



## Research article

# Increasing faculty support, respect, and ability to help doctoral students explore non-academic research career opportunities

Ambika Mathur<sup>a,b</sup>, Melanie Hwalek<sup>c</sup>, Victoria Straub<sup>c</sup>, Christine S. Chow<sup>d,\*</sup><sup>a</sup> Graduate School, Wayne State University, Detroit, MI, 48202, USA<sup>b</sup> Graduate School, The University of Texas at San Antonio, San Antonio, TX, 78429, USA<sup>c</sup> SPEC Associates, Southfield, MI, 48075, USA<sup>d</sup> Department of Chemistry, Wayne State University, Detroit, MI, 48202, USA

## ARTICLE INFO

## Keywords:

Career exploration

Non-academic careers

Broadening experiences in scientific training

Faculty support of doctoral student careers

## ABSTRACT

We examined the role of the NIH-funded Broadening Experiences in Scientific Training (BEST) program at Wayne State University in increasing faculty (1) support for doctoral students exploring non-academic research opportunities, (2) respect for non-academic research, and (3) ability to help students with non-academic research career exploration. Ninety-seven faculty participated in one or more BEST activities over a five-year period. Fifty-three of those faculty (55%) completed an online survey about their participation in the program and their support, respect, and ability to help students explore non-academic research careers. Sixteen of these faculty were also interviewed in depth about their perspectives on the role professional development can play in enhancing faculty perspectives about non-academic research career options for their students. The survey and interview data reveal some changing perceptions of BEST faculty participants in their attitudes toward and respect for non-academic research careers, as well as in their ability to help students in career exploration. These faculty perceptions correlated with their level of participation in BEST activities. Importantly, this study also showed that some faculty believe they lack the experience and connections outside of academia to adequately support doctoral students' career exploration. The results of this NIH-funded BEST program on faculty attitudes underscore the influence of federally funded programs in changing institutional attitudes towards supporting student career choices that have broad societal impact.

## 1. Introduction

### 1.1. Doctoral student career preparation in the biomedical sciences

A national report in 2012 showed that almost 75% of the national doctoral biomedical workforce engages in careers beyond the traditional tenure/tenure-track (T/TT) faculty positions at research-intensive institutions [1]. In addition to preparing doctoral students for T/TT careers, which is common practice, universities also need to prepare students for careers in broad sectors of industry, government, teaching at primarily undergraduate institutions, policy, and scientific writing and communication [2]. Lack of broad career preparation has been ascribed to a lack of institutional resources, lack of knowledge among the graduate training community

\* Corresponding author.

E-mail address: [cchow@wayne.edu](mailto:cchow@wayne.edu) (C.S. Chow).

<https://doi.org/10.1016/j.heliyon.2023.e13052>

Received 20 January 2022; Received in revised form 11 January 2023; Accepted 13 January 2023

Available online 16 January 2023

2405-8440/© 2023 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Abbreviations

BEST	Broadening Experiences in Scientific Training
GPPD	Graduate and Postdoctoral Professional Development
IDP	Individual Development Plan
NIH	National Institutes of Health
OTL	Office of Teaching and Learning
RPT	Retrospective Pretest
T/TT	Tenure/tenure-track
WSU	Wayne State University

about what it takes to prepare and succeed in these multiple career pathways, and in some cases lack of faculty support for non-academic research careers [3], as defined in several earlier reports [3–8]. While some reports of faculty members' negative attitudes towards non-academic careers are anecdotal, others document a real prevalence at some institutions [2,4]. One negative view is that exploration and preparation for non-academic careers takes time away from students' research and may delay their time-to-degree completion; whereas, academic career preparation is already part of their graduate education. Such views are unfortunate, as 75% of all doctoral graduates are engaged in successful non-academic research careers that utilize their research training skills, implying that they need time during their graduate studies to explore these various career pathways. National reports emphasize the value of such jobs to the student and society, and such studies reveal that institutions and faculty must transform their attitudes and cultures to embrace the diversity of job sectors that are essential to advancing the research mission nationally and globally [4].

In response to the emerging values of multiple research career tracks, the National Institutes of Health (NIH) announced in 2012 a funding mechanism, Broadening Experiences in Scientific Training (BEST), to transform culture at institutions to respect all research careers as successful outcomes and, consequently, to prepare biomedical doctoral students for careers across all sectors [1,5]. Wayne State University (WSU) was one of 17 institutions awarded a BEST grant. BEST was designed for students in the biomedical disciplines (referred to as "BEST" departments), but WSU's BEST program was housed in the Graduate School, which oversees all graduate programs across the institution; therefore, WSU BEST activities were extended to students in non-biomedical disciplines (referred to as "non-BEST" departments; these are also called "non-biomedical" departments). The impact of the BEST program on doctoral students at WSU has been described in earlier reports [6–8].

It is well established that students should have realistic expectations of what it takes to be successful in any career. Faculty mentors are pivotal in influencing the career expectations of their mentees [4]. Therefore, it is incumbent on faculty to understand and respect the value of all research careers, as well as have the appropriate knowledge and skills (or knowledge regarding where to seek such direction) to provide high-quality mentoring with regard to the exploration of both academic and non-academic research careers [3]. Consequently, WSU faculty were asked to participate in BEST and were surveyed to determine their respect for non-academic research careers being sought by students and their ability to help and prepare students to succeed in these careers. Faculty were also asked whether having themselves and/or their doctoral students participate in BEST activities impacted their (faculty) knowledge, attitudes, and skills needed to help students explore non-academic research careers. In this article, we present results of surveys on the impact of BEST participation on faculty attitudes before and after their own participation in BEST programming. We show that participation by both doctoral students and faculty in professional development activities modestly increased faculty knowledge and respect for multiple career pathways. Perhaps more importantly, faculty participation increased their perceived ability to support and help students explore and prepare for success in non-academic research career pathways.

