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Building a valuable professional development course: instructor effort vs. perceived student value of activities in an online biotechnology course

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Providing undergraduate and graduate students with the appropriate preparation for transitioning to careers in their field after graduation is a key goal of higher education institutions, with many programs employing professional development workshops or courses to assist students and provide hands-on skills in this area. Although a wide variety of activities could benefit students, instructor and career specialist time is limited. Here, we describe an online biotechnology professional development course for undergraduate and graduate students, covering career exploration and the job search process, and the students' perceptions of the activities offered based on survey data. Overall response to the course was positive, with students at various stages of their education indicating appreciation of most of the course assignments. Interestingly, students ranked the activities that took the most instructor time, namely review of application materials, mock interviews, and career panels, as the most valuable for their personal development. The career exploration aspects of the course influenced students to be open to new possibilities. However, students struggled to make time to complete the assignments for a fully online, largely asynchronous course. Discussion of the value of the course activities, their relevance to social cognitive career theory and cognitive information processing, and suggestions for smooth implementation are provided.

KEYWORDS

professional development, career exploration, social cognitive career theory, cognitive information processing, biotechnology, stem, course development, student perspectives

Introduction

Many colleges and universities offer specific courses or workshops for students to assist in their career preparation, professional development, and transition to the workforce. For example, a search of the course catalog at NC State University reveals 25 separate courses with "professional development" in the title, typically specific to departments (e.g., Professional Development in Crop & Soil Sciences, Professional Development for Animal Science Careers, etc.), with many more courses covering professional development content as a part of the curriculum. Universities also typically have offices dedicated to career services that help the general student population; however, their ability to provide field-specific advice can be limited. Thus, offering tailored professional development courses for specific majors or fields can be very advantageous for students to network and succeed in their careers. The imposed structure of a course that meets weekly is beneficial for keeping students on track

in generating documents and performing career exploration in a timely manner while providing the expertise and emotional support that they need throughout the process. Despite the abundance of undergraduate professional development courses, there is a significant gap in the literature about the student experience in these courses. Most of the literature in this area focuses on professional development for K12 educators or professors (Avery and Reeve, 2013; Manduca et al., 2017; Hill et al., 2020) or is targeted on student development of science identity through a wide variety of activities (discussed below).

The career decision-making process generally involves awareness of existing career choices and comparison of the options available to personal priorities and values (Harren, 1979). The theoretical frameworks of social cognitive career theory (SCCT) and cognitive information processing (CIP) provide an outline for this process. SCCT asserts that personal self-efficacy, expected outcomes, personal goals, and external influences shape career development through both active and passive mechanisms (Lent et al., 1994; Lent and Brown, 2002). CIP outlines how an individual's knowledge of themselves (self-knowledge) and their potential career (occupational knowledge) are used in that individual's information processing cycle (Communication, Analysis, Synthesis, Valuing, Execution; CASVE cycle) leading to metacognition that ultimately decides career selection (Peterson et al., 1991; Peterson et al., 2003). Our professional development course contributes to this process by (1) providing external influences and occupational knowledge through career panels, peer networking, interviewing of professionals, and the instructors themselves; and (2) requiring students to reflect on their own values and self-knowledge in the context of the options that are presented to them, through career panels, reviewing posts to the course job board, and their own searching of job listings.

