the projects, working up in each subsequent session to different versions of impact storylines (2 sessions), and impact cases. The remaining sessions toggled back and forth between these formats.

It was common for those developing “platform technologies” to want to state the broad ranging applications as the impact of their work. While this is appropriate, we recommended that they start to think about a specific application to discuss. We pointed out that while the broad applications can be mentioned, it’s important to ensure that at least one application is realistic (and would be the “first test” of the technology).

The vast majority of the research projects discussed were those of ongoing work; both work that had been conceived of and proposed (but not yet begun or in early stages), or that had been mostly completed. The advantage of discussing an ongoing project was that the Fellows were very familiar with the subject. The difficulty in some cases was that the Fellows found that when they thought about the project in more depth they felt that they could not defend the potential benefit sufficiently. In almost all of those cases a pivot was feasible which put the project on a better path. In the very few cases where this was not feasible, the Fellow recognized that the IMPACT process would be helpful in formulating future projects.

Some Fellows chose to discuss totally new project ideas, often because they were considering wholly new research directions or crafting a proposed research portfolio for their next career step. While the IMPACT process was useful for designing a project, it was generally a more difficult experience for the Fellows because they had much less background and did not always have the time to learn what they needed to learn. On the other hand, it was an efficient means to focus their questions and for their thinking to evolve. On several occasions, they ultimately eliminated some ideas and pivoted with other ideas.

After the experience of the various cohorts, our feeling is that the 11-week implementation of IMPACT is best suited for current projects or ones for which the Fellow has substantial foundational experience. With the foundational knowledge in hand, Fellows can focus on learning the IMPACT process for exploring the path to impact of their work. That said, we anticipate that, having had the IMPACT experience, the Fellows will be in a good position to use the methodology in their future work when conceiving new projects, as 94% stated they would (Table 1).

Our implementation of IMPACT was entirely voluntary. Fellows self-selected to apply and participation was entirely up to them. Making a program like this mandatory might raise other challenges.

Due to the COVID-19 pandemic, the IMPACT program switched to fully remote meetings. The in-person interaction was missed, however the program ran successfully with small group meetings in break-out rooms. A remote format opens the opportunity to involve trainees from broader geographical areas as well as across fields and sectors of biomedicine.

The educational program described here is one option for potentially accelerating the progress of OA imaging research, which has struggled over the years to find the sweet spots of impact within the multitude of technical studies. The clarity that comes with discussing research with those unfamiliar with the field may lead to new ideas, collaborations, and more direct pathways to impact.

We consider the primary accomplishment of IMPACT to be the careful and explicit consideration of the potential impact of research projects. We note the high number of trainees who reported that their research was affected by the process. Moreover, communication skills improved, and confidence in the choice of career in research was enhanced. The very high retention rate of this voluntary program, and the enthusiasm reflected in the confidential survey results, points to the needs that this unique program filled.

Having a diverse group work together had several benefits. It provided a source of naïve questioning of the trainees which, by definition, the research supervisors and peers cannot do. In addition, because the group was so diverse, both faculty and trainees participated in questioning, as no one had more expertise or experience than the others for a given project. This gave the trainees confidence, and the skill set to question work they hear about, as well as their own. Finally, the ability to articulate their work in a way that any scientist can understand should enable more effective networking, presentations, grant proposals, and job interviews.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

IMPACT survey results.

(1=strongly disagree.... 7=strongly agree)	M	SD	N	neg %	neut %	pos %
Overall:						
I found IMPACT an impactful learning experience.	6.34	0.97	157	2	4	94
The other trainees who are in my weekly sessions made progress	6.56	0.73	159	1	1	99
I found IMPACT provided me with a unique opportunity to explore my research direction and career path.	5.99	1.42	157	8	6	85
I would recommend IMPACT to other doctoral/post-doctoral students	6.33	1.11	157	3	6	91
Impact on Science:						
I am more able to identify the long-term potential of my research.	5.94	1.17	157	3	8	89
I am more able to identify the steps I need to follow in order to guide my research in the direction I would want it to proceed in the long term.	5.57	1.36	157	7	13	80
I am more able to identify gaps in my thinking about where my immediate research may lead in the future.	5.76	1.20	157	4	8	88
I found testing my assumptions and impact proposition with stakeholders outside of the IMPACT Intensive sessions useful.	6.00	1.05	127	2	10	88
My discussions with stakeholders outside of the sessions have led me to rethink the long-term direction my research should take in order for it to make an impact.	5.45	1.40	127	9	13	77
My discussions with stakeholders have broadened my view of where my research interests might lead.	5.80	1.32	127	8	6	86
Communication:						
I am more able to discuss my work in an effective, focused manner with researchers, faculty members, or people in industry.	6.21	0.97	157	2	3	96
I am more confident in my ability to make a persuasive case for a research idea to a potential, but skeptical funder.	5.85	1.06	157	3	8	90
I am more able to talk about my work to diverse audiences.	6.32	0.93	157	2	3	95
Confidence, Networking, and Career Path: ^d						
My progress (in IMPACT) motivated me	6.02	1.27	159	4	7	89
I am more willing to contact people whom I do not know to discuss my current or future research	5.71	1.29	157	5	13	82
I found meeting with a Professional Development Advisor of value	6.33	0.99	123	2	2	96
My discussions with stakeholders have energized me	5.83	1.15	127	3	11	86
I am more able to create career opportunities for myself	5.38	1.32	157	8	15	77
My professional network has grown	6.09	1.05	157	3	2	95
I am more able to build a professional network	5.59	1.26	157	6	12	82
I am more confident in my ability to make the right decisions about my career path	5.32	1.36	157	9	17	75
Next Steps:						
Remain in contact with IMPACT faculty members	5.89	1.30	157	6	7	87

