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RESEARCH ARTICLE

Career planning courses increase career readiness of graduate and postdoctoral trainees [version 1; peer review: 2 approved]

Rebekah L. Layton [iD][1], V. Scott H. Solberg[2], Arthee E. Jahangir[3], Joshua D. Hall[1], Christine A. Ponder[4]*, Keith J. Micoli[3]*, Nathan L. Vanderford [iD][5]*

[1]Office of Graduate Education, University of North Carolina at Chapel Hill School of Medicine, Chapel Hill, NC, USA
[2]Department of Counseling & Applied Human Development, Boston University Wheelock College of Education and Human Development, Boston, MA, USA
[3]Postdoctoral Affairs, Office of Science and Research, New York University School of Medicine, New York, NY, USA
[4]Research Affairs, Vice Provost for Research, New York University, New York, NY, USA
[5]Department of Toxicology & Cancer Biology, University of Kentucky College of Medicine, Lexington, KY, USA

* Equal contributors

Abstract

Background: Given national calls for intentional career development during graduate and post-graduate scientific training, this study assessed career readiness development within the context of academic career courses. The current study evaluated the effects of academic career courses offered at two institutions that were specifically designed to increase career awareness, interest, and career-related confidence among doctoral students and postdoctoral fellows.
Methods: Participants enrolled in a career course at trainees' respective academic institutions and responded to pre- and post-course surveys (n=32, n=148). The paper offers a thematic analysis of each of the two courses using an individualized learning plan career development framework and describes the results of their respective pretest-posttest evaluations which indicated increases in career readiness.
Results: Though the format and content provided in each course varied, participation was associated with increases in career readiness. Participants reported increased career-awareness including a greater familiarity with different types of careers overall. Furthermore, interest in tenure track faculty careers increased in both samples, which may assuage fears that exposure to diverse career pathways could reduce interest in academic careers. Transferrable skills, including career planning and awareness also significantly increased. Course participants reported an increase in the number and type of mentors they interacted with beyond their principal

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1. **Gary S. McDowell** [iD], Lightoller LLC, Chicago, USA

2. **Ronald J. Heustis** [iD], Harvard Medical School, Boston, USA

   Harvard Medical School, Boston, USA

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faculty mentor (other faculty, professional PhDs, peers, and administrative staff).

Conclusions: Findings provide supporting evidence for the benefits of implementing structured career development efforts during PhD training; even with varying content, delivery methods, and instructor type, both academic career courses led to significant gains in career awareness and readiness. Successful development and delivery of academic career courses, with a focus on career planning skills, suggest that institutions can utilize these and are an effective way to prepare PhDs for their transition from training positions into careers.

Keywords
Graduate education, professional development, career choice

Corresponding authors: Rebekah L. Layton (rlayton@unc.edu), Keith J. Micoli (Keith.Micoli@nyulangone.org), Nathan L. Vanderford (nathan.vanderford@uky.edu)

Introduction

Traditionally, doctoral and postdoctoral training employs a model by which graduate students and postdoctoral fellows work under the guidance and mentorship of experienced faculty members to prepare for similar careers in academia. Especially in the biomedical sciences, this often includes mentorship from a primary faculty advisor in expectation of one day becoming a principal investigator as well. Although this trend is evident across disciplines, in recent decades and in the biomedical sciences in particular, the number of doctoral trainees has grown more quickly than the number of faculty positions available (NIH, 2012; Stephan, 2012). Even after years of postdoctoral experience, two-thirds of biomedical PhD graduates are finding employment in non-tenure track faculty positions or nonacademic settings (Kahn & Ginther 2017; NIH, 2012). Given the relative scarcity of tenure-track opportunities, the National Institutes of Health (NIH) and other funders have encouraged the biomedical training system to provide career development support for early career biomedical scientists to facilitate exploration of non-academic career pathways and to build professional skills (Denecke *et al.*, 2017; NIH, 2012). Despite this, the traditional training model has remained fairly consistent in preparing doctoral and postdoctoral trainees for academic careers despite the fact that the career landscape offers a wide range of opportunities in other sectors.

Both empirical and anecdotal evidence also suggest that during doctoral training many students lose interest in pursuing academic careers (Fuhrmann *et al.,* 2011b; Gibbs & Griffin, 2013; Layton *et al.,* 2016; Roach & Sauermann, 2010; Sauermann & Roach 2012). As a result of these trends, recent efforts to improve biomedical research training has included calls for providing career development opportunities that promote awareness of the variety of careers that align with the doctoral-level skills and competencies associated with receiving a PhD in a biomedical field (Alberts *et al.,* 2014; Fuhrmann, 2016; Hitchcock *et al.,* 2017; McDowell *et al.,* 2014; Pickett *et al.,* 2015).

To encourage these efforts, NIH established the Broadening Experiences in Scientific Training (NIH BEST; Lenzi *et al.,* 2020; Meyers *et al.,* 2016) and the National Science Foundation established Non-Academic Research Internships for Graduate Students (INTERN; Tornow *et al.,* 2018). The motivation of national funding agencies such as these to prioritize creation of career development programs and services for biomedical doctoral and postdoctoral trainees is based on evidence that graduates lack training and exposure to options that reflect the wide variety of labor market opportunities associated with the diverse biomedical industry in the United States, especially among those who remain for an extended period in post-doctoral positions (NIH, 2012). Additional data suggests that even with increased career familiarity, career goal clarity remains low for both graduate trainees and postdoctoral fellows (Gibbs *et al.,* 2015). To date, the design and implementation of career development programs and services in biomedical programs is only recently beginning to become broadly accepted beginning (i.e., https://careerdevelopment.aaas.org/; Denecke *et al.,* 2017; Mathur *et al.,* 2018; Schnoes *et al.,* 2018). Furthermore, while career courses have been widely utilized and studied in under-graduate populations (Reese & Miller, 2006), integration of career training into graduate coursework and curricula is relatively rare (Fuhrmann, 2016) and there is a paucity of research evaluating its effectiveness at the doctoral and postdoctoral levels.

This study reports on the initial effort of two institutions to offer doctoral career development courses in the form of aca-demic credit-bearing courses, each designed independently, while sharing a common goal of supporting exploration of the many career opportunities that can be found outside of academia. The purpose of this study was to: (a) use a career development framework from which to conduct a thematic anal-ysis of the course content, and (b) analyze course evaluations to assess whether adding a career development course shows promise in facilitating doctoral and postdoctoral trainees' career exploration skills, as well as consideration of alternative career opportunities beyond academia.

Career course thematic analysis

The first career course examined in this study was created and implemented at a large public university in the south-central region of the United States as an academic career-development course that was cross-listed as "Preparing Future Profes-sionals" and "Preparing Science Professionals" (PSP; see Norman-Burgdolf & Vanderford, 2016 and Vanderford, 2017 for more about the development of the course). The second course was created by a large private university in the northeastern region of the United States as an academic career-development course entitled "Hope is Not a Plan (HINAP): Taking Charge of Your Science Career." The first course (subsequently referred to as "PSP") is taught by a faculty member, while the sec-ond course (subsequently referred to as "HINAP") is taught by professional development staff.

In conducting a thematic analysis of the course content, the syllabi content was examined in relation to how course participants engage in three career development skill domains (Solberg, 2019; Solberg *et al.,* 2018): self-exploration, career exploration, and career management and planning. Program activities that develop self-exploration skills are those designed to help participants become aware of their talent, skills, interests, and values. Activities that develop career exploration skills are those that help participants identify: (a) how their talent and skills transfer into a wide range of career opportunities, (b) emerging labor market opportunities and the competencies needed to pursue them, and (c) career and life goals. Career management and planning activities involve: (a) job search skills such as informational interviewing, interview skills, and resume preparation, as well as (b) plans for acquiring the additional technical and human relation skills needed to successfully pursue their career and life goals. This framework is a variation from the traditional themes of "career awareness," "career exploration," and "career preparation/career immersion" (e.g., Colorado, Massachusetts) derived from a multi-method,

multi-study of individualized learning plans (ILPs; Solberg *et al.,* 2014). Currently ILPs have been adopted by a number of states (U.S. Department of Labor, ODEP, https://www.dol. gov/agencies/odep/topics/individualized-learning-plan/map), and many of the states have moved to adopting this revised career development framework (e.g., Solberg, 2019). This revised framework differs from the traditional focus on career awareness, exploration, and preparation in two fundamental ways. First, the revised framework focuses on providing evidence-based activities that result in an individual acquiring career development "skills." Traditionally, career development programs focused primarily on providing activities but did not emphasize the idea that these activities should result in positive development outcomes such as becoming proactive and self-directed with respect to engaging in future career development efforts (Solberg & Ali, 2017). The second departure from the traditional model involves replacing "career awareness" with *self-exploration*. Career awareness activities are most strongly associated with a career decision-making paradigm whereby the process begins with completing a career interest inventory with the purpose of narrowing career options that best match their personality type (Hartung *et al.,* 2015). In response to new advances in career theory such as Life Design (Savickas, 2016; Savickas *et al.,* 2009) and increasing disruptions in the world of work brought about by technology and globalization (Schwab, 2019), made even more relevant by current job market trends related to the global response to COVID-19 (Mathur, 2020), the focus on self-exploration skills has been used to bring more focus on skill-building activities that help individuals learn how to identify their skills, interests and values (including in graduate education; Vanderford *et al.,* 2018a & Vanderford *et al.,* 2018b) and examine whether and how these transfer into a wide range or career opportunities (Solberg, 2019).