As educators, we can positively impact the STEM self-identity and self-efficacy of our students (Le et al., 2014; Le et al., 2019; Pugh et al., 2021), and these metrics have been correlated with retention of STEM majors and career progression (Le et al., 2014). Self-efficacy is also part of the SCCT model as a major influence into career choice (Lent et al., 1994). In one weekly senior seminar for biology majors, learning about biology careers and practicing the technical aspects of the job search (myIDP, portfolio, scientific societies, job charts, elevator pitch, personal statement, résumé, and recommendation letters) led to an increase in science and biology identity in senior level undergraduate students (McCartney et al., 2022). The students in the course also ranked the personal statement and résumé modules as the most helpful and "made me feel like a scientist." The same students also mentioned that they would have preferred to engage in the professional development course earlier in their college career, around their second or sophomore year of college (McCartney and Colon, 2023). Surveys from a 100-level STEM career exploration course that involved guest speakers and preparation of résumés, cover letters, and LinkedIn profiles increased students' self-awareness, self-confidence, and career self-efficacy (Liu et al., 2022). Discovering new career paths earlier in a student's career can help students develop several potential career paths (Winters et al., 2018) as well as facilitate pursuit of internships and co-curricular jobs prior to graduation (McCartney and Colon, 2023). These targeted professional development courses can also be a valuable source of guidance, confidence, and career self-efficacy for those with marginalized identities and backgrounds (Kezar et al., 2020; McCartney and Colon, 2023).

When developing a professional development course, it is helpful to know which activities will be most meaningful to the students and will produce the desired outcomes (i.e., the student receiving a job offer). Instructor time is often limited, and professional development courses often carry a low credit hour load, so streamlining for high-impact practices is beneficial for both instructors and students. To assess the perceived student value of activities that contribute to career decision-making and positive outcomes in a biotechnology-based professional development course, students were surveyed during the last week of the semester about their experience in the course.

The following research questions guided our analysis and discussion:

1 At which stage of the job search process are the course participants?
2 Which course activities are most valued by course participants?
3 How does course-guided career exploration affect career interests of course participants?
4 What are the challenges faced by course participants in a largely asynchronous online course?
5 What was course participants' overall view of their experience in the course?

Materials and methods

Course description

The Biotechnology Networking & Professional Development course is a 1-credit, combined undergraduate/graduate course that partially fulfills the requirements for a biotechnology minor or certificate. Students who enroll in the course come from a variety of majors, including biological sciences, biochemistry, genetics, microbiology, physiology, animal science, bioprocessing, statistics, and chemical engineering. This course was taught by at least one of the authors during each of the semesters surveyed (SHC and JTD Fall 2020, AOH and JTD Spring 2021, JTD Fall 2021, SHC Spring 2022). During the course, students engage in a variety of activities to help them prepare application materials and explore careers (Table 1). Due to the COVID-19 pandemic, most of the activities were performed asynchronously, with only the career panels and practice interviews being synchronous via the Zoom video streaming platform. While different instructors taught the course during the four semesters surveyed, the course structure remained the same. Students in the course ranged from sophomores up to PhD candidates, with the majority (62%) being undergraduate students in their last year, followed by junior-level undergraduates (15%) and master's students in their last year (13%). Course learning outcomes are available in Supplementary Table S1.

Survey implementation

Students enrolled in the BIT 402/502 Biotechnology Networking and Professional Development course at a large, doctoral-granting institution in the southeast took an online exit survey (available as Supplementary data) during the Fall 2020, Spring 2021, Fall 2021, and Spring 2022 semesters as part of the course activities. After

TABLE 1 Topics covered in the course, accompanying assignments, and mapping to theoretical frameworks by week.

Week	Topic	Assignment	SCCT/CIP Alignment
1	Design Thinking	Myers-Brigg personality assessment	Self-knowledge (CIP) Self-efficacy (SCCT) Expected outcomes (SCCT)
2	Finding job openings	Locate a relevant job posting	Occupational knowledge (CIP) Personal goals (SCCT) external influences (SCCT)
3	Professional communication	Draft a practice communication	Occupational knowledge (CIP)
4	*Career Panel 1 (Government)	Submit questions for panelists Post-panel reflection	Occupational knowledge (CIP) External influences (SCCT)
5	Résumé and cover letter part 1	Draft résumé and cover letter	Personal goals (SCCT)
6	Résumé and cover letter part 2	Perform peer review	Personal goals (SCCT) External influences (SCCT)
7	*Career Panel 2 (Academic Laboratory)	Submit questions for panelists Post-panel reflection	Occupational knowledge (CIP) External influences (SCCT)
8	CV and biosketch	Draft CV or biosketch Perform peer review	Self-knowledge (CIP) Self-efficacy (SCCT)
9	Networking	LinkedIn profile	Self-knowledge (CIP) Self-efficacy (SCCT)
10	Interview strategies	Prepare responses to interview questions	Self-knowledge (CIP) Self-efficacy (SCCT) Personal goals (SCCT)
11	*Career Panel 3 (Clinical)	Submit questions for panelists Post-panel reflection	Occupational knowledge (CIP) External influences (SCCT)
12	*Interview practice part 1	Peer interviews	Personal goals (SCCT) External influences (SCCT)
13	*Interview practice part 2	Mock interviews with professionals	Personal goals (SCCT) External influences (SCCT)
14	*Career Panel 4 (Biotech Industry)	Submit questions for panelists Post-panel reflection	Occupational knowledge (CIP) External influences (SCCT)
15	Biotech industry review	Report on a biotech company	Occupational knowledge (CIP)