### 1.2. BEST program description

At WSU, we developed three main activities for BEST that involved doctoral student career planning and career preparation [6,9]. The first activity was an orientation for first-year graduate students and any students and postdocs who had not previously participated in the program. Career planning and career development were also mandated in the Graduate School requirements for all doctoral students through the Individual Development Plan (IDP). The implementation of the IDP encouraged discussions about career goals between students and their faculty advisors. The second activity that was developed was a three-phase exploration and experiential learning series (called BEST *Phases I, II, and III*) for preparation in various career tracks, in collaboration with the Graduate School's Graduate and Postdoctoral Professional Development (GPPD) seminar series. The GPPDs provide insight on skills and techniques that can be broadly applied to students' research and professional activities. A digital microcredentialing system was used by students to track and demonstrate acquisition of these skills [10]. The third activity involved evaluation of program outcomes and dissemination of that information to the university to make program improvements and institutionalize program activities. Individual faculty from departments across the university were also provided with funding (ranging from \$1500 to \$4000) to develop career programming in their own units, with workshops that utilized the BEST format (referred to as "mini-BEST" events, or "BEST mini-grants"). The departments applied for mini-BEST funding and were selected by the BEST Steering Committee, which also provided guidance on event planning and assessment of activities.

Students at WSU participate in hour-long panel discussions (*Phase I*) with alumni, program partners (e.g., industry, nonprofit, and government employees), and faculty moderators that focus on different career tracks. The *Phase I* sessions highlight career

opportunities and provide knowledge about expectations and skillsets of a professional working in that track. Students subsequently attend *Phase II*, in which they engage in daylong interactive career workshops focused on building skills and gaining knowledge about careers in a specific track. These workshops include a variety of activities, such as interactive projects in teams and presentations to the larger group of students and workshop facilitators. In *Phase III*, students have the opportunity for an in-depth work experience with an organization whose mission addresses one of the career tracks from *Phases I* and *II*. The duration of the *Phase III* experience is typically 160 h over the summer. The mini-BEST events ranged from discipline-specific career panels, career workshops (typically two to 3 h in length) on various topics (e.g., bioinformatics, preparation for careers in clinical settings, teaching at primarily undergraduate institutions, industrial careers in cardiovascular research, career paths for mathematicians, careers at the National Institutes of Health, transitioning from industry back to academia, and preparation for careers in research administration), and communication for diverse audiences, and were organized and run by Wayne State faculty members. A total of ten BEST mini-grants were awarded to ten different departments, including six from biomedical or STEM programs, two from social sciences, and two from the arts and humanities.

The BEST program developed learning outcomes for each track in *Phases I* to *III* and the mini-grants. In the first two years of the program, we held workshops and seminars for faculty to learn about the BEST program, which helped them develop career programming in their own departments (mini-BEST). Ideas generated from these mini-BEST events were, in turn, used to improve BEST *Phase I - III* and GPPDs, and to develop survey and interview questions.

The faculty roles in the BEST program were multifaceted (roles reported here occurred between 2013 and 2018). The first group included 41 faculty who were the primary advisors of doctoral students participating in *Phase III* research experiences. These faculty had to approve the students' time away from the research laboratories and dissertation work. Upon completion of BEST *Phase III*, the students discussed the experiences with their faculty advisors and prepared reports. The second group included 26 faculty who participated in development of *Phase I* and *Phase II* content and served as moderators for the panels and/or workshops. Others served as panelists in *Phase I* or as facilitators in *Phase II* due their content expertise (e.g., business, communication, government, law, nonprofit, and teaching). The third group included 10 faculty who applied for and received funding (BEST mini-grant) for a mini-BEST event, which they organized and implemented with guidance from the BEST program. The fourth group included 31 faculty who voluntarily attended a mini-BEST event. The faculty attendance was generally higher for the departmental mini-BEST events compared to the BEST workshops in which each event had no more than one or two faculty serving as moderators and/or facilitators.

The breakdown of faculty by rank and number of activities that they participated in are shown in Table S1 (Supporting Information). Nearly 100 faculty across all disciplines participated in BEST activities, with full professors from both biomedical and non-biomedical departments having the highest level of engagement (48% of all faculty participants were full professors). In part this was due to program design, because the BEST organizers invited the more experienced full professors to help facilitate workshops and career events. Associate and assistant professors were slightly more likely to volunteer to organize and lead events such as the mini-BEST workshops. While this trend is encouraging, the number of associate professors who participated is small (24 total), so drawing any strong conclusions about engagement is challenging. The non-biomedical faculty engaged in more BEST activities (average of 6.2 events) than biomedical faculty (average of 3.2 events), but again this is likely due to program design, since several faculty were invited to participate every year in the same workshop (such as leading an activity on communication of scientific information, careers in law or government, research administration, or teaching pedagogy). Eleven faculty had roles in more than one of the four different activities mentioned in the previous paragraph. The 97 faculty participants from these four different groups were invited to complete a survey. Faculty who participated in the online survey were invited to be interviewed.

### 1.3. Research questions

This study set out to better understand faculty perceptions of non-academic research career options for their doctoral students and what institutions can do to help faculty be better prepared to support their students in exploring multiple career pathways. In particular, the study examined whether *participation* in BEST interventions correlates with changed attitudes and increased respect of faculty for non-academic research careers, and improved ability of faculty to help doctoral students with career exploration. A special focus was the effect of the BEST mini-grant program on enhancing faculty attitudes.

## 2. Materials and methods

### 2.1. Surveys and data collection

Data for this study came from two sources: 1) an online survey of faculty who participated in one or more components of BEST at Wayne State University, and 2) follow-up telephone surveys of a subset of faculty who completed the online survey. All eligible faculty (97 total) were invited to participate via email from the BEST program director. The researchers then sent a follow-up invitation email with a link to the online survey. This methodology legitimized the survey because the initial invitation came from a known WSU faculty member. It also assured faculty that their participation was voluntary and that their responses would be anonymous.

After the online survey ended, the BEST program director sent an email to faculty survey respondents inviting them to participate in a telephone interview. This email was followed by an email from the researchers to extend the invitation to be interviewed and to schedule a time for interview completion.