Table 1 summarizes this syllabus content of each course in relation to the revised career development framework described above. In many ways, the pedagogy in PSP is consistent with Life Design (Savickas, 2016; Savickas *et al.,* 2009) and the integration of constructivist models of career assessment and counseling (Brott, 2004; Schultheiss, 2005). For example, the course emphasizes the use of classroom discussions and written career narratives that engage participants in an idiographic assessment of their transferable skills (i.e., relies on examination of unique and subjective experiences), and the use of classroom discussions to further explore career goals and develop plans to pursue those goals. Alternatively, HINAP uses a more traditional nomothetic assessment and structured career planning strategy. For example, to begin the course, HINAP participants complete an online skills assessment that matches the participants results to a range of career pathways and uses the online system to complete a structured set of career development planning activities.

With respect to *self-exploration skills*, PSP provides opportunities for participants to reflect on their talent, skills, and interests. For PSP, the goal is for course participants to begin by reflecting on their current transferable skills and then to develop career exploration skills through exposure to career paths that align with those skills. Based on the ILP career development framework, rather than incorporating self-exploration as a self-discovery process, HINAP's syllabus relied instead on the use of a skills assessment strategy; as result, this activity was classified under *career exploration*.

With respect to developing *career exploration skills*, both PSP and HINAP incorporated role models and informational interviews as a strategy for expanding participants awareness of how their transferable skills align to a wide range of careers.

Table 1. Thematic analysis of biomedical course syllabi using the ILP Career Development Framework. Comparison of PSP Course and the HINAP Course using an ILP Framework identifies two common areas of career development themes identified (career exploration skills; and career management and planning skills).

ILP Framework	PSP course	HINAP course
Self-exploration skills	Identify transferable skills Reflections on what one enjoys (interests and values)	
Career exploration skills	*Access to role models* *Engage in information interviews* Connect transferable skills to career pathways Identify career goals	*Access to role models* *Engage in information interviews* Assessment to identify careers that match to skills Identify long-term goals Focus on four career pathways Individual Development Plan assessment
Career management and planning skills *Goal setting* Job search	*Practice resume and cover letter writing*	*Practice resume and cover letter writing* *Goal setting* *Job search* Practice Interview skills Learn how to negotiate job offers Learn how to read a job ad

PSP used this to help course participants reflect on how their transferable skills connect to different career pathways and to encourage establishment of career goals. Alternatively, HINAP directed course participants to complete an online individual development plan (IDP for PhD scientists; MyIDP) provided by *Science Career*s and that was specifically designed for the biomedical field (Fuhrman *et al.,* 2011a; Hobin *et al.,* 2012). MyIDP is a free-access system (https://myidp.sciencecareers.org/) sponsored by the American Association for the Advancement of Science (AAAS) that helps users explore to what extent their skills and interests match to 20 scientific career paths (Table 2). MyIDP also helps users identify short-term goals to

further develop and expand one's skills and advance in one's career. Using the MyIDP system features, career exploration activities include a skills assessment and career pathway matching exercise, identification of long-term career advancement goals, and selection of potential career pathways of interest for further exploration.

With respect to *career management and planning skills*, both PSP and HINAP emphasize a number of job search skills including preparing resumes and cover letters and learning where to look for viable job opportunities. Both syllabi focus goal setting, with HINAP additionally delineating between

Table 2. MyIDP biomedical career pathways. Sample biomedical career pathway definitions drawn from MyIDP are displayed to illustrate the diverse career options available to graduate and postdoctoral trainees during career exploration.

Biomedical career pathways	Examples
Research in industry	Discovery or preclinical researcher; manager of a research team or facility
Principal investigator in a research-intensive institution	Independent researcher at a medical school, private research institute, government lab or university with minimal teaching responsibilities
Research staff in a research-intensive institution	Staff scientist or researcher in academia or government, lab manager, director of a multi-user research facility in an academic institution
Combined research and teaching careers	Faculty at a liberal arts college or university whose job includes both research and major teaching responsibilities
Science policy	Public affairs/government affairs staff at scientific societies, foundations, government entities, or think tanks
Science education for non-scientists	Education or public outreach specialist such as at a science museum or scientific society
Science education for K-12 schools	Classroom teacher; curriculum developer; science specialist
Sales and marketing of science-related products	Medical science liaison; technical sales representative; marketing specialist
Business of science	Management consultant; business development professional in a biotech company; venture capitalist; market researcher; investment analyst
Entrepreneurship	Starting your own business
Science writing	Science, medical, or technical writer or journalist; science editor; science publisher
Scientific/medical testing	Testing specialist in an environmental, public health, genetics, or forensic science setting (intelligence agencies, federal/state departments of justice); clinical diagnostician
Public health related careers	Public health program analyst or evaluator; epidemiologist; biostatistician; medical informaticist
Intellectual property	Patent agent; patent attorney; technology transfer specialist
Research administration	Research administrator in private or public research institutions, government or academia, including compliance officers, grants and contracts officers; dean or director of research programs
Support of science-related products	Technical support specialist; field application specialist; product development scientist or engineer
Teaching-intensive careers in academia	A primarily teaching faculty position in a research university, liberal arts college, community college
Clinical research management	Clinical research project/trials manager or coordinator
Drug/device approval and production	Regulatory affairs professional; quality control specialist
Clinical practice	Clinician such as genetics counselor, therapist, physician

setting short- and long-term goals. The ICDP online system used by HINAP provides an overview of how to develop "SMART" goals (Specific, Measurable, Achievable, Realistic and Timely; Fuhrmann *et al.,* 2013). HINAP also specifies additional job search skills including interview skills, negotiating job offers and learning how to read job advertisements.

In sum, PSP and HINAP both offer a range of similar career development activities for biomedical doctoral and postdoctoral trainees that enable them to expand their career options, connect with role models, and begin developing a number of job search skills and set career planning goals. Each program is unique with respect to PSP's emphasis on self-discovery using discussions and narrative development that aligns with more recent constructivist and life design approaches to career development. Alternatively, HINAP uses a more traditional, structured approach that relies on an online career information system that was designed specifically to explore biomedical science careers.

Course evaluations

Each institution conducted independent evaluations of their respective courses. Both institutions used online surveys, and each conducted a nonrandomized repeated measures pretest-posttest design. This design is classified as a "pre-experimental" by Campbell *et al.* (1963), which means that while the results can be used to assess whether the courses show promise in supporting biomedical graduate student and postdoctoral fellow career development, the evidence should be considered correlational in nature and therefore one cannot draw conclusions regarding cause and effect. Each evaluation varied significantly and therefore the method and results are presented separately. Collective and noteworthy trends and their implications are addressed in the discussion, along with recommendations for future courses.

Study 1 – Preparing Science Professionals (PSP) course

Based on the thematic analysis, the PSP career development course aims to support biomedical doctoral and postdoctoral trainees' ability to engage in self-exploration of their skills, career exploration by examining both academic and non-academic career pathways, and the development of career management and planning skills. The purpose of this evaluation study was to assess whether participation was associated with increased awareness of their transferable skills and a wider range of career options, career management self-efficacy, and self-efficacy associated with pursuing academic and non-academic career opportunities.