Synchronous sessions are indicated by an asterisk. SCCT = social cognitive career theory; CIP = cognitive information processing.

completing the course exit survey, students were directed to a second survey, not accessible to the course instructors, containing the informed consent form, where students could choose whether to have their responses used for research. After grades were submitted for the semester, instructors/researchers were given access to the list of consenting students. Out of 70 students across all four semesters, 56 consented to participate (80%). This research was considered Exempt under the NC State Institutional Review Board #23589.

Survey data were collected using the Qualtrics online survey platform. Results were exported to Microsoft Excel and data from non-consenting students was deleted. Data from consenting students was de-identified by using a codebook linking student names to random four-letter codes. The de-identified quantitative data were analyzed in Microsoft Excel by performing descriptive statistics (average, standard deviation) and creating bar graphs. Violin plots were produced from aggregated Likert scale data using Graphpad Prism version 9.5.1.

Coding free responses

The coding strategy for the free-response answers was developed and implemented as follows. SHC, AOH, and JTD served as coders. The coders each read the free-response answers and determined codes *de novo* independently prior to an initial meeting to agree on a coding scheme. Following this first meeting, each coder independently coded answers according to the agreed upon categories. A second meeting identified refinements to the coding scheme that were required to capture the breadth and nuance of responses more precisely. This meeting was followed by a second round of independent coding according to the final coding scheme detailed below. The coders met one final time to compare their results and reach consensus on any statements for which differences in coding occurred.

In the finalized coding scheme, responses for each question were first coded into four broad categories: Positive, Negative, Course Improvement, and Other. Positive responses were then further divided into four subcategories: General appreciation, Specific to instructor, Specific activity, and Specific outcome. Statements expressing general thanks for the opportunities the course provided were considered "General appreciation." Statements directly mentioning an instructor were considered "Specific to instructor." Statements referring to a particular course activity were considered "Specific activity." Statements in which the student mentioned a specific outcome for them personally (e.g., getting an interview, being hired for a job) were considered "Specific outcome." "Negative" comments were complaints without actionable suggestions. "Course improvements" were those statements that included specific, actionable suggestions. Each student response could be assigned more than one code.

Results

Q1: At which stage of the job search process are the course participants?

To understand where students were on their job search journey, students were asked in the post-survey to select from statements about their status, including "I was not actively looking for a job this semester," "I was looking for a job to begin after graduation this semester," "I was applying to internships or other research opportunities," "I was applying to graduate school programs," or "Other (please specify)" (Figure 1A). Nearly half of the enrolled students are looking for jobs upon graduation after the semester in which they took the course (48.2%). This proportion increases in Spring semesters (51.7%) compared to Fall offerings (28.7%), consistent with a larger number of students typically graduating in the

Spring semester. These choices were not mutually exclusive, and many students not actively looking for a job were still applying to internships or other research opportunities.

With all four semesters taken together, 48.2% indicated that they were looking for a job to start immediately after the semester in which they took the course; 21.4% were applying for internships or research opportunities; 16.1% were applying to graduate school programs; and 25% were not actively looking for a job. Three students (8.9%) selected "Other;" two did not specify, despite being prompted, while the third mentioned applying to full-time jobs. It is unclear why this did not fit into the existing categories; perhaps the student was not graduating at the conclusion of the semester, but was still applying to full-time positions.

