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Internship Experiences Contribute to Confident Career Decision Making for Doctoral Students in the Life Sciences

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ABSTRACT

The Graduate Student Internships for Career Exploration (GSICE) program at the University of California, San Francisco (UCSF), offers structured training and hands-on experience through internships for a broad range of PhD-level careers. The GSICE program model was successfully replicated at the University of California, Davis (UC Davis). Here, we present outcome data for a total of 217 PhD students participating in the UCSF and UC Davis programs from 2010 to 2015 and 2014 to 2015, respectively. The internship programs at the two sites demonstrated comparable participation, internship completion rates, and overall outcomes. Using survey, focus group, and individual interview data, we find that the programs provide students with career development skills, while increasing students' confidence in career exploration and decision making. Internships, in particular, were perceived by students to increase their ability to discern a career area of choice and to increase confidence in pursuing that career. We present data showing that program participation does not change median time to degree and may help some trainees avoid "default postdocs." Our findings suggest important strategies for institutions developing internship programs for PhD students, namely: including a structured training component, allowing postgraduation internships, and providing a central organization point for internship programs.

INTRODUCTION

The past several decades have seen a major shift in the career outcomes of PhD-level biomedical trainees, with a minority of PhD biomedical scientists now employed in academic tenure-track positions (National Institutes of Health [NIH], 2012). This is due in part to the diminished number of available faculty positions relative to the increased number of PhDs produced (Schillebeeckx *et al.*, 2013) but is also a result of the genuine interest many doctoral trainees have in careers outside academia (Fuhrmann *et al.*, 2011; Sauermann and Roach, 2012; Roach and Sauermann, 2017). Graduate students report that they are actively considering multiple posttraining options, often reporting a simultaneous interest in the faculty track and several other career tracks (Fuhrmann *et al.*, 2011; Roach and Sauermann, 2017).

Without clear post-PhD career goals, many PhD students continue on the research-training trajectory by planning for a postdoctoral position even while acknowledging disinterest in a future academic research career (Sauermann and Roach, 2016). Undecided PhDs who have pursued postdoc positions simply because it is the culturally expected "next step" have been labeled "default postdocs" (Sauermann and Roach, 2016). The opportunity cost to both the individual and the biomedical sciences

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community of pursuing a default postdoc can be significant, particularly when the trainee eventually chooses a science-related career that neither requires nor significantly values a postdoctoral research-training period (Schillebeeckx *et al.*, 2013; Kahn and Ginther, 2017). Therefore, the biomedical training community needs effective mechanisms by which PhD students can investigate and actively choose post-PhD careers *during* doctoral training, thereby avoiding default postdocs (Yamamoto, 2014). This imperative extends to the broader life sciences training community as well (Yamamoto, 2014).

Here, we report the outcomes of an experiential education program that was developed at the University of California, San Francisco (UCSF), and replicated successfully at the University of California, Davis (UC Davis). The goal of the program was to use internships to help PhD students make informed career decisions before the end of their graduate training or just after they finish their training, so that students could avoid committing to default postdocs. The benefits of internship experiences are well documented for many populations, such as MBA students and undergraduate science, technology, engineering, and mathematics students. Studies demonstrate that students completing internships improve work-related skills, grow their networks, and are more attractive to prospective employers (Wright *et al.*, 2007; Musante, 2009; Graduate Management Admission Council, 2012, 2014). However, to our knowledge, this study is the first to examine the benefits of internships for PhD life sciences students interested in a variety of careers beyond academic research.

When launching the program, there were two main questions that the team from UCSF wanted to address. First, could an internship program provide the desired benefit for students? That is, would participation in the program increase students' confidence in their ability to choose a career path and decrease the likelihood that students pursue a default postdoc? And, if so, could this be done without significantly lengthening time to degree? Second, could the program be designed to work at other institutions? That is, if the program was successful at UCSF, could it replicated at another university?

With funding from the Gordon and Betty Moore Foundation, UCSF partnered with colleagues from UC Davis (replication site) and the Northwestern University Feinberg School of Medicine (external evaluation team) to address these questions. Together, we have demonstrated that the UCSF Graduate Student Internships in Career Exploration (GSICE) model could be replicated at a comprehensive university, UC Davis. We have determined that time to degree is not extended for students who complete an internship and that student confidence in career decision making was increased after interning. Finally, we found that students who participated in the internship training program were less likely to pursue postdoc positions without a specific career goal in mind.

GSICE Program Model

To our knowledge, when it was established in 2009, the UCSF GSICE program was the only formal, university-based internship program aimed at supporting life sciences PhD students as they explore the full range of careers available to them.

The GSICE model has two components: 1) a workshop-based training curriculum, organized as a course and designed to build career-exploration and decision-making skills along with job search skills; and 2) an internship experience beyond academic research designed to provide sufficient information about a chosen career path for students to effectively exercise those career decision-making skills.

The program targets graduate students from UCSF's basic and biomedical sciences graduate programs (see Supplemental Table S1). Students must have passed their qualifying examinations to apply to the program, and students accepted into the program complete a 10-week curriculum as a single cohort. The cohort model was explicitly chosen to foster peer support and peer learning, which provide important career development and psychosocial functions (Kram and Isabella, 1985).

After students complete the training component of GSICE, they are considered "eligible" (but are not required) to pursue an internship. To pursue an internship opportunity, students must obtain permission from their graduate programs and dissertation mentors (referred to hereafter as "principal investigator," or "PI"). Administratively, students who have not graduated yet are placed on leave-of-absence status while engaged in their internships. This status reduces potential complications around intellectual property and liability, maintains access to student health insurance, and removes the obligation to pay tuition and fees for that quarter.

Internships are commonly full-time, 3-month experiences completed before graduation. However, students may defer internships until immediately after graduation. In those cases, PI approval is not required. Students may also accept part-time internships for which PI approval and leave-of-absence status is not mandatory.

Wages are paid to the student by the internship site, with GSICE requiring that trainees completing a full-time internship receive a wage that matches or exceeds the graduate student stipend plus the cost of buying into UCSF's student health insurance program. In limited circumstances, grant funds were used to cover the partial or full wages of trainees interning at not-for-profit sites with limited resources. Part-time internship wages vary, with most part-time arrangements being unpaid. Full-time internships without remuneration are not permitted.

Students who are on fellowships (institutional or individual) must work with their fellowship program officers to determine whether taking an internship is possible without loss of the fellowship. Anecdotally, UCSF and UC Davis have found that funding agencies such as the NIH and the National Science Foundation (NSF) tend to be very supportive, which is in keeping with their own policies and programs related to internships (NSF, 2015, 2017; National Institute of General Medical Sciences, 2016). However, every situation needs to be negotiated individually, and the internship program coordinators are available for advice and strategy on how to navigate conversations with the funding agencies. The unit that serves as the local administrator of the fellowship also needs to be informed and a part of these conversations.