The research was approved by WSU's Institutional Review Board on the Use of Human Subjects (IRB# 094013B3E, "Independent Evaluation of BEST Program"). A research information sheet was provided in the email invitation as well as in the introductory section of the online survey. For the telephone interviews, a research information sheet under the title of "Independent Evaluation of BEST

Program” was emailed to faculty prior to the interview, which contained the approved consent language. The consent statement was also reviewed with the faculty respondents at the beginning of the telephone interview. All data are reported in aggregate or with identifiable information removed. The *Online Survey of Faculty*, *Interview Questionnaire: Telephone Interview with Faculty Survey Respondents*, and *Interview Questionnaire: Telephone Interview with Mini-Grant Recipients* are included as Supporting Information.

## 2.2. Sample

Study participants are faculty who participated in one or more of the BEST interventions described above. There are two types of study participants: 1) those who completed the online faculty survey, and 2) those who completed the telephone interview of which the majority had also completed the online survey. Faculty who received a BEST mini-grant but who had not completed the online survey were also invited to be interviewed.

## 3. Results

### 3.1. Online survey respondents

The online survey (Supporting Information) obtained descriptive information about the faculty and their reports of participation in the different components of BEST. It also assessed whether participation in BEST affected: 1) faculty attitudes about actively supporting doctoral students in their pursuit of non-academic research careers, 2) level of respect faculty have for non-academic research careers for their doctoral students, and 3) faculty perceptions of their ability to help students engage in non-academic research career exploration.

The online survey also asked faculty if they had applied for or participated in a BEST mini-grant. Those who responded affirmatively were asked: 1) why they applied and/or participated, 2) what roles they had in the grant activities, and 3) if their BEST mini-grant experiences changed their perspectives about non-academic research careers in any way. Ninety-seven (97) faculty who met the criteria for inclusion in the study (identified as participants at some level in involvement with delivery of BEST programming) were sent a link to an online survey. Of these, 53 (55%) completed the survey. Table S2 (Supporting Information) gives the gender and academic status of the survey respondents. Most faculty who participated were tenured and hold professorial level status at the university. Table S2 also provides the survey respondents' history of mentoring doctoral students. These faculty have had considerable experience mentoring various types of doctoral students and postdoctoral researchers.

Thirty respondents were from the designated “BEST” departments (with biomedical focus), which included: Biomedical Engineering from the College of Engineering; Biological Sciences, Chemistry, Nutrition & Food Science, and Psychology from the College of Liberal Arts and Sciences; Biochemistry & Molecular Biology, Immunology & Microbiology, Pathology, Physiology, and Pharmacology from the School of Medicine; and Pharmaceutical Sciences from the College of Pharmacy and Health Sciences. Twenty-three respondents were from “non-BEST” (non-biomedical) departments, which included: Theoretical & Behavioral Foundations from the College of Education; Chemical Engineering & Materials Science from the College of Engineering; Art & Art History, and Communication from the College of Fine, Performing, and Communication Arts; Law from the Law School; Mathematics, Political Science, and Sociology from the College of Liberal Arts and Sciences; School of Medicine; and School of Social Work; or did not report their department.

### 3.2. Retrospective pretest

The Retrospective Pretest (RPT) methodology was used to measure faculty perceptions of changes in attitudes toward non-academic research careers, in their level of respect for non-academic research careers, and in their ability to help their students with non-academic research career exploration. RPT methodology refers to the research design in which survey questions are administered at the end of the program and ask respondents to rate their level of understanding, attitudes, or skills after participation in an intervention. A second series of identical questions, included on the same instrument, asked respondents to reflect on their level of understanding, attitudes, or skills prior to participation in the intervention. The difference between the “now” and the “then” ratings constitute the measures of change. The RPT methodology was selected as the preferred method for measuring change for two reasons. First, there was no way to know which faculty would participate in which parts of the broad array of BEST opportunities at the onset of the program. Therefore, it was not possible to gather true pretest data. Second, RPT removes two threats to internal validity that are present in studying the BEST interventions: response shift bias and scale recalibration [11]. In response shift bias, participants' understanding of the constructs being measured changes as a result of the intervention. If the traditional pretest-posttest method was used, faculty would be reflecting on different meanings of the constructs when they completed the pretest than when they completed the posttest. Response shift bias is likely in the faculty who participated in BEST because their understanding of non-academic research careers and what it takes to support students in career exploration are likely to change because of what they learned from participating in the program.

Recalibration is the effect that response shift bias has on participants' ratings of their pre-intervention levels of understanding [12]. Participants could have an over-inflated perception of their understanding of concepts before the intervention and realize after the intervention that those estimates were inflated. RPT allows faculty to recalibrate their pre-BEST self-assessment to what they believe is a more accurate assessment than what they would have had at the time of a pretest. For example, faculty may think that they know a lot about ways to help their students explore non-academic research career opportunities, but they learn from BEST that they didn't know

as much as they thought. RPT methodology allowed faculty to mentally recalibrate their level of pre-BEST knowledge.

### 3.3. Data analysis

SPSS was used for the quantitative analysis of the online survey data. Descriptive statistics were produced on the demographic items. Scale scores were created for the three variables expected to change because of faculty participation in BEST: 1) attitudes toward helping students explore non-academic research careers, 2) level of respect for non-academic research careers, and 3) behaviors and knowledge related to concrete ways to help students explore non-academic research careers. A scale score was also created to measure level of participation in BEST. The items used to measure participation level are described below. Coefficient Alpha was used to examine the reliability (internal consistency) of each of the three measures, both for the retrospective pretest and for the posttest.

Paired t-tests were computed on the before vs. now RPT measures to test the significance of the differences. Correlations were calculated between the change scores of the three measures and faculty reports of their level of participation in BEST.

### 3.4. Measures

New measures were created to assess the three constructs: attitudes, respect, and ability to help students explore non-academic research careers. Many of the items on the three scales were adapted from the faculty surveys that were developed in the national evaluation of BEST [13]. Other items were generated through discussions between the researchers and BEST program staff who had insights regarding how the content of the BEST program was expected to affect the three constructs.