(1=strongly disagree.... 7=strongly agree)	M	SD	N	neg %	neut %	pos %
Remain in contact with Professional Development Advisors	5.94	1.41	157	6	10	84
Expand professional network further through IMPACT contacts / referrals	5.96	1.23	157	5	9	86
Continue to develop long term plan	6.31	0.97	157	1	3	96
Misc:						
I discussed my research, research interests, or future career plans with IMPACT faculty, mentors, or other IMPACT Fellows outside of the IMPACT sessions	5.54	1.49	157	13	4	83
I discussed my ideas or plans that evolved from the IMPACT sessions with my PI and/or people in my lab	4.97	1.71	157	19	13	68
I discussed my ideas or plans that evolved from the IMPACT sessions with people I had not previously met	4.89	1.68	157	19	18	62
Aside from those in the weekly IMPACT meetings, how many people did you meet with about your project and/or career as a result of the IMPACT program?	M	SD	N	Min	Max	
Impact on Science, Part 2: ^a	4.10	4.17	156	0	40	
My research was impacted by my participation in the IMPACT program	n					
If it was impacted, it was through: (check all that apply)	17					
A shift in the application or problem being targeted						
A change in the approach to the target you were considering initially	12					
A change in strategy or in priorities towards addressing your target	33					
Other	14					

^aNote that 123 (77%) of the respondents stated that they met with professional development advisors and 128 (81%) having met with stakeholders and answered related questions.

^bThese questions were added to the survey after 4 cohorts had already completed the program, so these questions were sent to 104 Fellows, with 86 (83%) responding to the questions.*The survey asked for respondent's agreement to a set of statements using a 7-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = neutral, 5 = slightly agree, 6 = agree, 7 = strongly agree). The neg, neut, and pos indicate what *percentage* of respondents responded negatively (scale of 1-3), neutral (scale of 4), or positive (scale of 5-7). There were 159 (89%) responses from 179 Fellows who completed the program over the years 2016 through 2021. Rounding errors account for percents not totally 100%; they occurred as a result of not reporting percents to one decimal place.

Table 2

Subset of open comment responses to the survey.

PROGRAM OVERALL

The IMPACT program has truly been a transformative experience.

The IMPACT program has truly changed the way I think and communicate my scientific ideas and research.

IMPACT not only helps you grow as a scientist and a professional but it allows you to better understand your own research so you can describe it in a way that others (scientist, professionals, friends and family) not in your lab or area of expertise can follow.

This experience exceeded my expectations. I now think about my research as to how it impacts society and also the target points that anyone could understand. I am so happy that I spent four months participating and experiencing this program. I have seen a drastic change in how I approach my research.

IMPACT on SCIENCE

My proposed application was not well considered, and IMPACT helped evaluate options using the metric of impact to pick something just as feasible but more impactful.

Through IMPACT, I deepened my understanding of what the results of some of my experiments mean in a larger context, by having to articulate why I found them exciting. This has led me to propose a different set of future experiments, which I think will be more interesting and useful than those I was planning previously.

In a way they taught me how to think outside the box. Is difficult to think that way when you are surrounded by people that in a way understand your research. I learned how to have a different approach to my hypothesis and questions and think further about what is needed from my research in order to have a better and larger impact.

COMMUNICATION

I was surprised by how many assumptions I had made when preparing talks. Ultimately IMPACT helped me streamline my ideas, which will be valuable regardless of the audience.

It was so much easier for me to write my NIH K application once I had gone through the IMPACT process.

The feedback I received from the IMPACT faculty is different from the one I typically get from my lab colleagues, and although challenging, it helped me to build a much more compelling narrative about my research project.

CONFIDENCE

Before IMPACT, I thought my work was very exploratory and found it difficult to imagine the impact my work my have in science and beyond. IMPACT helped me find where my project fits and where it will make a change.

I really looked forward to the IMPACT meetings- they helped remind me how interesting and fun science and research can be.

Prior to joining the IMPACT program, I have worked on this research for some time and I was not happy with my progress. With faculty, peer mentor's help, feedback, enormous support, guidance, and expertise, I have learned how to go from a draft to building a strong case for research and making an impact.

At first, talking to stakeholders felt daunting, but with each new round it got easier, in the end, I managed to speak to 10 different stakeholders.

CAREER PATH

Participating in the program definitely helped me crystallize the main points of my research and I was able to use my new skills to develop a presentation for a job interview which was immensely successful.

The sessions with different speakers, meeting a career development advisor, and expanding my network has opened up career possibilities and avenues I had not considered or otherwise would not have been aware of.

When I first started the IMPACT program I was very uncertain about what I wanted to do with my future. I was aware of all my possible choices, but the sheer number of things that were possible was overwhelming. After completing the IMPACT program, I have found incredible clarity in what it is I want to do with my career throughout my whole life.