Content of the Course

The curriculum for the course that was developed at UCSF and later adapted at UC Davis covers eight topics in 2-hour training sessions over a 10-week academic term. Course sessions are held during normal workday hours (9 am to 5 pm), either in the morning or afternoon, depending on the cohort year. The time of day is selected to accommodate instructor and room availability

and is advertised to students before they apply to the program. The course involves active participation and required homework, and its learning objectives follow a practical, well-defined career development progression, from self-assessment to career exploration, job search strategies, and skills for successful interactions during the internship (see the Supplemental Material, Text S1). Development of networking skills is interwoven throughout the curriculum. Session topics include the following:

Topic 1. Self-assessment: Understanding the skills, values and interests that drive career satisfaction
Topic 2. Career exploration: Learning how to learn about your universe of career opportunities
Topic 3. Choosing a best-fit future career path and setting goals for the future
Topic 4. Creating and sharing an individual development plan (IDP)
Topic 5. The internship search process: Job search strategies and résumé writing
Topic 6. The internship search process: Interviewing and negotiating skills
Topic 7. Succeeding in an internship: How to work with supervisors and peers in the nonacademic workplace
Topic 8. Communication styles: Getting along with others in the workplace

Source of Internship Opportunities

Students who decided to pursue internships sought them in various ways. Program staff connected some students to internships by publicizing opportunities using the program listserv. These internships ranged from formalized programs to first-time or one-off positions cultivated through relationships with local employers. Other students found internships through personal connections, informational interviews, and Internet searches. In some cases, students identified and applied to posted internships on their own, but typically students solicited help from program staff to secure or develop the position, prepare application materials for interviews, or negotiate final details.

Replication at UC Davis

UCSF is a graduate-only health science campus and resides in the heart of the San Francisco Bay Area with a wealth of employers of PhD scientists. Therefore, UCSF sought to test the program model at a partner institution with three important characteristics: supportive leadership, a diversity of graduate programs extending beyond biomedicine to life sciences more generally, and a smaller employment hub. UC Davis emerged as an ideal partner for our replication experiment. In 2014, the Career Exploration Through Internships (CETI) program was launched at UC Davis, recruiting PhD students from biomedical disciplines as well as the areas of plant biology and food science.

Theoretical Analytic Framework

UCSF and UC Davis partnered with the Scientific Careers Research and Development Group (SCRDG) at the Northwestern University Feinberg School of Medicine to build an evaluation protocol for the programs. The group, headed by Dr. Richard McGee, has extensive experience with program evaluation and research on the development of young scientists (Gazley *et al.*, 2014; Remich *et al.*, 2016; Williams *et al.*, 2016a,b). Their research and the research of others in this field draw on social science theories that help explain and provide underlying principles that guide career development and exploration.

Social cognitive career theory (SCCT) is an established framework in the social sciences that is useful for interpreting how programs like those at UCSF and UC Davis impact career planning and decision making among doctoral students. The elements of SCCT account for individuals' interests in science, the level and nature of confidence in their own ability to perform well in a position, what to expect in various science careers, and the context in which career decision making occurs (Lent *et al.*, 1994). Applied to the many highly specialized career options available to PhD-level life sciences scientists, SCCT provides insights into how certain experiences and activities can improve the ability of PhD students to decide, before finishing the PhD, on a general career direction to pursue with their degree. In this paper, several of the elements of SCCT are particularly useful for framing and contextualizing students' descriptions of being in an experience-based career program: interests, self-efficacy (the sources of which are mastery experiences, vicarious learning, social persuasion), outcome expectations, and contextual supports and barriers. Table 1 presents and defines the elements of SCCT in full, including those elements that were less germane to these programs.

TABLE 1. Elements of social cognitive career theory

Element	Description
Interests	The evolving sense of what someone finds interesting or not
Self-efficacy	The sense of how well one can meet the tasks and expectations required of a field or area within a field
Mastery experiences	The feeling that one has mastered a difficult task, contributing to a sense of self-efficacy within a defined career domain
Vicarious learning	Learning by watching others like themselves make decisions and take action related to career development and then observing the results of those decisions
Social persuasion	Encouragement or discouragement from others
Affective states	The positive and negative emotions and feelings that arise within the context of performance within a field
Outcome expectations	Anticipation of the results of a potential career decision
Goals	Desired career objectives that guide career decisions and actions. Goals can shape, and be shaped by, self-efficacy and outcome expectations.
Contextual supports and barriers	Social as well as a professional space and various supports and barriers that can promote or impede progress toward career goals

There is evidence that students interested in science careers beyond academic research have lower confidence in their ability to make career decisions (St. Clair *et al.*, 2017). The UCSF and UC Davis internship programs aim to help students like these explore and identify scientific interests, to provide opportunities to perform the work of a particular career, and to bolster students' sense of self-efficacy in pursuing any science career. As students are exposed to a variety of science professions, they can consider the degree to which particular professions are attainable and can envision the outcomes of their decisions. SCCT also accounts for institutional and interpersonal supports and barriers (e.g., departmental policies, adviser support, local job market) that students encounter during career development.

METHODS

The evaluation of GSICE at UCSF and its replication at UC Davis, including the survey and interview guide, was designed collaboratively by leaders of the programs and the SCRDG. The SCRDG conducted the surveys and interviews and reviewed deidentified data collaboratively with program leaders. The UCSF Institutional Review Board (IRB) reviewed the research plan and determined it to be exempt from IRB oversight and continuing review and approval. UC Davis sought reliance on UCSF's IRB approval, which was granted by the UC Davis IRB (UCSF IRB #: 13-11203; UC Davis Reliance #: 1519-UCSF).

Trainee Participation

Doctoral students from UCSF and UC Davis selected into the respective internship programs, which were optional, non–credit bearing activities at both institutions. There is potential selection bias with this nonrandom participation model; more motivated students may opt-in to the program, while those who are less motivated do not.

Data Collection

Evaluation data came from focus groups, semistructured interviews, and surveys. Table 2 displays the timeline of qualitative data collection activities. The student internship data collection reported here ended in September 2016 for UCSF and August 2016 for UC Davis.

Focus Groups

Focus groups were conducted with students several months after they completed the UCSF or UC Davis course to obtain an overall view of perceptions of the course and to guide the design of interview protocols and surveys. The UCSF (10 students) and UC Davis (four students) focus groups were conducted by R.M. Notes were taken during the focus groups to capture key themes and messages, and focus groups were also audio-recorded for completeness. Audio recordings were transcribed professionally and used to enrich and complete the notes. Focus group questions are provided in the Supplemental Material (Text S2).

Semistructured Interviews

Interviewers used a semistructured protocol with questions designed to elicit student perspectives on the value of various components of the course curriculum, reflections on the process of deciding whether or not to do internships, internship experiences, how internships affected career thinking/plans, and the role of faculty PIs/major professors in career planning and participation in the internship programs. Interview questions are provided in the Supplemental Material (Text S3).

Participants were recruited via email from the SCRDG after an initial email introduction from UCSF or UC Davis program staff. Two follow-up recruitment messages were sent to nonresponders. Most interviews occurred after students had graduated; others were distributed across years 4 through 7 of PhD training, nearing graduation in most cases. Initially, only students who had completed an internship were invited to participate in an interview (UCSF 2010–2014 and UC Davis 2014 cohorts). After early analysis of those interviews, we recognized the value in exploring the decision making of students who did not pursue internships, and subsequently invited the full 2015 UCSF and UC Davis cohorts to participate in interviews. Overall, 28 (58%) of UCSF interviewees and nine (64%) of UC Davis students had done internships at the time of their interviews (Table 3). Also shown are the numbers of participants who planned to do an internship and those who did not.