*Measures of the Three Key Outcome Variables.* Coefficient Alpha for each scale is shown in Table 1. The reliability of the three measures is strong, given the small number of items comprising each scale. Each scale had an Alpha Coefficient close to or above the generally acceptable 0.70 level.

*Measure of Participation in BEST.* The BEST Participation was calculated by summing the affirmative answers of faculty on the following questions.

1. Have any of your doctoral students or postdocs participated in the BEST *Phase III* experiential learning program? (YES = 1)
2. Were you the recipient of one or more BEST mini-grants? (YES = 1)
3. Did you participate in one or more workshops that another faculty organized with support from a BEST mini-grant? If yes, how many of these mini-grant workshops organized by other faculty colleagues did you attend in the past two years? (No/None = 0, One = 1, Two or more = 2)
4. Did you participate in one or more BEST *Phase I* or *Phase II* workshops? If yes, how many of these BEST *Phase I* and *Phase II* workshops did you participate in the past two years? (No/None = 0, One = 1, Two or more = 2)

Although all faculty were selected for this study because program records showed that they participated in one or more components of BEST, the total scores on the BEST Participation scale ranged from 0 to 6. We surmise that those faculty who did not report participating in any of these BEST interventions could not remember, or did not know that the workshop they attended was a BEST event. There were 13 faculty who scored zero on the BEST Participation scale and these were removed from all analyses related to faculty participation in BEST, since it would be challenging to analyze their perceptions after participation if they didn't remember

**Table 1**

Coefficient alpha reliabilities of three faculty outcome measures.

SCALE	# OF ITEMS	RETRO-PRE ALPHA	POST ALPHA
<b>Attitudes toward supporting students' pursuit of non-academic research careers (Response options: strongly disagree, moderately disagree, disagree, neutral, moderately agree, strongly agree)</b>	3	0.787	0.849
ITEMS:			
1) I try to understand the career goals of doctoral students and seek the training most appropriate to help them accomplish their personal goals.			
2) I speak with all doctoral students about non-academic career options.			
3) I encourage doctoral students to attend career development activities at conferences/workshops run by the relevant scholarly societies in my field.			
<b>Respect for non-academic research careers for doctoral students (Response options: strongly disagree, moderately disagree, disagree, neutral, moderately agree, strongly agree)</b>	2	0.617	0.630
ITEMS:			
1) I believe that it's important for all students to explore multiple career opportunities.			
2) I think my department should financially support student events sponsored by non-academic professional associations (e.g., AMA, ABA).			
<b>Perceived ability to help students engage in non-academic research career exploration (Response options: strongly disagree, moderately disagree, disagree, neutral, moderately agree, strongly agree)</b>	3	0.740	0.662
ITEMS:			
1) I am knowledgeable of the diverse career paths available to today's doctoral students.			
2) I am connected with businesses and professionals beyond academic research.			
3) I know about industry conferences where I could encourage my students to attend.			

participating.

### 3.5. Paired T-test comparisons

Table 2 shows the results from the paired *t*-test comparing faculty perceptions of their attitudes and skills now, with their retrospective ratings of these attitudes/skills before participating in BEST. On all three measures, faculty perceived themselves improving because of their participation in BEST. The differences on all three measures are statistically significant.

Table 3 shows the non-parametric correlation coefficients between faculty recall of their level of participation in BEST and their reports of changes in attitudes toward, respect for, and ability to help students explore non-academic research careers. While none of the correlations reached statistical significance at the traditional  $p \leq 0.05$  level, it is notable that the correlation between participation and faculty perceptions of their ability to help their students explore non-academic research careers was more than twice as strong as the correlation between participation and changes in faculty attitudes toward giving students support. The correlation between participation and change in their perceived ability to help students was nearly twice as large as the correlation between participation and change in faculty level of respect for non-academic research careers.

Table 4 shows faculty responses to a survey question about how much their attitudes and abilities increased as a result of their BEST experiences. While these results do not control for level of participation, they do confirm the results of the correlational analyses. Faculty report greater change in having suggestions for how to help their students engage in non-academic research career exploration (83% reported increasing some or a lot) compared with their reports of changes in wanting to be more supportive (66%) and compared with their reports of changes in respect for non-academic research professions (64%).

### 3.6. Telephone interview respondents

The follow-up telephone interviews (Supporting Information) explored with faculty their interpretations of the online survey results. The interviews also delved into whether professional development could be a way to enhance faculty appreciation and support for non-academic research career exploration, and who within a research university should be responsible for this type of training. Finally, the telephone interviews explored the types of incentives that might motivate faculty to be more supportive of doctoral students' exploration and pursuit of non-academic research careers. All of the 53 faculty who completed the online survey were invited to participate in a telephone interview, plus six mini-grant recipients who had not completed the online survey. A total of 16 (27%) faculty agreed to be interviewed. Assuming that these 16 interview respondents are similar to those who did not respond to the interview invitation, the N of 16 is more than sufficient to capture all of the themes that would have emerged had all 59 faculty had been interviewed. Research by Namey et al. [14] found that an N of 16 interviews yields a thematic saturation rate of 90%. We acknowledge that the small sample size is a limitation of this study, along with potential self-selection bias. Nonetheless, we sought to use this qualitative assessment to give a broader perspective and to help understand faculty viewpoints along with the quantitative survey data.

### 3.7. Telephone interview findings

The telephone interviews explored the reasons why some faculty may have become more supportive of students because of participating in BEST, while others had not. The most frequent reason given for faculty becoming more supportive after BEST is that they have limited exposure to research careers outside of academia. The other two frequently mentioned reasons why faculty felt that they became more supportive of students' pursuit of non-academic research career opportunities after BEST is that: 1) BEST made them aware of the scarcity of academic jobs, and 2) BEST offered them the opportunity to hear other faculty discuss the importance of non-academic research career exploration.