Methods

Participants. A total of 32 respondents completed pretest and posttest evaluations (of 32 who were enrolled; see *Underlying data* – S1 & S2 (Layton *et al.,* 2020)). Two respondents were missing data from a single timepoint due to missing either a pre- or post- survey. PSP course participants were informed of the study's purpose and their rights as research participants using an emailed cover letter that also included a link to respond, and consent to participate was indicated by choosing to complete the survey. Participants were asked to select

gender from a list of possible identities and 61% identified as female, 36% as male, and the remainder (<3%) identified as transgender or declined to identify a gender preference. Among the respondents, 44% were enrolled in a 17-week semester-long version of the course, whereas 53% were enrolled in a 7-week version of the course, and 3% of the respondents did not indicate which course was completed.

Participants included students enrolled in doctoral (83%) or Master's (13%) programs with the remining being post-doctoral researchers (3%). The majority of course participants enrolled in the courses were from the Integrated Biomedical Sciences umbrella program (53%), followed by Biology (6%) and Nutritional Sciences (6%), and the remainder included representation equally spread across the following programs (3% each): Anthropology, Chemistry, Civil Engineering, Education, Integrated Plant/Soil Sciences, Nursing, Pharma-ceutical Sciences, Physiology, Public Health, Social Work, and Toxicology/Cancer Biology. Most graduate students were in the 1st or 2nd years of their respective programs (M=1.65, SD=1.25; ranged from 1-7 years in program, including a 7+ option).

Ethics. Exempt status was sought and obtained through the Institutional Review Board of the respective institutions (University of Kentucky, IRB protocol #: 16-1034-X2B). All analyses were conducted on de-identified data sets to maintain confidentiality (see *Underlying data:* S1 & S2 (Layton *et al.,* 2020)).

Measures. Measures were rated using a five-point scale from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*), unless otherwise noted.

Confidence to Pursue an Academic or Non-Academic Career. Two items were used to assess confidence for pursuing either an academic or nonacademic career. The first item asked, "To what extent [you are] confident [that you] understand the process, materials, and skills that are needed to transition into and excel in an academic career (i.e., faculty career path)." Using the same format, the second item asked about confidence to transition and excel "in a career outside academic or research (i.e., alternative or non-traditional career)." Each item was evaluated separately to assess whether course participation was associated with an increase in confidence toward pursuing each career pathway, respectively. Because the two single-item responses were considered separately, internal consistency esti-mates are not applicable.

Awareness of Transferable Skills. Participants were asked to evaluate the extent to which they believe they had developed 15 transferable skills including: "discipline-specific knowledge", "ability to gather and interpret information", and "ability to ana-lyze information." The 15 items were summed with higher scores reflecting more awareness of transferable skills (Sinche *et al.,* 2017; Sinche, 2016). Internal consistency using Cronbach's Alpha was .72 at pretest and .83 at posttest.

Career Management Self-efficacy. A total of 10 items assessed confidence to engage in career management activities. Sample activities included "conduct job interviews," "identify job

openings," and "effectively pursue a career path." Items were summed with higher average scores indicating higher career management self-efficacy. Internal consistency using Cronbach's Alpha was .74 at pretest and .92 at posttest.

Biomedical Career Path Familiarity. Using a four-point scale ranging from 1 (*Not at all familiar*) to 5 (*Very familiar*), participants were asked to rate how familiar they were with 15 career paths (mirroring NIH BEST Consortium baseline survey; Lenzi *et al.,* 2020). The items were summed with higher average ratings indicating more career path familiarity. Internal consistency using Cronbach's Alpha was .72 at pretest and .83 at posttest.

Career Choice. Participants were asked to select one of the 15 career choices provided or to indicate "other" accompanied with a free-response text box. Sample career choices included "faculty academic research," "teaching," "policy," and "academic administration." This item was evaluated with respect to whether participation was associated with changes in the individual's career choice selection pre- versus post-course participation, and whether there were shifts in the overall percentages in selected careers. To assess whether the course participation was associated with a change in one's career, participants received a "0" if their post-course career choice matched with their pre-course career choice, and received a "1" if their post ratings reflected any change in career choice.

Results

Career readiness. Paired-sample t-tests (Tabachnick & Fidell, 2007; all analyses conducted using IBM SPSS) were used to assess whether participation in a biomedical career development course was associated with Confidence to Pursue an Academic or Non Academic Career, Awareness of Transferable Skills, Career Management Self-efficacy, and Biomedical Career Path Familiarity, respectively (see Table 3). Following completion of the course, participants reported increased Confidence to Pursue an Academic ($t[28] = 6.25$, $p < .001$) and Non-Academic Career ($t[28] = 4.34$, $p < .001$), Awareness of Transferable Skills ($t[28] = 3.41$, $p < .01$), Career Management Self-efficacy ($t[26] = 7.74$, $p < .001$), and Biomedical Career Path Familiarity ($t[24] = 7.60$, $p < .001$).

Career pathway. Prior to the course, trainees indicated an interest in the following careers (3 responses were missing), of those who responded: 31% indicated non-academic research (n=9); 24% indicated teaching faculty (n=7); 10% (n=3) each indicated teaching/outreach, industry administration, and consulting; 3% (n=1) each indicated policy or regulatory affairs; 7% (n=2) indicated other.

Post course trainees continued to indicate an interest in the following careers (1 response was missing): 19% non-academic research (n=6); 16% industry administration (n=5); 13% teaching faculty (n=4); 10% (n=3) each indicated teaching/outreach, policy, and tenure track academic; 7% academic administration (n=2); 3% (n=1) each indicated non-faculty academic research-focused, consulting, entrepreneurship/startups, or medical science liaison, and other. Of these, the following were indicated post course, but not selected initially pre-course by any respondents: tenure track academic, academic administration, non-faculty academic research, entrepreneurship/startups, and medical science liaisons.

Course role in changing career pathways. A little over half of the respondents (54%) changed career preference over the duration of the course (46% remained the same; see Figure 1). The category of "other" was reduced in half from pre- to post-course (7% to 3%); however, given the small sample size this should be interpreted with caution.

In summary, results suggest that PSP participants' career readiness increased on various measures of career efficacy, including pursuing an academic or non-academic career, awareness of transferable skills, career management self-efficacy, and biomedical career path familiarity. Further, trainees continued to be interested in several different types of career paths. Interestingly, about half of the participants changed their career preference with some indicating careers that were not selected at the beginning of the course, including tenure track faculty.

Discussion

In Study 1, the PSP career development course sought to help biomedical trainees explore how the skills being developed could be applied across a wide variety of academic and non-academic career pathways as well as career management and planning skills. Examination of pre- and post-course results indicated that participation in the PSP course was associated with increased self-efficacy related to pursuing academic and nonacademic job opportunities, respectively, as well as increased

Table 3. Pre- and post-course composite variable means and standard deviations (PSP). Career readiness composite variable summaries pre- and post-course participation (means and standard deviations).

Variables (Scale range)	Average Pre		Average Post		Composite Pre		Composite Post	
	M	SD	M	SD	M	SD	M	SD
Biomedical Career Path Awareness (1-4)	**1.69**	0.37	**2.54**	0.55	25.38	5.59	38.13	8.22
Career Management Self-Efficacy (1-5)	**3.24**	0.45	**4.17**	0.51	32.38	4.35	41.66	5.05
Awareness of Transferrable Skills (1-5)	**3.72**	0.35	**4.00**	0.38	52.07	4.94	56.00	5.34
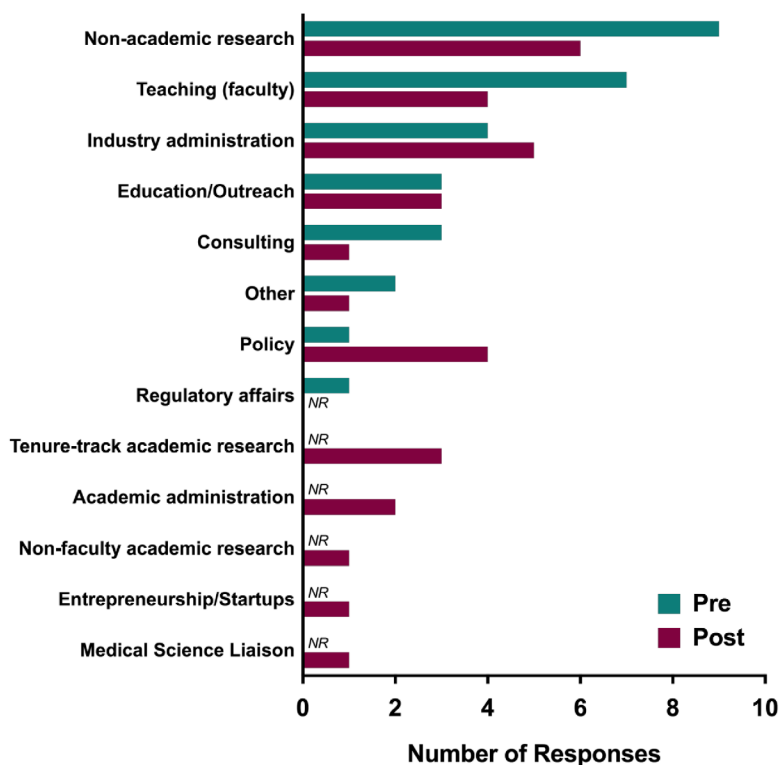
Figure 1. Pre- and post-course career interest areas – PSP. PSP participants were surveyed before (blue) and after (red) participating in the course about their career interest areas. NR designates no responses for that item.