Interviews ranged from 30 to 60 minutes and were digitally recorded, except for one respondent who declined recording, and professionally transcribed to prepare for coding. Interviews were confidential; identifying information was removed before data were summarized for UCSF and UC Davis and has been removed from the transcript excerpts in this paper.

Interview Data Analysis

Several principal questions guided the analysis of interview and open-ended survey data:

- What was the range of experiences with course sessions and what were the perceived values and impacts of them?
- What was the range of experiences with internships and what were the perceived values and impacts of them?
- How did faculty respond to their students expressing interest in and/or participating in course workshops and internships?

TABLE 2. Qualitative data collection timeline

	UCSF	UC Davis
Spring 2013	Focus group (in-person)	—
Summer 2013	Interviews (in-person) postinternship	—
Fall 2014	—	Focus group (in-person) preinternshipInterviews (in-person) preinternship
Fall 2015	—	Interviews (in-person) postinternship
Spring 2016	Interviews (phone) (internship and noninternship)	Interviews (phone)(internship and noninternship)

TABLE 3. Students interviewed by program cohort

Program cohort	Total no. enrolled in cohort	No. enrolled in cohort and did internship	No. interviewed	No. interviewed with current or completed internships	No. interviewed without internships but plan to do one	No. interviewed with no plans to do internship
UCSF 2010	17	9	7	7	—	—
UCSF 2011	18	10	5	5	—	—
UCSF 2012	31	14	5	4	1	0
UCSF 2013	32	8	7	5	1	1
UCSF 2014	41	8	2	1	1	0
UCSF 2015	35	5	22	6	5	10
UC Davis 2014	26	7	2	2	0	0
UC Davis 2015	17	4	12	7	2	2
TOTAL	217	65	62	38	10	13

- What factors affected the feasibility of or decisions around doing an internship?
- What led students to NOT seek internships?

Transcripts of interview and focus groups and text data from open-ended survey questions were inductively and deductively analyzed. Once primary themes had been identified with a number of early interviews, the coding scheme was introduced to the qualitative software NVivo (version 10, QSR International). Subsequent interviews were coded using the initial framework while looking for new themes to add.

While an inductive approach was used to analyze interview data, protocols were structured around key elements of the program, which drove data analysis within broader categories such as "workshops," "internships," and "PIs." SCRDG focused on capturing the full variation of experiences within these categories using the guiding questions listed above, being mindful of emerging factors that influenced the students' experiences. This structure also allowed us to quantify some aspects of the interview data to reveal frequencies of common themes without losing less frequent ones that were important to some individuals. This method of qualitative analysis is commonly denoted "evaluation" or "descriptive" coding when the goal is not to reduce data to a few most common themes or to compare data with an analytical theory (Miles *et al.*, 2014). The themes that emerged, along with large numbers of deidentified student quotes that depicted them, were then provided to the UCSF and UC Davis leadership for comparison with their perceptions of students in their programs and to provide clarifications where needed.

Interviews occurred at varying times with respect to students' completion of the training course and/or internships. Approximately 60% of participants were interviewed less than 1 year after completing the training course, 10% at 1 year, and 30% at 2 to 3 years after training course completion. This led to variation in the level of detail of recall of workshop and internship experiences. Some interviewees reported difficulty remembering details of specific program components. While this might result in less nuanced responses, interviewees readily recalled significant pieces of their experiences and provided more global assessments of how the program influenced their career decision making.

Potential Selection Bias

Many interviewees spontaneously stated that they were happy to participate in an interview, because they hoped it would help keep the program going. While this is positive evidence for the programs, it may indicate selection bias; those who felt neutral or negative about the program might have been less likely to respond to interview requests. However, multiple interviewees freely provided critical comments and suggestions about the course, processes for identifying internships, and their individual internships. This feedback is presented in the *Results*.

Surveys

Three surveys were administered online. Postcourse and postinternship surveys were introduced in 2013. In December 2015, a post-PhD survey was sent to students from all previous cohorts who had graduated. Surveys were constructed collaboratively between the SCRDG and leaders of the UCSF and UC Davis internship programs. Except for the post-PhD survey, the data were collected and analyzed confidentially by the SCRDG to encourage candor. For the post-PhD survey, participants were aware that their names and responses would be shared with UCSF and UC Davis program leadership. Table 4 summarizes all of the surveys conducted, which program cohorts received them, the number who did internships from each cohort, and survey return rates.

The postcourse survey was distributed at the conclusion of each course. Its purpose was to collect respondents' perception of the quality of the course sessions and the course's impact on their ability to explore career options.

The postinternship survey was distributed only to students who had completed an internship. This survey was designed to discern the usefulness of the internship to students, factors related to their decision to pursue internships, and the impact of internships on their career planning.

The post-PhD survey was sent to all past UCSF and UC Davis internship program participants who were known to have had completed their PhDs as of December 2015. This survey was administered by UCSF and UC Davis, which then shared the data with the SCRDG for analysis. Participants were informed of who would be reviewing the data and for what purposes.

Although overall return rates are satisfactory, they are disproportionate across cohorts, potentially biasing findings toward more represented cohorts. All three surveys contained open-ended items that were used to supplement and triangulate interview data.

A fourth survey was conducted by email to all students in the UCSF and UC Davis programs who had graduated: the

TABLE 4. Survey data collection timeline and response rates

Program cohort	Total enrolled	Total completing internship	Postcourse survey return rate	Postinternship survey return rate	Post-PhD survey return rate (*n*)	Post-PhD postdoctoral experience[a] return rate (*n*)
UCSF 2010	17	9	—[b]	—[b]	65% (11)	71% (17)
UCSF 2011	18	10	—[b]	—[b]	61% (11)	72% (18)
UCSF 2012	31	18	—[b]	—[b]	76% (19)	84% (31)
UCSF 2013	32	11	69%	38%	70% (15)	61% (28)
UCSF 2014	41	10	83%	88%	—[c]	68% (34)
UCSF 2015	35	5	77%	60%	—[c]	71% (17)
UC Davis 2014	26	7	100%	71%	57% (8)	38% (9)
UC Davis 2015	17	7	94%	100%	63% (5)	75% (7)

[a]Survey was sent to participants September 14, 2016.
[b]The postcourse and postinternship surveys were not administered to the UCSF 2010–2012 cohorts because this was before the development of the replication experiment and subsequent evaluation protocols discussed in this article.
[c]The post-PhD survey had no respondents for UCSF 2014 and 2015 because no students in the cohort had been known to have graduated at the time of the survey release (December 18, 2015), and therefore the survey was not sent to those cohorts.

post-PhD postdoctoral experience survey. Though we had administered the post-PhD survey, we realized later that we had neglected to ask specific questions about students taking postdoctoral positions for a year or longer, and whether their intention in taking these positions was to gain further training for an eventual independent research-related position. We rectified this omission in a short email questionnaire; the results were analyzed by UCSF and UC Davis program leadership. The survey questions for all surveys are included in the Supplemental Material (Texts S4–S7).