Students were also asked to indicate which job search activities they participated in during the course of the semester (Figure 1B). Statements included "I did not apply to any positions," "I participated in a phone interview (other than mock interviews)," "I participated in an in-person interview," "I received a job offer," or "Other;" and students could select more than one. Among all respondents, 37.5% did not apply to any positions, 42.9% participated in a phone interview, 14.3% had in-person interviews, and 25% received a job offer during the semester. At least one student had an in-person interview each semester, including Fall 2020. Three students (in Spring 2021) did not respond to this question, perhaps because none of the categories were appropriate. In Fall 2020, three students (20%) had an offer or interview withdrawn due to COVID-19; this choice was not offered during the other semesters polled.

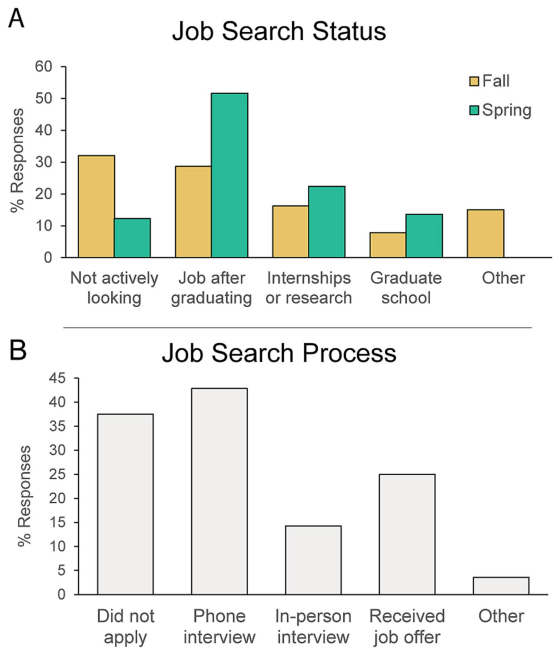

FIGURE 1
(A) Percent of students who selected each response to job search status statements, divided into Fall and Spring semesters. Fall $n = 25$, Spring $n = 31$. (B) Percent of students who selected each response to job search process statements across all four semesters. Students could select more than one choice, so percentages do not add to 100% across statements. $n = 56$.

Q2: Which course activities are most valued by course participants?

Students were asked to rank their agreement with several statements about the course (Figure 2). Overall, students overwhelmingly found the course helpful (96% Strongly agree or Agree). Students also felt they had their questions answered (87.5% Strongly agree or Agree), and felt confident to face the job market (87.5% Strongly agree or Agree).

Looking at responses to statements about particular course activities, students appreciated the career panels (96.4% Strongly agree or Agree), mock interviews with faculty (92.9% Strongly agree or Agree), and peer review of their application materials (85.7% Strongly agree or Agree). Notably, two respondents indicated "Strongly disagree" for the value of peer review; this is likely correlated to the quality of peer review that they received. Due to the anonymous nature of the survey, this correlation could not be confirmed. Students were largely satisfied with the four career panels offered, as only 39.3% wanted additional panels to be offered.

Next, students were asked to rank 10 of the main course activities from most valuable to least valuable (Figure 3). While there were a broad range of responses, they fell into three main groupings. In the top group, the majority of students found the mock interviews (76.8% ranked 3 or above) and the preparation of application materials (76.8% ranked 3 or above) to be the most valuable parts of the course. Career panels, creating or updating their LinkedIn profile, interviewing a professional, and writing practice communications were in the next grouping (ranked 4–6 on average). The lowest-ranked activities (ranked below 7 on average) were the Design Thinking discussion [guided by an online TED talk (Alsleben, 2017)], the MyIDP questionnaire [offered online by AAAS (Fuhrmann et al., 2011)], the Myers-Brigg personality test [using an online tool (Humanmetrics, 1998)], and personal reflections. Rankings did not change significantly between semesters or between undergraduate and graduate students, with the three groupings remaining steady.