familiarity with biomedical career pathways. Participants also reported more awareness of how the transferable skills they were developing in the graduate programs and more confidence in career management and planning. While the sample size (n = 32) is small, the ability to detect significant increases in posttest ratings is an indication that the career information and pedagogy effectively met the goals of the course. It is important to note the lack of a comparison group, which makes it impossible to draw cause and effect conclusions. However, the evaluation of the evidence supports the conclusion that course participation is associated with increasing career development. In order to draw conclusions about the impact or causal nature of the course, future evaluations should consider using a separate-samples pretest-posttest design whereby participants are randomly assigned to be observed before or after the course. More details on the applicability of this assessment strategy will be described in the *General discussion* section.

Three points are especially noteworthy regarding career pathway trends and changes. First, a greater variety of career interest areas were endorsed after (12 total career paths) compared with before (8 total career paths) the course, suggesting that familiarity with a wider number of career options developed during the course. Second, if "other" is interpreted as "undecided," then the decrease in this category from pre- to post-course may indicate the selection/identification of specific

career interest that developed during the course. In this case, as no "undecided" option was available, this interpretation seems plausible. Third, and perhaps surprisingly, interest in faculty careers increased after familiarizing trainees with other career options.

Study 2 – Hope is Not a Plan (HINAP) course

The HINAP career development course centers around effective use of an existing online resource, an Individual Career Development Plan (MyIDP) to help biomedical trainees to examine how well their skills and interests match to 20 scientific career paths and facilitates users to set short and long-term goals related to pursuing identified career paths of interest. The course is typically 8 weeks long for a total of 12 hours (initial versions of the course ran 10 weeks for 15 hours but has since been modified). On average, course enrollees attended approximately 7 of the 8-10 sessions offered in a semester (M = 6.88, SD = 1.63).

Methods

Participants. A total of 148 respondents (of 359 who were enrolled; see *Underlying data* – S3 & S4 (Layton *et al.,* 2020)) completed pre and post data over a five year period. The HINAP course participants were informed of their rights as research participants at the start of the survey, and consent was indicated by confirmation of intent to participate at the

conclusion of an embedded one-page summary. The course is offered both as a required graduate course in some programs as well as an elective course open to both doctoral students and postdoctoral fellows. The current sample represents 10 course sections (mode = 18 responses per section, ranging from 5-35 responses each). A subset of respondents (n = 14) were missing demographic data responses, including department, gender, etc. Of those who responded, participants identified as female (63%), male (36%), or elected not to provide a response (1%). The average age of the sample was 29 years (M = 29.16, SD = 3.99; ranged from 23 to 47 years of age). About half identified as US Citizens (42%), with a large international contingent (55%; including Green Card holders, J1/F1 visas, H1B visas, etc.).

Slightly over half of the enrolled course participants were graduate students (56%), with the remainder identifying as postdoctoral trainees (44%). The majority of participants (83%) identified as biomedical scientists from a variety of departments (specifically: 26% Biomedical Sciences umbrella program, 7% Neuroscience, 7% Biochemistry, 5% Microbiology and 18% other biomedical - e.g., Radiology, Neurology, Surgery, Pathology, Population Health, Medicine, Dental, and 20% Biology). The remaining 17% included other primarily STEM departments such as 10% Chemistry, with 7% of responses from a variety of other departments (e.g., Psychology, Mathematics, Population Health, Basic Sciences, Physics, Mechanical Engineering). Graduate students were typically in their 2nd or 3rd year of training (M = 2.90, SD = 0.97; range 1–6 years) and postdoctoral trainees were typically in their 1st or 2nd postdoctoral position (M = 1.33, SD = 0.57, ranged from 1–3 positions).

Ethics. As with Study 1, exempt status was sought and obtained through the appropriate Institutional Review Board (New York University, IRB protocol #: I13-00727). All analyses were conducted on de-identified data sets to maintain confidentiality (see *Underlying data:* S3 & S4 (Layton *et al.*, 2020)).

Measures. Career Readiness. A composite variable was created to approximate Career Management Efficacy by summing three items, to which respondents could endorse or not endorse

(*yes* or *no*). These items evaluated whether trainees knew where to look for jobs in their desired field, understood how candidates are evaluated for jobs in their chosen field, and whether they felt prepared to seek a position in their desired field (mean responses range from 0 to 3).

Career Professional Mentoring. Participants were asked to indicate who served as their own mentors (including PI, faculty, professional, and/or peer) pre- and post-course participation. The number of mentors cited by trainees was compiled into an arithmetic sum; in addition, changes in endorsement of each category were also examined. Career staff mentors were only included in the post measure, hence results are presented both with and without including that option when comparing pre- to post-mentorship measures.

Career Pathway. At the beginning and end of the course, participants were asked to select the career pathway most closely aligned with their current career goal from 10 specified options, plus "not sure," or "other" with a free-response text box. Career options included tenure-track faculty; other academic, research or teaching; private industry, research or non-research; government/non-profit; science writing, publishing, and communications; law; consulting; and entrepreneur.

Reason for Changing Career Goal. Participants were asked whether they had changed their career goal as a result of participating in the course. If they responded affirmatively, participants were then asked to explain "why has your career goal changed."

Results

The HINAP course evaluation strategy included measures of career confidence, career and professional mentorship, career path familiarity, and included a rich commentary descriptive in nature, hence the results include qualitative themes that explore whether and how participation in the course was associated with helping biomedical trainees consider diverse career pathways.

Career readiness. Career Management Efficacy significantly improved from pre- to post-course on the composite variable (see Table 4 for individual item response trends), t(132) = 18.65,

Table 4. Pre- and post-course career management self-efficacy (HINAP). Career readiness composite variable questions, percentage of yes endorsements by item (increase or decrease noted).

Career management self-efficacy items (Yes/No)	Pre Yes	Post Yes	Change Score
Do you know where to look for jobs in your desired field?	46%	88%	+ 42%
Do you know how job candidates are evaluated in your desired field?	1%	78%	+ 77%
Right now, do you feel prepared to seek a position in the field you desire?	17%	37%	+ 20%
Total endorsements (0-3)	0.64	2.03	+ 1.39

p<0.001), with trainees agreeing with fewer than one of three questions on average pre-course (M=0.64, SD=0.73) and agreeing with two out of the three questions on average post-course (M = 2.03, SD=0.86).

Career professional mentorship. The overall number of mentors cited by trainees (including PI, faculty, professional, and/or peer) increased significantly from pre- to post-course (M=1.65-1.95, t(137) = 3.09, p=.002, Table 5). In addition, the pattern of mentorship increase was maintained and the effect was enhanced when program mentors (i.e., Science Training Enhancement Program mentors) were included as a mentor option (M=1.65-2.10, p<.001). Furthermore, the number of trainees who cited having no mentors decreased, with 15% of participants (n=20) citing having no mentors pre-course and only 5% (n=7) post-course. In addition, the number of people who endorsed having a contact (or mentor) in their career field of interest rose from pre- to post-course from 24% to 70% (although the wording was slightly different, so direct statistical comparison is not appropriate for this question). Although these results should be interpreted with caution, since it's impossible to rule out confounding factors (e.g., mentor vs. contact; having identified one's field of interest during the course; meeting staff or faculty instructors; etc.), the pattern of increasingly diverse mentorship is consistent with the results from identical pre- and post-survey, which show gains of similar magnitude across almost every category (higher percentages endorse having mentors of each type). Ratings of trainees' own PI engagement remained constant (no significant change from pre- to post- course, M=3.48-3.43, t(81)=-.54, p=0.59, NS), suggesting that PI support and mentorship remained consistent throughout this career exploration process – even while the overall number of mentors that trainees reported having available to them increased concurrently.