Survey Data Analysis

Survey data (anonymized to UCSF and UC Davis program leaders with the exception of the post-PhD survey and the post-PhD postdoctoral experience survey) were reviewed by all members of the SCRDG, GSICE, and CETI teams. These data were reviewed for frequencies of various responses and other data patterns to arrive at key observations, with no intent to apply inferential statistical testing for significant differences.

Time-to-Degree Data Analysis

Time to degree (TTD) was calculated as the difference between matriculation and graduation dates. TTD data were obtained for UCSF and UC Davis program participants and analyzed separately for each institution. The TTD analysis range was set at the start date of the earliest enrollment in a PhD program by a UCSF or UC Davis participant through the Spring quarter 2016 (the most recent data available at the time of analysis). To be consistent with how both institutions calculate TTD, the time of any leave of absences was not subtracted from the TTD calculations. The TTD start date for UC Davis was Fall quarter 2007, while the start date for UCSF was Fall quarter 2000. The means and standard deviations of these data were then calculated for the following groups: 1) TTD for eligible PhD students who did not participate in an internship program, 2) TTD for students who did participate in the UCSF or UC Davis program, and 3) TTD for students from UCSF or UC Davis who participated in the program and also participated in an internship. For one of the UC Davis programs, Molecular, Cellular, and Integrative Physiology, no participants had yet completed their degrees, so no data were available for TTD calculations. This was similarly true for the UCSF graduate program Oral and Craniofacial Sciences. Independent *t* tests were performed to determine whether significant differences were evident between groups.

RESULTS

Trainee Participation

Both the UCSF and UC Davis programs attracted graduate students from a wide range of years in training and from a diversity of programs (Supplemental Table S1), but most students joined the programs after year 4 (NB: at both UCSF and UC Davis, students were eligible to join the programs only after passing their qualifying examinations, which normally occur in year 2). Both programs attracted more female than male participants (63 and 70% female at UCSF and UC Davis, respectively). The sizes of the cohorts at both UCSF and UC Davis were similar, averaging 29 and 22 students, respectively (Table 5 and Supplemental Table S2). Given typical enrollment sizes, we estimate that ~7% of the eligible student population at UCSF participated in GSICE, and an average of 40% of the cohort students completed internships as of September 2016. Given the typical enrollment sizes at UC Davis in the eligible programs, we estimate that ~12% of eligible students in 2014 and 5% in 2015 participated in CETI (in 2015, CETI expanded the overall number of eligible graduate programs from six to nine). Approximately one-third of the CETI cohort students completed internships as of August 2016.

The subgroup of program participants who went on to complete an internship experience found their opportunities across a wide variety of fields, ranging from full-time assignments at the bench within large biopharmaceutical employers' established internship programs, to part-time opportunities to assess startup company valuations within venture capital firms (Figure 1).

TTD for Internship Program Participants

We observed no statistically significant differences in the TTD of students at UCSF or UC Davis who did or did not participate in the respective programs. We also found no significant differences in TTD between GSICE or CETI students who did an internship (full- or part-time) and those who did not (Figure 2).

TABLE 5. UCSF and UC Davis training cohort size and internship participation

Cohort (years)	Range cohort size	No. students who went on internships	No. internships[a]	No. internships postgraduation	No. part-time internships	Average % cohort who went on internships
UCSF (2010–2015)	17–39	63	71	17	17	40
UC Davis (2014–2015)	17–26	14	14	2	3	34

[a]Some students did more than one internship.

Observed Faculty Response to PhD Student Internship Program

Faculty play a key role in students' research options, publication goals, graduation, and postgraduate options. Thus, students' perceptions of their PIs' support for their participation in the internship program can be a significant form of social persuasion (SCCT) in students' career development (Table 1).

Quantitative studies of career development among biomedical doctoral students have found that 60–75% of students report their PIs are neutral or supportive of their interest and participation in such programs (Petrie *et al.*, 2017; St. Clair *et al.*, 2017). In our sample, 88% of surveyed students who did an internship *during* grad school said they did not have difficulty getting their PIs to agree ($n = 34$, GSICE/CETI 2014 and 2015 postinternship surveys). Similarly, 82% of interviewees who talked about their PIs during the interview ($n = 56$) explained that their PIs respected, or at least did not stand in the way of, their career interests and aspirations beyond academic research. In ~37% of those cases, PIs actively supported their students by providing advice, encouragement, and professional contacts outside academia. Conversely, 16% of interviewees described PIs who discouraged them from pursuing paths beyond academic research, explicitly forbade them from doing an internship before graduation, or spoke negatively or dismissively of science work outside academia. However, strong opposition was minimal in our sample at both UCSF and UC Davis.

Whether supportive or not, students said that PIs' biggest concerns were that the internship would jeopardize their research time, dissertation writing, and publishing commitments.

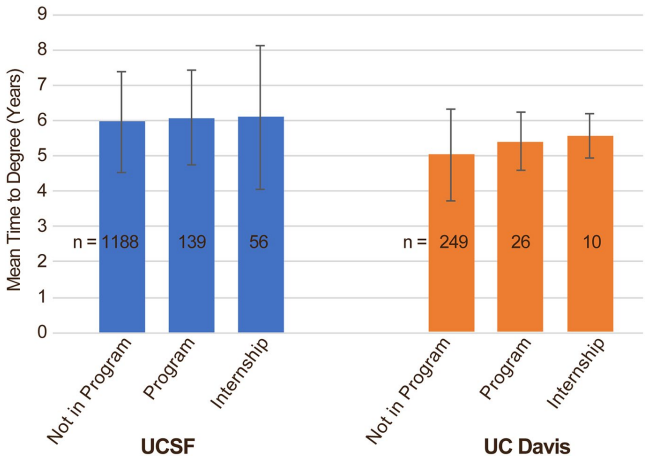

FIGURE 2. Mean TTD in years. Labels for the figure indicate the following: "Not in Program" represents students who did not participate in either GSICE or CETI at UCSF or UC Davis, respectively; "Program" represents students who participated in GSICE or CETI; "Internship" represents students who participated in GSICE or CETI *and* participated in an internship (not all students in GSICE or CETI did an internship). Error bars represent the SD of the means. Independent *t* tests between the "Not in Program," "Program," and "Internship" groups at each university found no significant difference between the groups (unpublished data). To be consistent with how both institutions calculate TTD, the time of any leave of absences was not subtracted from the TTD calculations.