The most common reason given for why faculty did not increase their level of support for students pursuing non-academic research opportunities is that faculty were already supportive prior to participating in BEST. That is, BEST attracted faculty who were already inclined to support their students in this way. This reason is supported by the survey data, which show that, by and large, faculty perceived their pre-BEST level of attitudes and respect for non-academic research careers to be quite high (quotes are provided in Supplemental Information).

**Table 2**

Paired T-test comparisons: changes in faculty attitudes and perceived skills in helping students explore non-academic research careers.

SCALE	MEAN	STD DEVIATION	STD ERROR MEAN	T-TEST	DF	SIG (2-TAILED)
<b>Attitudes toward supporting students' pursuit of non-academic research careers</b>						
RETRO-PRE	12.893	2.514	0.475	-2.819	27	0.009
POST	14.071	1.120	0.212			
<b>Respect for non-academic research careers for doctoral students</b>						
RETRO-PRE	7.655	1.798	0.334	-4.004	28	0.000
POST	8.724	1.334	0.248			
<b>Perceived ability to help students engage in non-academic research career exploration</b>						
RETRO-PRE	9.536	3.061	0.578	-3.201	27	0.003
POST	10.786	2.283	0.431			

**Table 3**

Non-parametric correlations between participation in best and perceived changes in attitude, respect, and ability to support students in pursuit of non-academic research career exploration.

	Participation	Change in Attitude	Change in Respect	Change in Ability to Help
<b>Participation</b>	1.0	0.059	0.141	0.269
<b>P-value</b>		0.770	0.473	0.175
<b>N=</b>		27	28	27

**Table 4**

Faculty survey responses—all BEST participants.

Please indicate HOW MUCH you increased in the following areas as a result of your BEST experience(s)	Responses of All Faculty Who Completed the Survey							
	Not at all		Some		A lot		Total	
	Count	%	Count	%	Count	%	Count	%
Participating in BEST made me want to be more supportive of students pursuing non-academic research careers	16	34.0%	15	31.9%	16	34.0%	47	100.0%
Participating in BEST gave me a higher degree of respect for non-academic research professions	17	36.2%	17	36.2%	13	27.7%	47	100.0%
Participating in BEST gave me suggestions for how to help my students engage in non-academic research career exploration	8	17.0%	23	48.9%	16	34.0%	47	100.0%
Participating in BEST gave me more connections to non-academic research opportunities for my students	16	34.0%	22	46.8%	9	19.1%	47	100.0%

Table 5 shows the standardized scores on the three outcome variables. Standardized scores were created because the three scales had a different number of items. Recalibrating the scores so that the lowest possible score is 0 and the highest possible score is 100 allows for comparison of faculty scores across the three outcomes. Table 5 reveals a median score of 90.0 on faculty perceptions of their attitudes toward supporting their students in career exploration before participating in BEST. Similarly, faculty had a median score of 80.0 on their level of respect for non-academic research careers before participating in BEST. That is, more than half of the faculty perceived that they were already very supportive and respectful of non-academic research careers prior to participating in BEST. On the other hand, the median score on ability to help students pursue non-academic career exploration before participating in BEST was much lower, 70.0. The modal scores (the scores that had the most survey respondents) were also much higher for faculty pre-BEST attitudes and respect than for their perceptions of their ability to help students along this journey. The majority of faculty who participated in BEST appear to respect non-academic research careers and are appreciative of their students exploring non-academic research careers. What they may lack is the ability to guide their students in this pursuit.

Already having positive attitudes and respect was not the only reason faculty surmised for the small degree of change on these variables (Table 2). Other reasons telephone respondents gave for no change in faculty support is that some faculty believe that attaining an academic job is a sign of student success. Some of this, interview respondents said, is due to faculty attitudes. Some may also be due to institutional incentives that privilege academic job success. A similar reason was commonly given for why some faculty did not increase their level of respect for non-academic research careers because of participating in BEST. These faculty, telephone interview respondents surmised, already had set attitudes regarding the primacy of academia.

During the telephone interviews, some faculty gave reasons for why BEST provided them with skills to better help their students explore non-academic research career opportunities. Listening to guest speakers was one reason. On the survey, 85% of faculty said that participating in BEST gave them “a lot” or “some” suggestions for how to help students. While faculty did not give specific suggestions, they did acknowledge that generally speaking, faculty do not know enough about non-academic research careers to adequately advise their students.

**Table 5**

Descriptive statistics on matched before and after outcome standardized scale scores.

	Attitudes Before	Attitudes After	Respect Before	Respect After	Ability to Help Before	Ability to Help After
<b>N</b>	28	28	29	29	28	28
<b>Valid</b>						
<b>Missing</b>	0	0	0	0	0	0
<b>Mean</b>	85.952	93.810	76.552	87.241	63.571	71.905
<b>Median</b>	90.000	93.333	80.000	90.000	70.000	70.000
<b>Mode</b>	100.00	100.00	70.00	100.00	40.00 <sup>a</sup>	66.67
<b>Minimum</b>	40.00	73.33	30.00	50.00	33.33	40.00
<b>Maximum</b>	100.00	100.00	100.00	100.00	100.00	100.00

<sup>a</sup> Multiple modes exist. The smallest value is shown.



### 3.8. Impact of BEST faculty mini-grants

Six of the faculty who completed the online survey said that they received a BEST mini-grant. These faculty were asked which of many factors was important in motivating them to apply for the mini-grants. Table 6 shows that clearly, having funding was extremely important to most of these faculty. The desire to help students find alternatives to postdoctoral positions was the other factor important to these faculty.

Five of the faculty who received mini-grants were interviewed. They explained that the impact of their mini-grants was largely to open their eyes about non-academic research career options. Making connections with non-academic researchers was another impact of the BEST mini-grant mentioned during the interviews.