Career choice. At the beginning of the course, participants were asked "Right now, what is your main career goal"

(see Figure 2). Given that the HINAP course is focused on exploring nontraditional career options, it is not surprising that 36% of the participants indicated either "Not sure" or did not respond the question. Of the 95 who did identify a career pathway, 38% (n = 36) indicated Private Industry; 27% (n = 26) indicated Tenure-Track Faculty; 11% (n = 10) indicated Other Academic Research or Teaching; 9% (n = 9) indicated Consulting or Entrepreneurial; 8% (n = 8) indicated Science Communications; 6% (n = 6) indicated Government/Non-profit; and <1% selected Law (n = 1) or Medicine (n = 1).

When asked the same question after the course was completed post-course participation ("Now, what is your main career goal"), only 18% (n = 27) responded "Not Sure" (n=26) or did not respond (n = 1). Of the 121 participants who did indicate a career pathway, 40% (n = 48) indicated Private Industry; 29% (n = 35) indicated Tenure-Track Faculty; 9% (n = 11) indicated Other Academic Research or Teaching; 9% (n = 11) indicated Government/Non-Profit; 6% indicated Consulting or Entrepreneurial; and 2% (n = 3) indicated Law (n = 2) or Medicine (n = 1).

In sum, the results indicate two trends. The first trend was that course participation was associated with a decrease in "unsure" or blank responses – from 36% at pretest to 18% at posttest. The two most popular pathways – industry and tenure-track faculty – remained the most popular. Specifically, an increase from 36 to 48 participants (2% increase) indicating private industry and an increase from 26 to 35 participants (2% increase) indicating tenure-track faculty. Of note, as observed in Study 1, following participation in the course a subset of participants moved into the Tenure Track Faculty category from other categories, indicating again that career exploration courses did not discourage participants from pursuing academic careers but enhanced interest in some cases.

Course role in changing career pathways. With respect to whether participation in the course was associated with

Table 5. Career professional mentorship (HINAP). Career and professional mentorship endorsements by category increased pre-to post-course participation, suggesting that more mentors were identified during course participation (increase or decrease noted).

Mentor	Pre Yes	Post Yes	Change
Principal Investigator (PI)	39%	37%	- 2%
Faculty (Other)	12%	21%	+ 9%
PhD (Professional)	41%	56%	+ 15%
Peers	73%	83%	+ 10%
Total Endorsements (Mean)	**1.65**	**1.95**	**+ 0.30**
Science Training Enhancement Program Mentors	-	14%	+ 14%
Total Endorsements including Program Mentors (Mean)	-	**2.10**	-
None	15%	5%	- 10%
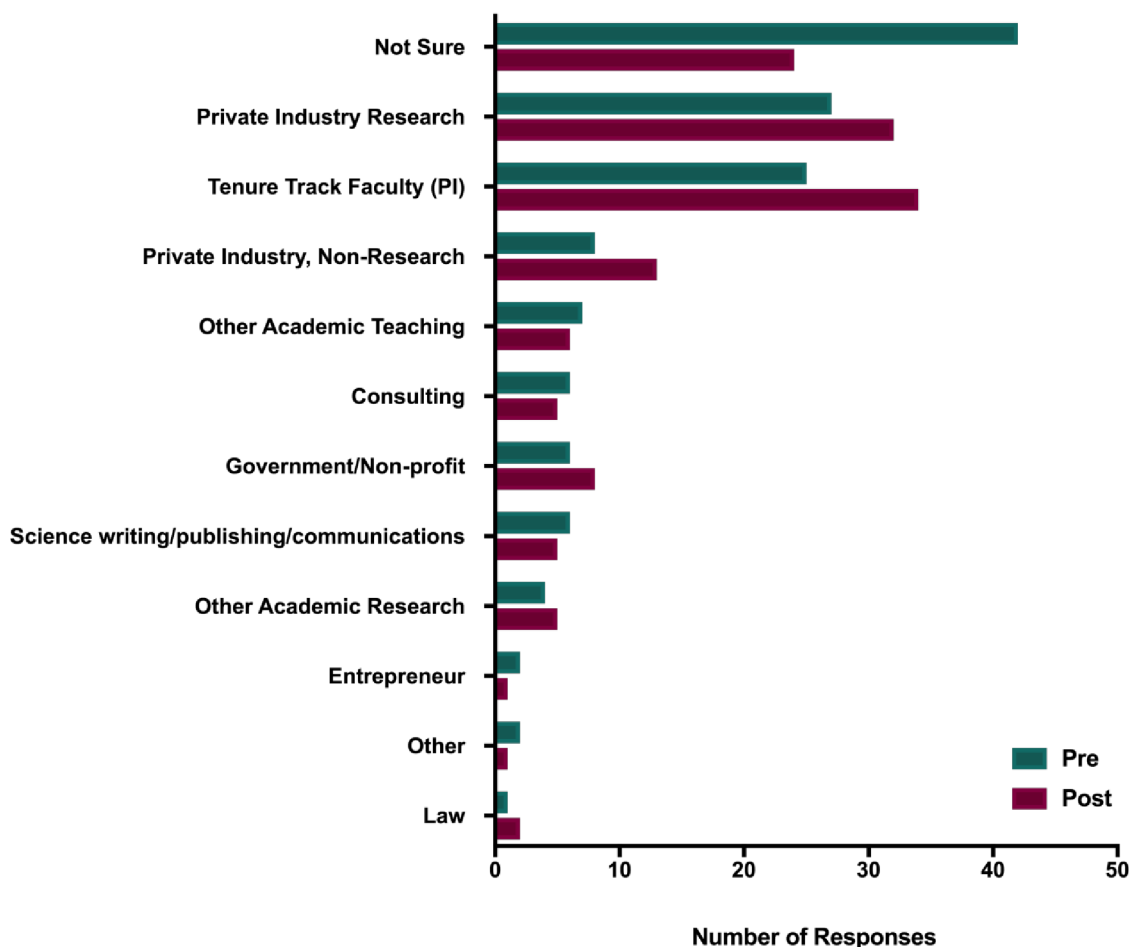
Figure 2. Pre- and post-course career interest areas – HINAP. HINAP participants were surveyed before (blue) and after (red) participating in the course about their career interest areas.

changing participants career pathway goals, among the 148 respondents, 58% reported "No" or "Not Sure" and 42% indicated "Yes."

A total of 37 participants provided written responses about the course role in supporting their career exploration, choice, and decision-making (see de-identified responses in *Underlying data:* S3 & S4 (Layton *et al.*, 2020)). For some participants, responses indicated that the course helped them clarify their career goals and intentions. Sample responses include:

> *Although the official job title associated with my main career goal has not changed, how I intend to fill this role has changed, which influences the higher-education institutions I am interested in.*

> *Although I am still unsure, the course helped me identify some good career path matches and even learn about careers that I did not know science PhDs could pursue.*

> *Debating between non-profit/outreach and industry and realized would be happier doing research in biotech setting.*

> *Don't really have a desire to go into consulting after researching the work/life balance. I am leaning toward for-profit industry either on or off the bench, not sure what yet.*

> *I am definitively considering more seriously a career in research in a private company.*

> *I am not sure what my career goal is but the class made me consider my values and how they would impact my job choice.*

> *I didn't change my career goal really but I learned a lot about how to positively influence my chances at getting a job that I like.*

Other responses indicated that the course expanded their consideration of career pathways outside of academia.

> *I got to know possibilities in the private industry, with better wages and faster dynamics.*

> *It verified that I want to pursue a career that has less to do with the academic setting, a more with the regulatory aspects of small molecule regulation in food products, environment, etc...*

I was already becoming less interested in Industry research but this class helped me come to the conclusion that I will probably pursue patent law.

Some respondents indicated that the course helped them understand how to evaluate their options and set goals for further examination and clarification.

It didn't affect my primary goal, but definitely provided new insights into the process of applying and interviewing for academic jobs. The class also encouraged me to keep an open-mind and to explore various other career paths I'd been considering.

It certainly helped me sit down and consider my options, my skill set and what aspects of my work I enjoy the most - and how that could become a full-time career! I've got a few options now that I am hoping to pursue.