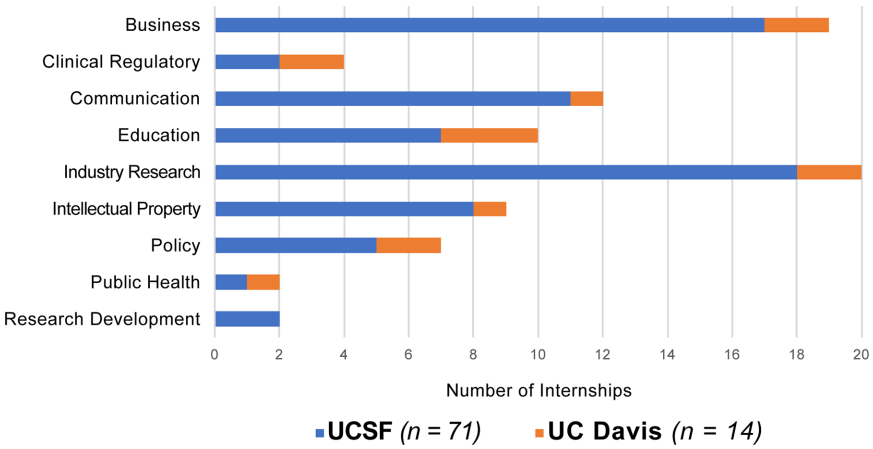

FIGURE 1. Distribution of internships in general career fields for UCSF (GSICE program) and UC Davis (CETI program). The UCSF data represent 71 internships (GSICE 2010–2015). The UC Davis data represent 14 internships (CETI 2014–2015).

Some students waited to do or even discuss an internship until after their research experiments were finished, because they were apprehensive about approaching their PIs to request permission for time away. In fact, 60% of surveyed students who did an internship at the *end* of grad school ($n = 10$) said that they did not do one during grad school, at least in part, because they thought their PIs would not approve. Representative quotes from students demonstrate the range of PI responses.

> "Some people have problems with their relationship with their PI but ours was a very working relationship … their only requirement was that I have my papers submitted before I left."—Participant 60

> "We compromised and he let me take the position if I promised to help finish the paper … it's difficult. You can't necessarily time these internships and you can't time job opportunities like you can academic things, so yes, your PI definitely has to be flexible to work with these timelines but you know … you still can't give up these opportunities because they don't come that often."—Participant 14

> "I wanted to do something while I was still in my program but my major professor was extremely opposed to that. Vehemently opposed to that, so I did do some smaller-scale volunteer work, but I was not able to do an actual internship during my graduate work … [My PI] basically told me absolutely not; that if I decided I wanted to do something like that, then that just meant that I was not serious about finishing my PhD and that I was putting their lab and program at risk."—Participant 43

> "He really was pushing me to do a traditional research post doc and he really wasn't happy when I [did some additional nonlab work] my last year of grad school, so I had to fight him over it. I mean it wasn't … I think we came to a good agreement … but he didn't like it at all."—Participant 18

Career-Exploration Skills. The course sessions provided the tools, skills, and space to explore the breadth of science careers unfamiliar to participants. A number of students reported that they were able to clarify their career path goals by completing the course component alone, without ever pursuing an internship.

> "One of the things that was really helpful for me personally about CETI was the reassurance and the support that … you don't have to do exactly the same thing you've been doing, you know, for the rest of your life. So that kind of support to explore other things, but also build that confidence that I could be successful in that."—Participant 43

> "No one had ever told me to sit down and say what are your skills, what are your values, what are your interests and I found that to be incredibly helpful. Where are the overlaps and where are the disconnects? Because I had never really thought to acknowledge that just because I'm good at something doesn't mean I'm interested in it."—Participant 17

Designated Time for Career Planning. The benefit of being in a program that "forced" them to designate time to career planning was a prominent theme among study participants, as respondents reported difficulties in setting aside time for career planning because of demanding research obligations.

> "The thing that I liked about CETI was that it gave me time that I had to participate to actually work on and look into what I really wanted to do as a career, because that's something you always are kind of thinking about and you don't normally act on it until, you know, it's like you're three months away from dissertation and then it's kind of too late … I felt that that was very helpful just to kind of think about like where are you now, what I want to do and try to fill in the middle of how I get from where I am to what I want to do."—Participant 45

Job Search Skills. Training on practical job-seeking skills increased students' confidence in their ability to secure internships and jobs. Participants valued help with the practical aspects of job seeking such as résumé and cover letter writing, interviewing skills, and the application process.

> "I really liked talking about networking and how to really utilize that … I'll admit I don't necessarily do it as much as I should, but just knowing about it was really helpful and you know, if and when I move on to my next job, I know how to do everything a little bit better."—Participant 44

> "I think that's one like main thing I learned from GSICE is 'Wow, gosh, I don't know how to write a résumé and I'm almost 30' or that I really don't know how to interview and network like I should and that is good for academia as well."—Focus group participant

Peer-to-Peer Community Effect on Career Planning. The course provided a sense of community among peers with similar career interests. They appreciated being able to develop career plans in an environment that does not attach the same stigma to careers beyond academic research that some students encountered with PIs and research colleagues.

> "I could express my interest in pursuing careers outside of academia and discuss these ideas with people having similar feelings. The GSICE program gave me the guidance but also the space to explore many options and find the path that is right for me, without having to worry about potential backlash of seeming unfocused or uncommitted to my graduate work."—Survey respondent

> "[The program] connects students with a community of people who are very supportive of actually exploring all careers … which includes putting a more critical eye to sort of an academic career. Which I think is useful even if you want to stay in academia, right?"—Participant 4

Furthermore, the course component of the program ensured opportunities for participants to observe and listen to how their fellow students made decisions and took action toward their career goals. Learning from peers emerged as a valuable supplement to the course curriculum, allowing students to consider their own approaches to career development and the possible outcomes of the decisions they make along the way.

> "The one good thing about GSICE [was hearing] about other people's experiences and the things that they had done. So I would [be] like, "oh I've never heard of this" or "I've never heard of that," so it does expose you to other … ideas that you're not aware of."—Participant 19

> "I think the number one thing was just simply speaking with other students, seeing students from other grad programs and other schools and med school immersing, I think … it was basically talking with other students I think was fun, where they were at, why they were pursuing it, seeing my peers being okay with pursuing nonacademic careers, supporting each other in kind of ideas that we could do other than postdocing."—Participant 40

Career Decision Making. Most students reported that the course increased their confidence in the career path they would pursue after graduation.

TABLE 6. Traditional postdoc activities for UCSF and UC Davis internship program participants

	UCSF (n = 145)	UC Davis[a] (n = 29)	National average (n = 9000)[b]
Percentage who did a traditional postdoc of >1 year	25	36	70
Of those, ratio of academic to industry postdocs	4:1	4:1	n/a
Of those, percentage still considering becoming an independent research scientist	79	50	n/a

[a]Note that number of UC Davis respondents was low.
[b]NIH, 2012.

> "I'd say it's been very influential … it just really built my confidence that I could, you know, have a nontraditional career path that I could be successful [in] and that I could do it and that there were options for me."—Participant 18

> "One of the more valuable components of the course is that it made me consider both the good and bad parts of the career paths I am interested in—so I don't think I came away with my true calling but I am more informed about my options."—Survey respondent

Those who reported not feeling more confident indicated a need for more information about or experience in that field before feeling confident to pursue it:

> "For me, it will take doing more of the things we learned about in the workshop series. For instance, we learned about the importance of doing informational interviews as part of the career-exploration process, and I think, for me, I need to follow up on this in order to feel more confident in the career path I want to pursue."—Survey respondent

Learning skills needed to obtain accurate information about careers outside of academic research, and actively applying those skills, increased students' sense of self-efficacy to set and meet career development goals. Peer support (social persuasion) and observation (vicarious learning) from fellow program participants also increased students' self-efficacy in pursuing a nonacademic career without judgment.