Fourteen of the surveyed faculty (29%) reported participating in one or more BEST mini-grant event. Ten of these reported their roles. Most were participants (60%), and other roles were member of a panel (30%), guest speaker (10%), or in some other role (10%). Nine faculty answered a question about whether workshop attendance changed their perspectives about non-academic researcher careers. Four of these faculty (44%) responded affirmatively; three of them stated that the workshops opened their eyes in some way about the non-academic research opportunities that are available for their students. Nine faculty answered the question about whether it was important that a faculty member designed the mini-grant workshop. Five faculty (55%) responded affirmatively. Faculty responses about their mini-grant experiences confirms the conclusion that professional development is more likely to teach faculty about ways to support their students than to change their attitudes about non-academic research careers, or their respect for it.

### 3.9. Is faculty professional development a good idea?

During the telephone interviews, faculty were asked if they thought faculty professional development on non-academic research career opportunities is a good idea. Ten (77%) responded affirmatively. Most of their reasoning is that faculty are largely trained for academia, and that universities incentivize academic research rather than non-academic research. Survey respondents surmised that most faculty could benefit from training because they don't know much about non-academic research careers. This, coupled with the lack of jobs in academia for Ph.D. graduates, makes it incumbent on faculty to know about non-academic research careers. The consensus among the faculty who did not think professional development for faculty on this topic was a good idea was that faculty would likely not attend.

### 3.10. Other ways to incentivize faculty to be more supportive of students in exploring non-academic research careers

There are other things that universities can do to incentivize faculty to support student exploration of non-academic research careers. Changing the culture is one way, *i.e.*, creating an environment in which non-academic research career attainment is celebrated equally to obtaining an academic career. Another culture change is getting faculty at research universities to be more student centric. This change may be more difficult to attain than celebrating non-academic career success, when the university promotion and tenure structures reward publications and grants more than the success of graduates. As two faculty explained:

"We have too many faculty members that have students where the interest is not in the student as much as it is just in the work that the student can perform. And really the interest should be, yes, I'm interested in the work that students can perform, but I'm also interested in what happens to this student once they leave my program. I think that should be more integrated a little bit more into the culture because right now we have too much of, it's all about me and not necessarily the students."

"Another approach to this might be making promotion and tenure committees accept this type of thing as a positive, as opposed to, promotion and tenure committee, all they want to see is how productive the faculty member was. And so a faculty member is going to feel like they're going to be less productive if their students leave for a summer or for a couple of months. But if promotion and tenure committees had very specific language in their guidelines that would get around that or make it so that it was not a penalty, that it was viewed as a positive in terms of the training environment, maybe faculty members would look on this whole thing more favorably."

**Table 6**  
Faculty survey responses—mini-grant recipients.

How important was each of these factors in motivating you to apply for these mini-grants?	Responses of Faculty Who Received Mini-Grants									
	Extremely important		Somewhat important		A little important		Not at all important		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
The amount of funding I could receive?	4	66.7%	1	16.7%	1	16.7%	0	0.0%	6	100.0%
It will be a plus when I apply for tenure or promotion?	1	16.7%	0	0.0%	1	16.7%	4	66.7%	6	100.0%
Something else about my department or graduate school?	1	16.7%	2	33.3%	0	0.0%	3	50.0%	6	100.0%
Some of my students have trouble obtaining post-docs so I wanted to help them think about alternative careers?	0	0.0%	3	50.0%	2	33.3%	1	16.7%	6	100.0%
Something (else) I learned from the BEST program?	0	0.0%	1	16.7%	1	16.7%	4	66.7%	6	100.0%
Something else?	0	0.0%	1	20.0%	1	20.0%	3	60.0%	5	100.0%



#### 4. Discussion

Faculty mentors play a large role in guiding the career choices of their doctoral student mentees. The traditional apprenticeship model in doctoral training is based on the mentor shaping the mentee to “be like them.” Such a model may lead to expectations of faculty for trainees to pursue similar faculty roles at research-intensive universities. Faculty know how to train for academic careers; however, only about 25% of all doctoral trainees actually engage in traditional faculty careers. The remaining 75% engage in research careers beyond academia, including jobs in various sectors such as government, industry, policy making, and communication [1,7]. Students choose these careers for a variety of reasons, including lifestyle choices, interest in the employer, or lack of T/TT faculty positions in academic research universities. These careers represent areas that are key to the success of the research mission nationally and globally, and have great societal impact. One example is the race to develop vaccines and therapeutics to combat the COVID-19 pandemic, which requires research-active, highly trained professionals to collaborate in public-private partnerships and to use effective communication strategies, develop public policy, and advise at the highest levels of government. It is clear that well-trained doctoral graduates are needed in these key areas. Therefore, it is crucial that faculty advisors and dissertation committees, as well as reviewers of training grants, embrace all research careers, academic and non-academic, as successful outcomes of doctoral training [15]. Many faculty mentors have accepted this as a responsibility, but may lack the knowledge to advise their doctoral students on research career exploration beyond academia. Others may be opposed to the notion of their trainees considering non-academic research careers. As such, some doctoral students are not able to approach their advisors to discuss their interest in careers beyond academia [4]. A transformation of culture is needed at multiple levels so that doctoral students can make career decisions openly, while having career exploration and preparation as an integral component of their training.

The NIH BEST program was established in 2012 with the goal of transforming institutional culture with respect to preparation of biomedical doctoral students for successful research careers across all sectors [1,5]. The 17 institutions that received funding focused their attention on implementing career development for their trainees. While the training is very beneficial for doctoral students, faculty mentor attitudes impact a student’s decision to participate in BEST activities [16-]. In addition to some faculty attitudes that non-academic careers are not successful outcomes, there is a perception that participation in professional development activities takes time away from research and thus impacts time-to-degree completion and research productivity. A study by 10 of the 17 BEST institutions (including WSU) revealed that students who participated in BEST activities at their institutions showed no difference in number of total publications, number of first-author publications, or time-to-degree completion in comparison with their peers who did not participate [17].