It helped me figure out ways to get the information needed to really determine which of the paths I have been considering (tenure track faculty, industry, or senior scientist) is the best fit for me.

This course has actually made me to sit down and write down my short and long term goals that has helped me to focus in choosing my career.

In summary, HINAP participants' career management self-efficacy and career and professional mentorship increased, with broadened career pathway selections including an increase in participants who were interested in tenure track research faculty roles. Furthermore, qualitative data indicated that the course supported participants' career exploration through clarification of career goals; exploration of pathways outside of academia; and evaluation of career options with goal-setting to support career decision progress.

Discussion

The HINAP course sought to expand biomedical trainees' awareness of career pathways that lie outside of academia and to help them set goals for pursuing their career pathway goals. Career readiness increased across each of the three items assessing career management self-efficacy, resulting in a significant increase for the composite variable. Mentorship options were broadened for participants from pre- to post-course: total number of mentors significantly improved; the number of those identified as lacking mentors decreased; and individuals identified as career and professional mentors and career field contacts increased. Virtually all categories of mentorship showed increases (with the exception of PI, which did not change). This suggests that career course participation may encourage trainees to identify potential mentors, reach out to mentors in a variety of categories, and/or to recognize existing mentorship relationships. As with Study 1, a wide variety of career choices were selected; the choice of tenure track research faculty increased; and the choices of unsure and other decreased. While a large percentage of participants selected private industry and tenure-track career pathways both pre-and post-course, the open-ended responses indicated that the course helped participants examine a broader range of career options and helped identify goals for further exploration as they pursue their selected career pathways. Finally, qualitative responses indicated support for career goal-setting, exploration, and clarity were provided through course participation.

General discussion and Recommendations for Future Course Implementation

The number of trainees seeking graduate study in the biomedical sciences continues to rise and the number of available tenure-track faculty positions continue to wane, with the net result of many graduates extending post-doctoral positions without a clear plan or opportunity for future job security. In response to this challenge, NIH and National Science Foundation have both encouraged graduate programs to introduce career development offerings that will enable trainees participating in doctoral and post-doctoral programs the opportunity to explore how their skills can transfer into a wider range of high paying career pathways outside of academia. This study evaluated the thematic content and course evaluations for two independently developed, complimentary academic courses career development courses for doctoral and postdoctoral trainees offered at the two distinct institutions.

The thematic analysis evaluated both courses in terms of how they facilitated the development of self-exploration skills, career exploration skills, and career planning and management skills. Self-exploration skills refer to activities that enable participants to become aware of their transferable skills, interests, and values before engaging in career exploration skill activities that help participants match these transferable skills to a range of occupations. Career planning and management refers to setting goals and developing plans for further exploration and for identifying and pursuing specific job opportunities. The results of the thematic analysis indicated that the PSP course emphasized a more narrative and constructivist strategy for helping participants engage in self-exploration using discussions. Alternatively, the HINAP course focused on effectively implementing tools from the online platform, relying on assessment tools for helping participants identify their skills which then matched their responses to a range of career opportunities. To facilitate deeper career exploration, the PSP course used role models who described their career journey as a way to introduce alternative career pathways. The HINAP model focused on establishing SMART goals as part of a career management and planning effort.

The two courses varied considerably in how they conducted their course evaluation. The PSP course relied on the use of quantitative measures that assessed constructs such as self-efficacy, career management, and familiarity of careers. While career management self-efficacy was also measured for the HINAP course, course assessments focused on identifying how course participation impacted their career choice and gathered qualitative responses associated with participants career choice and decision-making process.

The PSP course pretest-posttest design found that course participation was associated with participants reporting more confidence with respect to pursuing both academic and nonacademic career pathways. Participants reported more familiarity of biomedical pathways, and participation was associated with increased self-efficacy related to pursuing both academic and nonacademic job opportunities and career management and planning.

The HINAP course also showed an increase in participants' career management self-efficacy, but the primary course focus was on identifying whether participants expanded their career pathway choices, and to better understand whether and how the course facilitated their career exploration and goal setting. The two largest career pathways were private industry followed by tenure-track faculty. Results indicated that participation in the course was associated with reducing in half the percentage of participants who were uncertain about their future career pathways with 18% of the course participants indicating being unsure of their career pathways following the course compared to 36% being unsure when the course began. Qualitative responses offered insights into the number of ways in which the course supported participants in being able to clarify their career goals, deepen their understanding of their selected career pathways, and provide clear goals for further exploration and the job search process.

Uniquely, the HINAP course measured pre- and post-course participants' access to career and professional mentorship, which increased over the course of their participation. Principal Investigator (PI) engagement in mentorship showed no change pre- to post- course, which might be interpreted either as continued PI involvement in mentoring their trainees, irrespective of trainee participation in the course. Given the variety of demands on PIs time, it may be seen as a benefit to have trainees increase their mentorship network, thereby taking some pressure off of PIs to be a one-size-fits-all mentor for every career path. While undoubtedly PIs should play a primary advising role for every mentee in their lab, due to practical time limitations and lack of PIs experience outside academia, it may be unrealistic to expect PIs to serve all these advising roles simultaneously.

The impact of peer mentorship is another topic that has yet to be systematically examined in a career-focused setting. While trainees asking peers about job search experiences and sharing information as peer-mentors occurs anecdotally, the impact has yet to be quantified formally (Kram & Isabella, 1985). Our data suggest that the vast majority of trainees do indeed turn to peers for support and mentorship in the career planning paradigm (73-83% of trainees). Another important implication is that peer-to-peer training opportunities could be more formally encouraged, including leadership roles and career development opportunities for senior trainees; this could enhance the resources available to trainees as they are navigating the career development planning process (Dorman et al., 2018).

In addition, while the data is inconclusive, administrative career-focused staff (e.g., career and professional development staff) may have become a newly utilized resource – and almost certainly added to the potential mentor-pool from which trainees may choose to draw. The development of additional resources to support doctoral trainee career transitions (e.g., NIH BEST programs; Lara et al., 2020; Lenzi et al., 2020; NIH, 2012) is of growing national interest (e.g., [Blank et al., 2017; Benderly, 2015; FOBGAPT, 2017; Stayart et al., 2018); one solution to workforce preparation in graduate education includes the use of staff trained to provide guidance and resources leading up to and during this transition to the workforce. Furthermore, the focus on career transitions and career outcomes is especially salient currently due to the federal focus that has recently been introduced to encourage development of more such programs (e.g., federal training grants such as NIH/NIGMS T-32 including career development training requirements and career outcome reporting; Gammie et al., 2017); hence, it seems likely that the importance of shepherding trainees through career transitions will only continue to gain importance.

Increasing the interface between industry partners and professionals outside of academia is crucial. Across two measures of STEM PhD professional mentorship and contact endorsements, a positive shift was identified. Programs like NIH BEST and other sustained programs that develop on-going, long-term partnerships across professional fields are crucial to provide readily available, existing, robust networks of professionals that trainees can tap into. Career courses are one way to enhance these types of connections. While PI introductions to industry professionals can also be a direct route to connect with STEM PhDs in other fields, the opportunity for these may be limited to the personal connections of the individual trainee (or connections of the PI), despite the best intentions of both. Hence the recommendation to enhance the connections available to graduate and postdoctoral trainees via programmatic partnerships as a whole, which will facilitate departmental and institutional access to professionals across a variety of careers, to expose and connect trainees with. Career services and alumni offices may also be of help in these cases, as can access to alumni directories through each institution, and/or electronic networking connections (e.g., LinkedIn alumni search tool).

Recommendations

Both courses offer distinct, yet complimentary, versions of career development courses designed to help biomedical doctoral and postdoctoral trainees identify career pathways. While the PSP course emphasized self-exploration discussions and exposure to role models who used their doctoral degree to pursue a wide range of academic opportunities, future course design may want to consider incorporating HINAP course efforts to facilitating deeper career exploration. Career exploration could be enhanced through discussions or formal assessment of the RIASEC personality type (Holland, 1958; Holland, 1959) and by providing trainees access to an online career information system such as the individualized career development plan (ICDP) or O*NET. By using online systems, trainees will have access to more descriptive details and labor market information that may not be available comprehensively from role models, as well as offer additional opportunity to align their interests and RIASEC type to a wide range of

career opportunities. During the final third of the course, PSP could also incorporate HINAP's SMART goal exercises as a more explicit career management and planning effort. SMART goals should include both future work and balancing home and life related concerns.