The activities were then divided into three instructor-workload categories (high, medium, or low) based on the amount of preparation and assessment required. High effort activities included providing detailed feedback to each student or extensive organizational tasks ahead of the event (e.g., career panels). Medium effort activities required grading and some feedback on the assessment (e.g., review of LinkedIn profile). Low effort activities were activities that were given a course grade for effort and required no specific instructor feedback (e.g., reflections). The top three highest-ranked course activities are also the three that fall into the high instructor effort category.

Instructors also maintained an online forum on the learning management system each semester to post job openings and opportunities that they learned about during the course of the semester. Job postings consisted of any openings at the relevant level (bachelor's or master's degree) that were emailed to or otherwise brought to the notice of instructors in the Biotechnology Program, which were biotech-related but may not have applied to all majors enrolled in the course. Because this was a passive posting list and not a graded course activity, use of the forum was assessed separately (Figure 4). Students were asked about the usefulness of the forum by choosing from the mutually exclusive choices of: "Yes, I appreciated the postings!," "Yes, I applied to a job that was posted!," "I looked at them, but none of them were relevant to me.," or "No, I did not look at them." The majority of

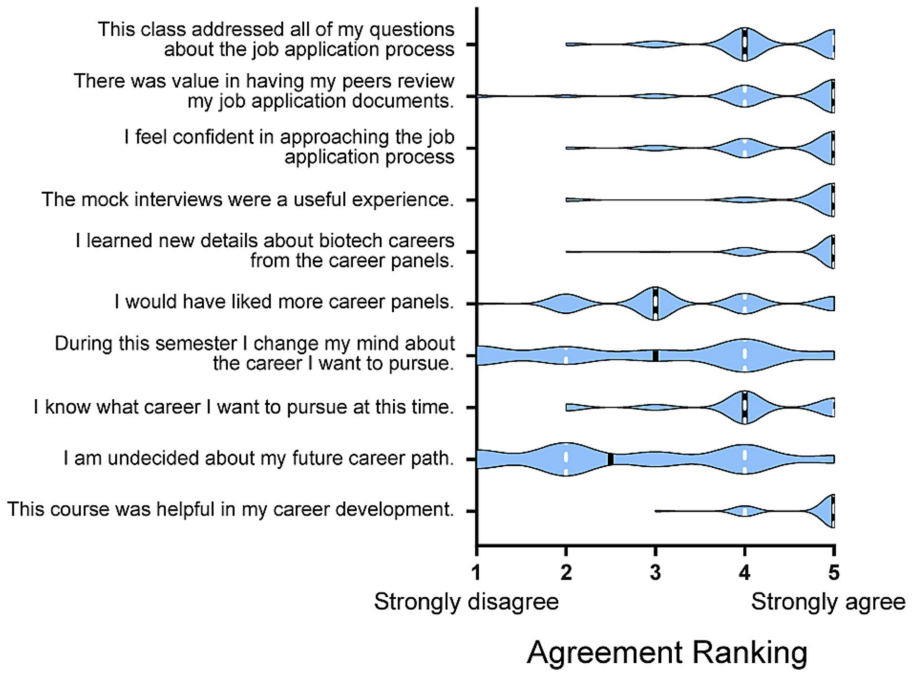

FIGURE 2
Using a Likert scale to respond to provided statements, students mostly agreed that structural aspects of the class are useful. Violin plots represent the distribution of student agreement to each statement (1 = Strongly Disagree, 5 = Strongly Agree). The median is displayed as a solid black line and quartiles are white dotted lines. *n* = 56.