In the BEST program at WSU, about 20% of all T/TT faculty were engaged in multiple ways. They were invited to participate in program development and to deliver career preparation and professional development activities (36 faculty responded and were directly engaged during the grant period of 2013–2018). The WSU faculty were also invited to town halls and discussions focusing on career exploration for doctoral students. Many of these faculty supported their trainees to attend workshops and events on campus (approximately 800 doctoral students participated in BEST between 2013 and 2018) [6], with 41 faculty supporting their mentees to participate in *Phase III* of BEST in which students had in-depth work experiences in various job sectors (typically 160 h). In addition, 31 faculty voluntarily attended career development events such as the mini-BEST panel discussions or workshops. We surveyed these faculty to understand their attitudes and respect toward their trainee’s desires to explore and prepare for research careers beyond academia, and further to understand their ability to help their students to do so, before and after a faculty member’s own participation in BEST programming. Our results show that faculty had some knowledge of non-academic research careers, but they considered participation in BEST activities to increase their respect and knowledge related to helping their students prepare for such careers. Importantly, faculty perceptions of improvement in their ability to help their students with career exploration were lower than changes in attitude and knowledge. This speaks to the need for institutions to help faculty build connections to industries and employers that are likely to hire their students for research careers.

Of note is that the level of engagement in BEST program activities correlated with the level of increase in each of the areas: attitudes towards students’ pursuit of non-academic research careers, respect for non-academic research careers, and perceived ability to help students engage in non-academic research careers. Furthermore, participation in activities that were delivered more “locally,” *i.e.*, in a department rather than “centrally,” *i.e.*, by the Graduate School, were perceived to be more effective. More than half of the faculty who attended mini-grant workshops said that it was important that faculty designed the workshop. This supports the idea that events like mini-BEST should be led by faculty and speaks to the importance of incentivizing faculty with mini-grants for career development. These results collectively lead us to hypothesize that an institutional culture that supports and incentivizes faculty to work “locally” with their students in exploring and preparing for research careers, academic or non-academic, is conducive to helping students to be successful in multiple careers following graduation. Respecting all career outcomes as being successful is important, and thus incentivizing faculty and departments financially will support these endeavors.

The faculty attitudes in our study mirror the results previously published by other members of the BEST institutions [3]. Our study shows that many faculty already have positive attitudes and are supportive of doctoral students’ pursuit of non-academic research careers, but they may still benefit from participating in BEST. More specifically, participation is important when it teaches faculty about concrete ways to help students engage in career exploration and/or connects faculty to future employers for their student trainees.

The 17 institutions awarded the BEST grants [14] focused primarily on students in the biomedical disciplines (BEST departments), but since WSU’s BEST grant was housed in the Graduate School that oversees all graduate programs across the institution, the programming extended to students in non-biomedical disciplines (non-BEST, or non-biomedical, departments). The broad impact of the BEST program on doctoral students at WSU has been described in earlier reports as the “halo effect.” [6–8,10] In addition to including

doctoral students across disciplines, the WSU BEST program also included faculty from 20 departments across nine schools and colleges. The faculty surveys therefore included faculty from nine non-BEST departments, suggesting that the attitudes described in this current study extend beyond the biomedical fields. Involvement of a broad range of faculty is crucial for success of programs like BEST because they bring their expertise in areas such as communication, law, government, research administration, entrepreneurship, and community engagement.

## 5. Conclusions

An important goal of the WSU BEST program, in addition to providing career development to doctoral students, was to emphasize the pivotal role of faculty in guiding their students' individual career choices. It is therefore important to understand the mindset of faculty regarding acceptance and respect for research careers of their trainees. Furthermore, the institutional culture must be supportive such that faculty are incentivized and able to acquire the knowledge and skills needed to help students directly, or to understand the partnerships needed to deliver such information. Faculty must be given the tools to be successful in these endeavors. We learned that partnerships between centralized units such as the Graduate School and departments, with faculty leading interventions in partnership with experts from the appropriate career sectors, are the best drivers of this success. As part of the shift in culture, institutions need to highlight the variety of successful research careers that their graduates pursue. There is also a need to intentionally prepare doctoral students for success in multiple research career tracks. Such an approach may lead to higher retention and completion rates. In addition, studies have shown that underrepresented students choose preferentially non-academic research careers [18]. As such, faculty play key roles in supporting career exploration for these students, which then provides valuable diverse perspectives in the workforce.

Overall, this study represents one component of a larger evaluation of the WSU BEST program that seeks to understand the needs of students, faculty, and potential employers in preparing doctoral students to be the best in any research career of their choice, such as T/TT faculty in academic research universities or in multiple non-academic sectors. The total number of WSU faculty who completed the survey and interview was small, and one might argue that some of those faculty who already supported career development were more likely to participate in BEST activities and surveys. Nonetheless, the participation rate of faculty in career development across campus was high, and the results obtained are still meaningful to understanding faculty support of student career options and preparation. These outcomes could lead to testable hypotheses in future research. Collaborations among multiple institutions in such endeavors allow comparisons and an understanding of how various models (e.g., cohort vs. ala carte), size of the institution, inclusion of non-biomedical faculty in programming, etc., impact faculty perceptions [3,19].

Given the ever-changing roles of doctoral graduates within various job sectors, it is incumbent upon faculty to provide high-quality mentoring with regard to the exploration of both academic and non-academic research careers. With such a pivotal role in student career guidance, incentivizing faculty to participate in and promote student exploration of non-academic research careers and professional development opportunities might well be amongst the most effective strategies to increasing faculty appreciation for non-academic research careers. Unexpected positive outcomes may arise such as the "halo" effect of WSU's BEST program with regard to participation of faculty in departments that were not part of the original biomedical umbrella, thus demonstrating that "BEST" activities create transformation of culture at the institution as a whole.

## Author contribution statement

Ambika Mathur, Christine S. Chow: Conceived and designed the experiments; Wrote the paper.

Melanie Hwalek: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Victoria Straub: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

## Funding statement

This work was supported by National Institutes of Health [DP7OD01827].

## Data availability statement

The data that has been used is confidential.

## Declaration of interest's statement

The authors declare no competing interests.