Program Participants Are Less Likely to Pursue Postdoctoral Research

Program participants who graduated were surveyed about their first post-PhD job. A minority of respondents (25% of UCSF respondents and 36% of UC Davis respondents) reported that they entered a traditional research postdoc lasting 1 year or more, as compared with the national average of roughly 70% (NIH, 2012). Of the UCSF respondents who went on to a traditional postdoc, most reported that, at the time of deciding to do their postdoc, they were still considering becoming an independent research scientist (Table 6).

Impact of Internships

Students who had completed an internship were asked to consider the level of confidence they had in their post-PhD career choice both before and after an internship (postinternship survey). The number who reported feeling confident or very confident increased from 58 to 86%, and those who said they were still considering a range of careers after their internship decreased from 45 to 14% (Figure 3). Because there is no true comparison group, we cannot totally rule out that these differences reflect a simple passage of time. However, the questions were all anchored to before and after the internship to focus the respondent on the internship. Additionally, all of the text comments in surveys and interviews showed that students were thinking about how the internships affected them.

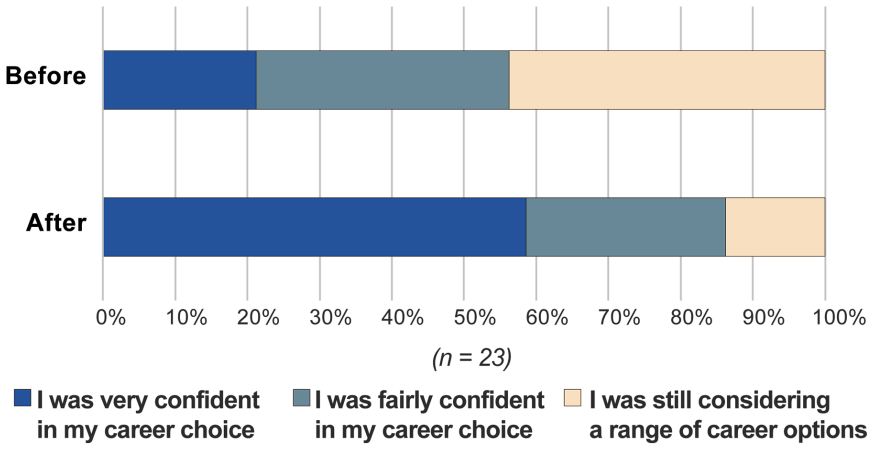

FIGURE 3. Career choice confidence before and after an internship. Figure shows combined UCSF GSICE (n = 14) and UC Davis CETI (n = 9) results. Data from the GSICE and CETI postinternship surveys. Data were gathered after the internship was performed. The "Before" label indicates the remembered confidence level before the internship.

> "I kind of recognized that my strengths would serve me better in industry rather than academia, that I really enjoyed building things, building tools rather than doing more abstract research, and that I really enjoy working in teams."—Participant 2

Of those students responding to the post-PhD survey after they had completed an internship and graduated, a high fraction reported positive impacts of their internships on selecting a career path to pursue after graduation (94%), clarifying career goals (76%), and confidence in securing a full-time job (82%) (Table 7).

TABLE 7. Impact of internship on postgraduate career decision making[a]

	GSICE ($n = 26$)	CETI ($n = 6$)	GSICE + CETI
This internship was an important factor in what career path I decided to pursue postgraduation.	88%	100%	94%
This internship clarified my career goals.	85%	67%	76%
As a result of participating in this full-time internship/temporary work experience, I feel more confident in my ability to: Secure a full-time job.	81%	83%	82%

[a]Five-point Likert scale (strongly agree to strongly disagree). Represented here are percent of students who strongly agreed or agreed (post-PhD survey).

Students also perceived, and experienced, internships as a means to additional opportunities. New connections at the internship site, job referrals, and robust résumés made students feel more competitive for jobs. In many cases, internships led directly to permanent positions within the same organization.

> "I don't think I would have gotten this job without the internship. I mean, I kind of knew I wanted this job before I started my internship, and I knew I needed industry experience to get it."—Participant 6

> "I would say overall it was extremely positive and ended up being really great for me on my résumé when I ended up applying to jobs, so I think that was really a key factor in me being able to actually find a full-time job."—Participant 48

From an SCCT perspective, internships allow students to "test" how particular careers align with their interests and gain confidence in their ability to do the work of that career (mastery experiences, self-efficacy). They also provide a direct experience that informs what to expect should they obtain a position in that field (outcome expectations). That is, by experiencing the tasks and environments associated with a particular career in science, and in succeeding at those tasks during the internship, a student begins to not only believe he or she can succeed in that profession but realizes that he or she is also able to attain that career. In fact, students did report that the firsthand experience of internships deepened their understanding of science careers outside academic research beyond what the workshops provided. Internships also opened doors for students as they entered the professional world (e.g., an expanded network, job offers).

> "Seeing how it actually worked, like research-type industry work compared to research at academia … I think I got good exposure to that, enough so that I could evaluate if it's one of my options for my career development. So I definitely think it's worth it … initially I thought I wanted a research job in industry but after the internship I would say not anymore."—Participant 62

> "I had always considered working in bio-tech, but even though I considered it, I hadn't had any experience or had been in the environment, so I didn't really know what that meant, and I just thought [an internship] was a great way to one, see if it was something that I enjoyed doing, two, to make connections and network, and three, to have that experience on my résumé."—Participant 25

Barriers to Internship Participation

Students at UCSF and UC Davis overwhelmingly reported that the biggest challenge to doing an internship was timing it around research and academic obligations. Not surprisingly, students in our study consistently called attention to the challenge of stepping away from doing experiments while in graduate school. Some also reported some potential solutions.

> "[An internship] wouldn't actually be three months. It would be more, because if I'm not in the lab for three months and my experiments take a while to set up, it would probably be like four or five months actually of like lost time … and the major thing I have to do in order to get a job after grad school is to finish grad school."—Focus group participant

> "Presumably I could have done [an internship] earlier in my graduate career and then that way I wouldn't have had to take on so many things at once, applying for jobs, finishing the internship, writing my dissertation, fulfilling things, doing experiments and so on." —Participant 5

Some students found that, with careful planning, they were indeed able to take a pause during the experimental/data collection phases of their dissertation research, so they could take a leave of absence to complete an internship. Other students waited to complete an internship until all of their research data had been collected. However, there were also students who commented that this approach presented a different set of challenges: the stress of dissertation writing and negotiating with committee members about graduation while simultaneously applying for or doing internships. Additionally, they had the added challenge of devising a "Plan B" should they graduate before securing an internship.

Alternatively, nearly one-quarter of UCSF students who completed an internship did so right after they graduated. For UC Davis, this number was lower, with only 14% doing an internship after degree completion. Doing an internship after graduation presented its own challenges for both programs. For example, as soon as freshly graduated PhDs were situated in their internships, they had to begin searching for permanent employment.