For HINAP, more emphasis could be placed on engaging in self-exploration prior to making career choices and setting career (SMART) goals. Incorporating PSP's strategy for using role models and having conversations about past, present, and future roles and life goals would enable a rich self-exploration foundation that is likely to facilitate career exploration and goal setting.

With respect to evaluation, both courses could benefit by incorporating a more rigorous, quasi-experimental, evaluation design. The separate-samples, pretest-posttest design described by Campbell & colleagues (1963) has been used in studies focused on interventions (e.g., increasing exercise, Amaya & Petosa, 2012; managing stress, Payrau *et al.*, 2017; among others). With respect to career development, Solberg and colleagues used a separate-samples pretest-posttest strategy to verify the impact of a social emotional learning intervention (Solberg *et al.,* 1998) and the effects of engaging in individualized learning plans (ILPs) on participants' career search self-efficacy and career readiness (Solberg & Gresham, 2011). Rather than randomly assigning participants to a treatment or control group, separate-samples, pretest-posttest design randomly assign whether participants complete a pretest or posttest. By designing a mixed methods evaluation strategy that incorporates both PSP's quantitative measures and HINAP's qualitative measures, it is possible to randomly assign participants to complete the quantitative assessment at pretest followed by the qualitative assessment at posttest or complete the qualitative assessment at pretest and quantitative assessment at posttest. Rather than conducting the pretest-posttest solely across a whole semester or summer term, future course evaluations could discretely measure each of three modules – self-exploration skills, career exploration, and career planning and management.

Conclusions

In summary, these studies offer two complimentary course design strategies for improving career readiness among doctoral and post-doctoral trainees. A thematic analysis of the courses indicated two complimentary but different approaches to career development. Using ILPs as a guiding framework, the first institution (PSP course) incorporated a number of life design elements by creating opportunities for discourse among course participants and professional role models. The second institution (HINAP) focused on examining interests and setting goals using the online career information myIDP. Using a quantitative pretest-posttest evaluation, we found that participants in the PSP course reported more awareness of how their PhD skills transfer into a wide range of career opportunities both in and outside of academia and they reported higher career management skills. The HINAP course employed a more qualitatively rich approach to evaluating career readiness, revealing that participants explored a broader range of career options and established career planning goals.

A perhaps surprising finding from examination of both courses was that in both cases, a subset of participants became interested in pursuing traditional tenure-track academic positions. A concern expressed by some faculty has been that broad career exploratory courses may discourage students from pursuing academic positions. Here, to our knowledge for the first time, we present data that the opposite is true – exposing trainees to the large breadth of career options available to them can actually enhance interest in academic careers for a subset of students.

As was supported by course participation in at least one of the courses, career exploration and professional development networks can be supported by building relationships with professionals in the field. Hence, building career mentor networks could also be a goal of future career courses in addition to the focus of exposing trainees to a myriad of career pathways and materials to explore them.

Furthermore, broad career exploration opportunities during research training should enable trainees to better identify and assess potential careers that are the best fits for their individual interests, preferences, and skills. In sum, offering graduate and postdoctoral students access to courses that enable them to expand awareness of careers that align with their advanced skill sets was beneficial in either supporting their ability to select new career options or to increase confidence in pursuing preexisting career choices.

Data availability

De-identified data is available. As per IRB limitations on data sharing to protect the identities of participants, all personally identifying information including demographic data has been removed, though it is reported in aggregate in the manuscript.

Underlying data

Open Science Framework: Career planning courses increase career readiness of graduate and postdoctoral trainees - Extended Data S1-6, https://doi.org/10.17605/OSF.IO/9WRBY (Layton *et al.,* 2020).

Information about each variable is embedded within the data files (SPSS version), removing the need for a data key; however, open source format versions (CSV) are also included for increased accessibility to data. Pre- and post-course survey questions are also embedded in the SPSS data files. This project contains the following underlying data:

- Extended Data File – S1. PSP De-identified Data (SPSS)

- Extended Data File – S2. PSP De-identified Data (CSV)

- Extended Data File – S3. HINAP De-identified Data (SPSS)

- Extended Data File – S4. HINAP De-identified Data (CSV)

Data are available under the terms of the Creative Commons Zero "No rights reserved" data waiver (CC0 1.0 Public domain dedication).

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PubMed Abstract | **Publisher Full Text** | **Free Full Text**

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PubMed Abstract | **Publisher Full Text** | **Free Full Text**

Open Peer Review

Current Peer Review Status:

Version 1

Reviewer Report 30 October 2020

Ronald J. Heustis iD

[1] Department of Biological Chemistry and Molecular Pharmacology, Blavatnik Institute, Harvard Medical School, Boston, MA, USA
[2] Program in Graduate Education, Harvard Medical School, Boston, MA, USA

Thank you - to both the authors and the editor - for the opportunity to review this article. I recommend indexing this article; I have some minor editing comments (relevant to papers that may be cited and some typographical corrections) but that should not detract from **my recommendation which is that this article go through the final stage of indexing.**

Summary and key points:

This article summarizes the delivery and evaluation of two "career exploration" courses, at two different institutions, accessible to both graduate students and postdocs.

Graduate and postdoc professional development has gained recognition and the field of professionals has grown larger. Published literature describing not only best practices but also the evaluation of those efforts is essential to share information within the community, including both those new to the practice and those looking to enhance existing training and evaluation protocols.

As a whole the paper provides a valuable perspective on the value of graduate and postdoc professional development courses, integrating what might be a series of standalone workshops into a structured offering. The authors describe two different courses (abbreviated as PSP and HINAP) and they do a good job distinguishing the models of the classes based on theoretical underpinnings. These are two good examples of <u>formal</u> "credit-bearing" courses and how they can benefit students.

Overall, the literature base - presented in the Introduction and Discussion - is sound, and includes both theoretical and applied publications as well as guiding policy/"white papers" which situate the value of this work and its contributions to the field.

The methods used in this work are clearly described, including statistical analysis. The authors explain the connection between these results and the conclusions they draw. It is noteworthy that they make efforts to acknowledge the limits of their sample sizes and also, in concluding, discuss how future projects can move to more experimental approaches to enhance the rigor of the evaluation methods used in this publication.

The descriptions of the courses outline the following similarities and differences:
- there are populations of two different sizes
- both include more participants who identify as female,
- both of which include participants from different disciplines, and,
- both of which include some grad students and some postdocs.

Some of the important findings from the paper:
- Participants in the courses are less likely, at the end of the course, to be completely "uncertain" about a career of interest.

- Trainees learn about more career options, and in some cases, they learn enough to shift interest to something else. Career interest is linked to values and values can be independently identified as a starting point, or be revealed through career exploration.

- Trainees get a better sense of the "next steps" including more details on the process of applying for jobs in certain sector and/or what it is like to work in those sectors.

- Career courses can be a good way to help students build their mentor networks.

- One of the very important findings from the results presented here is the observation that participation in these courses *increases* interest in tenure-track faculty careers. This is a very important point to underscore particularly as institutions grapple with national research funding mandates (as well as ethical priorities) to provide opportunities for trainees to explore careers, while addressing historical/institutional culture and faculty who may not support these goals.

Conceptual edits/places for commentary:

Some aspects that do not necessarily require change, but may benefit from clarification/comment:
- In the Introduction, the authors mention two references pointing to the fact that 2/3 of postdocs move onto non-tenure track or nonacademic positions. If the goal of this was to note only select examples of this evidence, no change necessary. If the intention was to be comprehensive, I would also include Silva *et al.* (2016[1]) as this publication similarly shows this proportion of trainees (of those U.S. trained PhDs) moving on to research tenure-track positions.
- In the Introduction, there is a sentence: "This framework is a variation from traditional themes of "career awareness", "career exploration," and "career preparation/career immersion" (e.g. Colorado, Massachusetts)". I believe these are references to the state plans for ILPs mentioned in the follow-up sentences, but this could be clarified before referencing the states.

○ In both studies, there is a conspicuous over-representation in the participants who identify as women in the study population. This breakdown by gender is very possible from a convenience sample (i.e. from those who register) but it might be worth commenting on factors that might influence women to pursue this type of opportunity over men. (This might be as simple as reflecting on the proportions in the trainee population.)

○ For the PSP course, n=32...over how many years/cohorts? Was it one offering of the 7-week version and one offering of the 17-week version?