## Acknowledgements

We thank the BEST steering committee, all BEST participants, Dr. Heidi Kenaga, and Dr. Nisansala Muthunayake for their roles in supporting the program.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2023.e13052>.

## References

- [1] NIH, National Institutes of Health Biomedical Research Workforce Working Group Report, 2012. Bethesda, MD.
- [2] A. Mathur, F. Meyers, T. O'Brien, R. Chalkley, C. Fuhrmann, Transforming training to reflect the workforce, *Sci. Transl. Med.* 7 (285) (2015) 285ed4.
- [3] S.W. Watts, D. Chatterjee, J.W. Rojewski, C. Shoshkes Reiss, T. Baas, K.L. Gould, A.M. Brown, R. Chalkley, P. Brandt, I. Wefes, L. Hyman, J.K. Ford, Faculty perceptions and knowledge of career development of trainees in biomedical science: what do we (think we) know? *PLoS One* 14 (1) (2019), e0210189.
- [4] National Academies of Sciences, Engineering, and Medicine, Graduate STEM Education for the 21st Century, The National Academies Press, Washington, D.C, 2018, <https://doi.org/10.17226/25038>.
- [5] F.J. Meyers, A. Mathur, C.N. Fuhrmann, T.C. O'Brien, I. Wefes, P.A. Labosky, D.S. Duncan, A. August, A. Feig, K.L. Gould, M.J. Friedlander, C.B. Schaffer, A. Van Wart, R. Chalkley, The origin and implementation of the Broadening Experiences in Scientific Training programs: an NIH common fund initiative, *Faseb. J.* 30 (2016) 507–514.
- [6] A. Mathur, C.S. Chow, A.L. Feig, H. Kenaga, J.A. Moldenhauer, N.S. Muthunayake, M.L. Ouellett, L.E. Pence, V. Straub, Exposure to multiple career pathways by biomedical doctoral students at a public research university, *PLoS One* 13 (2018), e0199720.
- [7] A.L. Feig, L. Robinson, S. Yan, M. Byrd, A. Mathur, Using longitudinal data on career outcomes to promote improvements and diversity in graduate education, *Change* 48 (2016) 42–49.
- [8] A. Mathur, A. Cano, M. Kohl, N.S. Muthunayake, P. Vaidyanathan, M.E. Wood, M. Ziyad, Visualization of gender, race, citizenship and academic performance in association with career outcomes of 15-year biomedical doctoral alumni at a public research university, *PLoS One* 13 (2018), e0197473.
- [9] C.S. Chow, A. Mathur, J.A. Moldenhauer, Across disciplines: multi-phase career preparation for doctoral students, in: L. Infante Lara, L. Daniel, R. Chalkley (Eds.), *BEST: Implementing Career Development Activities for Biomedical Research Trainees*, Academic Press, 2020, pp. 227–237.
- [10] A. Mathur, M.E. Wood, A. Cano, Mastery of transferrable skills by doctoral scholars: visualization using digital microcredentials, *Change* 30 (2018) 38–45.
- [11] L. Griner Hill, D.L. Betz, Revisiting the retrospective pretest, *Am. J. Eval.* 26 (4) (2005) 501–517.
- [12] T.D. Little, R. Chang, B.K. Gorrall, L. Waggenspack, E. Fukuda, P.J. Allen, G.G. Noam, The retrospective pretest-posttest design redux: on its validity as an alternative to traditional pretest-posttest measurement, *Int. J. Behav. Dev.* 44 (2) (2020) 175–183.
- [13] R.N. Lenzi, S.J. Korn, M. Wallace, N.L. Desmond, P.A. Labosky, The NIH "BEST" programs: institutional programs, the program evaluation, and early data, *Faseb. J.* 34 (3) (2020) 3570–3582.
- [14] E. Namey, G. Guest, K. McKenna, M. Chen, Evaluating bang for the buck: a cost-effectiveness comparison between individual interviews and focus groups based on thematic saturation levels, *Am. J. Eval.* 37 (3) (2016) 524–540.
- [15] A. Mathur, Meeting the moment: importance of preparing doctoral students for multiple career pathways to better manage the next crisis. A graduate school dean's perspective. *Inside Higher Ed.* <https://www.insidehighered.com/advice/2020/07/30/grad-school-deans-should-do-more-train-doctoral-students-careers-their-choice>, 2020.
- [16] C.N. Fuhrmann, D.G. Halme, P.S. O'Sullivan, B. Lindstaedt, Improving graduate education to support a branching career pipeline: recommendations based on a survey of doctoral students in the basic biomedical sciences, *CBE-Life Sci. Educ.* 10 (3) (2011) 239–249.
- [17] P.D. Brandt, S. Sturzenegger Varvayanis, T. Baas, A.F. Bolgioni, J. Alder, K.A. Petrie, I. Dominguez, A.M. Brown, C.A. Stayart, H. Singh, A. Van Wart, C.S. Chow, A. Mathur, B.M. Schreiber, D.A. Fruman, B. Bowden, C.A. Wiesen, Y.M. Golightly, C.E. Holmquist, D. Arneman, J.D. Hall, L.E. Hyman, K.L. Gould, R. Chalkley, P.J. Brennwald, R.L. Layton, A cross-institutional analysis of the effects of broadening trainee professional development on research productivity, *PLoS Biol.* 19 (7) (2021), e3000956, <https://doi.org/10.1371/journal.pbio.3000956>.
- [18] K.D. Gibbs Jr., J. McGready, J.C. Bennett, K. Griffin, Biomedical science Ph.D. career interest patterns by race/ethnicity and gender, *PLoS One* 9 (12) (2014), e114736.
- [19] L. Daniel, L. Infante Lara, R. Chalkley, Origin of BEST, and how 17 very different programs created 17 related approaches to help trainees with their career choices, in: L. Infante Lara, L. Daniel, R. Chalkley (Eds.), *BEST: Implementing Career Development Activities for Biomedical Research Trainees*, Academic Press, 2020 xiii–xxxiii.