Finally, some students sought part-time internships so that they could continue at full- or part-time pace on their dissertation research while simultaneously gaining internship experience. These students reported positive experiences and might not have been able to complete an internship at all if they had not accepted part-time opportunities.

SCCT expressly highlights the critical influence of contextual supports and barriers in career clarification and movement. Life sciences PhD student career development happens within the context of traditional academic careers and expectations. As the students report, the combination of the workshops and internships mitigate the barriers and provide support for actively exploring career options.

Critical Feedback from Students

Despite much evidence for students' positive reception of the internship programs at UCSF and UC Davis, three notable critiques emerged: the relevance of the course curriculum, difficulty finding internships, and dissatisfaction with the level of sophistication of their internship work.

Relevance of the Workshop Curriculum. Nearly all students who identified a course topic or activity as not useful for them also stated that it should remain part of the curriculum, because it was valuable as a "refresher" or that it was important content for other students to learn. Offering a breadth of topics in program curricula allows individual students to focus on those that address their specific needs or deficits.

Difficulty Finding Internships. Some students felt that program staff misrepresented the level of involvement they would have in connecting a student to an internship. With the program intent being to empower students to take responsibility for their internship search, staff should ensure that students understand from the outset that the primary responsibility of finding and securing an internship is their own.

Dissatisfaction with Sophistication of Internships. In cases in which internships involved low-skilled work or tangential projects, students were less satisfied with their experience. Program staff play an important role in communicating to internship sites that PhD-level interns desire and are capable of more sophisticated contributions than an undergraduate intern may be.

DISCUSSION

Our results provide evidence that internship programs modeled after those at UCSF and UC Davis can significantly develop young scientists' capacity to make career decisions. The tenets of SCCT explain why such programs are successful through its variables: interests, self-efficacy (mastery, vicarious learning, and social persuasion), outcome expectations, and contextual supports and barriers. SCCT purports that career decisions stem from the interaction of an individual's inward assessment of interests, potential, and desirability and that this assessment is influenced by dynamic social contexts.

SCCT and the Program Course

In a training environment that tends to favor academic careers (contextual barrier), students reported that the course provided the foundation, structure, and tools to explore careers beyond academic research, reflect on their own interests and strengths, and learn practical strategies for job seeking (contextual support). In turn, this increased their confidence (self-efficacy) to pursue unfamiliar career paths. For example, IDP exercises helped students discern career tracks that aligned more closely with their interests (interests) and map the action steps needed to pursue those careers. Similarly, the informational interview was lauded by students as an effective and efficient way to get a snapshot of specific career roles, the skills required to excel in them, and advice on entering the field, thereby developing students' sense of fit with a particular career. Informational interviews also helped students visualize what their lives might be like should they choose the interview subject's career (outcome expectations). Sessions on résumé building and job interviewing equipped students with concrete skills to market themselves outside academia (mastery and self-efficacy). The course alone effectively introduced students to the breadth of available careers, increased their confidence in finding a job and performing well in it, and promoted realistic ideas about those careers. For those who also participated in an internship, the immersive experience reinforced gains from the course considerably.

SCCT and Internships

Students who did internships explicitly noted that acquiring firsthand experience gave them a clearer sense of direction. Barring a few instances in which students did not feel sufficiently challenged or supervised in their internships (but still felt the internships to be worthwhile), the experiences required them to earnestly appraise their interests, abilities, and expectations. Where the course sessions gave students' knowledge of the skills required for a career, the internships allowed them to apply and assess those skills in practice; they gained confidence in deciding whether a career fit their disposition, interests, and competencies (self-efficacy). Additionally, internships provided opportunities to directly observe and participate in the norms of a workplace. Through mentors and colleagues, students learned about the organizational structure, nature of the work, and interpersonal environment. In this way, internships allowed students to adjust their original outcome expectations and answer the questions "Do I want to pursue this job?" and "Is it likely I have or can develop the skills to be successful in the job?" with more certainty than IDP exercises and informational interviews yield on their own. Furthermore, they were exposed to a professional environment that valued nonacademic science, something they might not have experienced through their academic training and research (contextual supports and barriers).

SCCT and the Cohort Model

Many students described the tendency of academic scientists—including some of their PIs—to denigrate nonacademic science as "not real science" or "selling out." For those students, the cohort structure of the UCSF and UC Davis internship programs provided a "safe" environment to talk openly with like-minded colleagues about their experiences within academia (social persuasion and contextual support). Working through course activities, students created a community where they learned from and validated one another. This destigmatization positively reinforced students' sense of potential for themselves (self-efficacy). Similarly, program staff served as experienced and knowledgeable coaches to guide students, a model that is emerging as an important adjunct to what students obtain from research mentors (Williams *et al.*, 2016a,b).

Our analysis has demonstrated how SCCT principles can guide institutions interested in developing career-exploration programs for PhD students. Students benefited from a model in which an expanded awareness of possibilities and interests, coupled with pre- and postgraduation action planning, yielded the self-confidence needed to make informed decisions about careers beyond academic research.

Faculty Buy-In

At both UCSF and UC Davis, little faculty opposition to the programs was recorded, and it was generally understood that most

faculty supported the internship programs being offered. This positive outcome may have been promoted by particular actions taken by the program staff.

First, significant and strategic faculty buy-in for the program was sought before the internship programs were launched on each campus, by engaging the graduate program leadership. At UCSF, two widely respected senior faculty members led an effort to secure the approval of the directors of all 10 UCSF basic science PhD programs, who agreed to allow the students who had passed qualifying examinations to apply to the program, as described earlier. Similarly, at UC Davis, graduate program directors were given the opportunity to decide whether or not to offer the internship program as a pilot opportunity through an effort led by the graduate dean, who was also a well-established research faculty member. Overall faculty buy-in may have also been facilitated by the decision at UC Davis to "start small" with six PhD programs and faculty familiar with the institution's long-established undergraduate internship program and the graduate internship opportunities offered through the T32-funded Designated Emphasis in Biotechnology program (DEB, https://deb.ucdavis.edu). Starting with a subset of PhD programs that validate the internships is likely more important and effective than attempting to mandate compliance by unwilling programs.

Second, on both campuses, the program was presented initially to faculty as a pilot.

Third, both programs incorporated levels of approval for student participation that ensured clear communication among students, faculty and the program. At UCSF, approvals were needed for students if they wanted to complete an internship before graduation; the PI, graduate program director, and graduate program coordinator needed to sign off before a student could take an official leave of absence for an internship. At UC Davis, students needed a letter of recommendation to join the program.

Participant TTD

As discussed earlier, students indicated that participation in the internship programs had a positive impact on their ability to make career decisions, particularly when the course and internship components were both completed. This was accomplished without lengthening the time to graduation, as was initially feared by some PIs and graduate program directors. Although it was not explored in depth through our evaluation, some survey respondents said they were more motivated to complete their PhD after doing an internship, suggesting that increased motivation may be due to a clearer sense of what they needed to accomplish to transition into their chosen careers. We believe this is an area that warrants further study.