○ For the PSP course, is there any reason to believe that that 17-week vs 7-week versions of the course might show differential outcomes? I know that given the sample size no conclusions can be drawn here, but for future reference it is worth noting as a consideration. The lengthened immersion may allow for more time for learning consolidation; however, the shorter version is likely more practical and if it accomplishes the same goals/outcomes of an extended course, the 7-week version seems like a recommendable best practice.

○ For the PSP course, there is a heavy emphasis on 1st and 2nd year students. This is not explained by the proportion of master's students (13%). Is there a factor that explains why students are so engaged so early in the career exploration? Do certain programs require this course? Published literature, including references in this paper (Fuhrmann *et al.* 2011 *CBE-Life Sciences Education*), suggest that students begin considering other careers slightly later...between years 2/3 of doctoral training. So, it is just interesting to note that there is such interest in the first-year students here.

○ For the HINAP course, why were career advising staff only included for the post-course surveys?

○ Overall, the Discussion of the manuscript can be enhanced by comparing the results of this work with those of Branan *et al.* (2018[2]) which describes a career exploration course for which the evaluation includes learning gains on overlapping outcomes such as understanding and using SMART objectives. This comparison would be more relevant for the HINAP course.

Some questions, in general, for future inquiry:

In reading this paper, two things came to mind. These are outside the scope of this paper, but may be future questions as we get more data from similar course implementations. The authors, if they have opinions on this or any relevant data from the course, are of course welcome to comment:

○ When we look at the impact of these courses to influence student career choice by engaging speakers in the different career trajectories, how much does the personality of the presenters, and alignment with the students' personalities matter? How, too, does the level of satisfaction with their own careers affect presenters' narratives and the influence they can have on the students.

○ For these studies, it would be interesting to follow-up with participants to see how the course ends up affecting them after course completion as in longer-term follow-up to find out if they class affected not only self-efficacy but also behavior.

Editing changes:
- ○ "Biomedical Career Path Familiarity. Using a four-point scale ranging from 1 (*Not at all familiar*) to 5 (*Very familiar*), participants were asked to rate how familiar they were with 15 career paths (mirroring NIH BEST Consortium baseline survey; Lenzi *et al.*, 2020)."
  This is a either a FIVE-POINT scale or the 5 should be a 4.
- ○ In the PSP discussion, there is a missing phrase in this sentence I believe: "Participants also reported more awareness of how the transferable skills they were developing in the graduate programs and more confidence on career management planning". I think there should be something like "…the transferable skills they were developing in graduate programs could be applied…" or perhaps just remove the word "how".
- ○ For the summary of the HINAP course, "Methods. **Participants.** A total of 148 respondents…completed pre- or post-data over a five year period." Either "completed" should be "contributed" or "data" should be "surveys".
- ○ There is a grammatical error in this sentence, from the general Discussion…
  "This study evaluated the thematic content and course evaluations for two independently developed, complimentary **academic courses career development courses** for doctoral and postdoctoral trainees offered at the two distinct institutions."

- ○ "Principal Investigator (PI) engagement in mentorship showed no change pre- to post-course, which might be interpreted either as continued PI involvement in mentoring their trainees, irrespective of trainee participation in the course.
  ~The word "either" doesn't fit unless the sentence was meant to be completed with something else.

- ○ "Hence the recommendation to enhance the connections available to graduate and postdoctoral trainees via programmatic partnerships as a whole, which will facilitate departmental and institutional access to professionals across a variety of careers, to expose and connect trainees with." ~ This sentence is incomplete or should be re-structured.
- ○ In the Conclusions, "The second institution (HINAP) course focused on examining interests and setting goals using the online career information myIDP". I believe "information" should be "platform".

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Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Graduate classroom-based learning of scientific concepts as well as academic and professional skills; the longitudinal development of life sciences graduate trainees, including their skills and career interests.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 29 October 2020

https://doi.org/10.5256/f1000research.28720.r72974

✔ **Gary S. McDowell** iD
Lightoller LLC, Chicago, IL, USA

In this study, the authors describe the assessment of career readiness development within the context of academic career courses at two institutions, particularly directed at graduate students and postdoctoral researchers, specifically designed to increase: career awareness; interest; and career-related confidence.

The studies are well-designed, and the authors describe the methods and results clearly and concisely. The authors give good descriptions of the limitations of the studies and what their results do or do not indicate, and the authors also provide suggestions for those working in this field on what to consider in future studies.

I thought the paper was well-written and overall is suitable for publication, and the article is very useful in providing supporting evidence for the benefits of implementing structured career development efforts during PhD training and postdoctoral professional development. Here I have laid out some minor points and questions that arose during my reading of the paper, which I

would be grateful if the authors could consider addressing.

General Comments:
I very much appreciated the description of the Individualized Learning Plan (ILP) in the Career Course Thematic Analysis. Would it be possible for the authors to perhaps expand this discussion to compare and contrast the ILP with the Individual Development Plan (IDP), something that the community may be much more familiar with (and especially as IDPs are introduced later in the paper)? In that way it may be possible to demonstrate whether one builds on the other (given my understanding of the use of ILPs and IDPs in industry, this may be the case). If it's not possible/considered appropriate to compare and contrast them, articulating why that is the case would be beneficial also. My impression is that a key strength of this paper is illustrating the utility the approaches seem to provide to develop career readiness in graduate students and postdoctoral researchers and a discussion of the utility of both of these tools would be of great interest to the article's likely readership.

Study 1 states: "Third, and perhaps surprisingly, interest in faculty careers increased after familiarizing trainees with other career options." - is it possible for the authors to determine that it is familiarity with *other* career options that is the cause of this? Or does it perhaps suggest that participants grew more confident due to an increasing familiarity with the academic career paths? Is it possible that exposure to well-structured and evidence-based training on the academic career path is the cause of this, as opposed to perhaps largely anecdotal, subjective and opaque information that participants may have received before? I would be interested for reflections on this point, and indeed some of the participant responses provided for Study 2 could suggest that such may have been occurring there. The discussion on peer mentorship (where, perhaps, many participants have been getting career information from peers/word of mouth, which may not necessarily be correct) may also point to this. I believe this phenomenon may have been described elsewhere (or perhaps I have simply heard it articulated by career development professionals at universities, but it has not been written into the literature). The authors may be correct that in learning about other career paths, participants may have become more certain about the academic path: it could be a simple case of knowing what you don't want helps to clarify what you really do want. But, I am reminded of (Van Noorden, 2018[1]) and the phenomenon of poor communication between PIs and trainees that affects a multitude of issues around training and career development. It may simply be that the approaches detailed in this paper increase academic career interest by providing clear information on what steps to take and how to think about it, in a structured way. I'm particularly interested, given the gender makeup of participants (in both, remarkably similar, with just over 60% being women), that this could even be pointing to gender biases in mentoring and the provision of guidance in professional career development. In short, any further reflections the authors could share on this would be appreciated, as I think they could have some answers to these points in their data.

Study 1 has very few postdoctoral researchers participating, compared to Study 2. Did the authors notice any differences viewing the data from that lens? I'm particularly interested in how the authors could relate this to some of Michael Roach's and Henry Sauermann's work: (Roach and Sauermann, 2017[2]) in terms of graduate students and (Sauermann and Roach, 2016[3]) in terms of postdoctoral researchers. It would be helpful to see whether these differing career stages have differing reactions in terms of the metrics described in this article.

It may be that there isn't enough data to draw any meaningful conclusions, but were the authors

able to see any differences based on gender, career stage, immigration status etc. where this data was collected? This does not seem to be referenced in the paper, so if it is not I would greatly appreciate some clarifying thoughts on whether anything was seen or not, particularly suggestions for how this could be addressed by researchers interested in these demographics in future studies.

Minor Comments:
- There is a possible typographical error: "To date, the design and implementation of career development programs and services in biomedical programs is only recently beginning to become broadly accepted **beginning".**

- The authors state that "This framework is a variation from the traditional themes of "career awareness," "career exploration," and "career preparation/career immersion" (e.g., Colorado, Massachusetts)" - I am unsure what (e.g. Colorado, Massachusetts) it is referring to?

- In Table 1: The box with the heading "Career management and planning skills" also has "Goal setting" and "Job search" written in it, and I was wondering if it was a copy/paste error into that cell - based on the content of this row of the table, perhaps that should be in the cell immediately to the right?

- In Study 1, under career pathways, is it possible to present the results simply in terms of n, rather than a percentage? The numbers are quite small, and I just didn't think having them described as percentages was useful, and also made the results a little harder to read.

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Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Academic research workforce development

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

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