Internship Program Participation and Default Postdocs

While outcomes data for the UCSF and UC Davis programs have been drawn from limited numbers of participants, they suggest that participants in an internship program following our model are more likely than the general PhD population to move directly from their PhD training into careers that do not require postdoctoral training. Further, those who do choose to pursue a postdoc after they graduate are doing so because, even after participation in an internship program, or perhaps because of it, they have determined that a career as an independent researcher may still be in their future. Thus, our internship program model may help students avoid unnecessary default postdocs (Sauermann and Roach, 2016), which was one of its goals at the outset. Cause and effect is nearly impossible to determine in this kind of program, but at the very least, our data suggest that participation in the components of an internship program are strongly correlated with desired outcomes (greater confidence, fewer default postdocs) and are not correlated with undesired outcomes (greater TTD).

Advice for Institutions Starting Internship Programs

Based on our experiences and the results described earlier, we offer several suggestions to other institutions on providing internship opportunities to life sciences PhD students.

Program Structure. We recommend adopting programs with upfront training followed by access to internship opportunities. Although not every student will find it possible or desirable to undertake an internship, our results show that the training component was useful and valued by students in and of itself. Similarly, we recommend employing a cohort model, as participants reap rich benefits from the support of their peers and the wisdom of the group.

Internship Opportunities. We recommend offering flexibility around the structure of internship opportunities, including timing and pay. Allowing students to complete part-time or full-time internships, before or after graduation, will allow for the greatest number of students to gain valuable experience. And while not ideal, allowing for part-time internships to be unpaid will make it possible for some employers, especially those in the not-for-profit sector, to offer opportunities to students, so long as those unpaid opportunities are within the bounds of recent employment law (U.S. Department of Labor, 2010). Although some guidance can be motivating, students should be strongly encouraged to accept responsibility for securing their own internship experiences rather than relying on faculty or program staff to "place" them. Many students want to gain unique experiences that use or develop highly specialized skills, and an internship program designed to place every student into a unique setting would be cost-prohibitive in terms of the staff time involved, and in many cases, it would be impossible to find a perfect match. In addition, developing specific internship job descriptions beforehand, without an interested student in mind, may result in disappointment for the potential employers who do not receive a placement and could weaken relationships between employers and internship programs. Program staff can have the greatest impact by initiating and maintaining relationships with potential internship sites and in providing training that gives students the skills needed to network, find leads for internship positions, and turn potential leads into real opportunities—skills they will need for pursuing jobs throughout their careers.

Faculty Buy-In. We recommend securing the public support of one or more campus leadership champions and influential research faculty members, including those in graduate education leadership roles, before announcing the launch of an internship program. The champions can facilitate conversations with skeptical or less supportive faculty to promote the program.

Centralized Staff. Both the UCSF and UC Davis internship programs were started with part-time dedicated staff (0.5 FTE). The staff recruited and managed their program cohorts, provided career advising services at all stages of students' progression through the program, and were seen by students as a source of networking connections and encouragement throughout the career-exploration and decision-making processes. Additionally, the part-time staff collaborated with campus career center staff to design and deliver the training component of the programs and with campus administrative offices, graduate programs, and internship sites to facilitate student internships. Most of the staff involved with the internship programs were PhD-level scientists who have gone on to pursue career development staff roles at their universities. Students can relate particularly well to staff members who have themselves experienced career transitions away from academic research. Faculty and internship mentors appreciate having a central point of contact as well. We recommend a staff lead of at least 0.5 FTE when launching an internship program and to make adjustments once the program is established, based on demand from students and internship sites.

Areas for Future Study

We have learned a great deal from launching successful internship programs at UCSF and UC Davis, and we know that many other institutions have launched programs in recent years, such as those funded through the NIH Broadening Experience in Scientific Training program (Meyers *et al.*, 2016). There remains much to be learned from examining the associations between internship programs and student outcomes through data collection and evaluation. Here, we offer a few suggestions of areas we believe worthy of additional study.

Empowering Students. As mentioned earlier, we believe that there is a great benefit to students finding their own internship opportunities. It would be helpful to understand what training best prepares students to take the steps necessary to identify the type of internship that is well suited to their needs and then to pursue opportunities successfully. Empowering students in this manner is a challenge worth tackling, as we think it holds positive benefits for student development and lessens the burden on program staff. However, an alternative hypothesis would be that this requirement could serve as an excessive barrier for some students, deterring them from doing an internship. We recommend a targeted exploration of what can promote or hinder students' sense of empowerment around identifying and securing internships.

Understanding Impacts Relative to Internship Duration. While our results show that both part-time and full-time internships have a positive impact on career decision making, it would be helpful to understand the relative contributions of different internship constructs—hours per day or week and overall duration. We hope that additional work will take this type of dose–response or threshold approach to evaluating internship experiences and might even include mini-internships that offer a brief (e.g., 1-day) glimpse into what it would be like to have a particular career.

Leveraging Employers' Time. We found that the employers we worked with were very willing to participate in our internship programs, especially after hosting an initial student intern. They often requested multiple subsequent interns, but we could not always meet their requests, given the relatively small size of our programs. In addition, employers who could not offer an internship at the time a student expressed interest were often very willing to offer assistance in other ways, such as through informational interviews. We recommend a focused effort to identify best practices for leveraging employer energy and interest in our students. There are likely multiple ways to engage employers with internship programs and additional ways that programs and institutions could cooperate to meet employers' needs.

Associations with Program Location. UCSF is situated in the rich life-sciences job market in the San Francisco Bay Area. While the area surrounding UC Davis is, by comparison, a smaller job market for life sciences PhDs, it is still rich relative to some areas of the country. We know that other internship programs have launched in smaller job markets, and we look forward to learning about their experiences. Taking employers' interests into consideration, there could be valuable opportunities for institutions in different job markets to collaborate on internship placements and to explore distance-learning models.

Measuring Culture Change and Influences on PhD Training. We found that some internship program participants shared their acquired knowledge with fellow students and faculty, suggesting the potential for these career programs to have influence beyond their individual participants. It is worth asking whether students are vehicles through which programs can influence the culture of PhD training at their institutions to be more inclusive of activities outside the traditional academic model. In other words, is there potential for a "trickle-up" normalization of careers beyond academic research from students to institution? Similarly, is the visible presence of internship programs like those at UCSF and UC Davis a signal in themselves to the community that there is support for the pursuit of a range of science careers? Might such programs become part of formal PhD curricula? Although we did not systematically collect data about students' perspectives on program support for the full breadth of science careers, there is evidence that it may have greater impact on students' self-efficacy than adviser support (St. Clair *et al.*, 2017). Disentangling the relationships among PI support, program support, institutional culture, and self-efficacy has implications for the future of PhD preparation in the sciences and warrants additional study.

CONCLUSION

Overall, study of the internship programs at UCSF and UC Davis demonstrated that UCSF's GSICE program model could be launched successfully at an academic medical campus and a large comprehensive research university. Additionally, studying the two programs revealed insights into what students need for career decision making and effective ways of using an internship program to meet those needs.

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