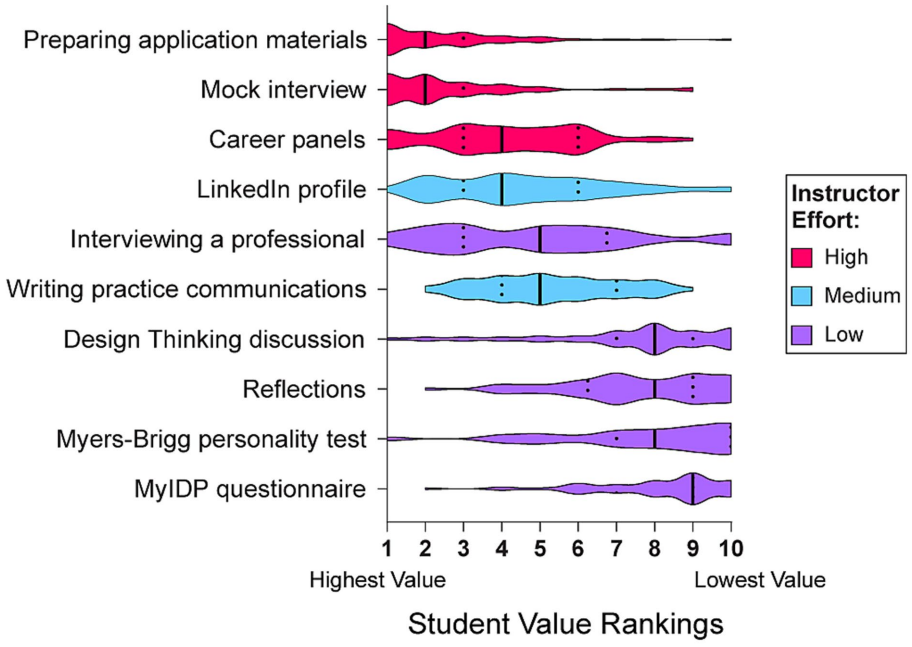

FIGURE 3
Students place high value in activities that require high instructor effort. Violin plots represent the distribution of student ranking (*n* = 56) of the most valuable (1) to least valuable (10) class activities. The median is displayed as a solid black line and quartiles are displayed as black dotted lines. Activities are ordered with the most valuable at the top to least valuable at the bottom. The color of the violin plot represents instructor effort with pink as high effort [copious feedback and/or behind the scene preparation], blue as medium effort [requires feedback], and purple as low effort [requires grading, but no feedback].

students (58%) appreciated the postings, with another 12% applying to jobs that were posted; 21% indicated that none of the postings were relevant, and 9% did not look at the job board.

Q3: How does course-guided career exploration affect career interests of course participants?

This course serves a variety of majors that fall under the broad category of biotechnology. To obtain an idea of the broad sectors of employment that students were interested in, students were asked to indicate their interest in the areas of Academia, Health, Industry, Government, or Other (please specify). Choices were not mutually exclusive and students could select as many as they wanted. While specific definitions were not provided within the survey, the course included career panels in these four specific areas (see Table 1) that provided context of the types of careers available in each.

In order of interest, participants expressed interest in Health (75%), Industry (66%), Government (34%), Academia (32%), and Other (7%), specified as Startup, Nonprofit, and Community organizing (Figure 5A). Most students (76.8%) selected more than one area, with some students selecting as many as four. In cases where a single item was selected (23.2%), it was either Health (61.5% of single-choice respondents) or Industry (38.5% of single-choice respondents).

As part of the four career panels during the course, the instructors included professionals from a variety of educational levels, from recent bachelor's degree graduates to experienced PhD-holders; and career paths, including careers that may be unfamiliar to the students, such as coordinating clinical trials, patent law, medical writing, running a core equipment facility, and project management. After completing all course activities, including attending these panels, reviewing job postings, and researching biotech industries (see Table 1), students were asked about how their career interests have changed as a result of participating in the course. Students could choose from the mutually exclusive options of "More options than before (open to new possibilities)," "No change," or "Fewer options than before (narrowed down)" (Figure 5B). The majority of students (68.4%) indicated that they were open to more career possibilities after taking the course. Due to an error in survey setup, this question was inadvertently left off of the Spring 2021 survey, so data presented are from the other three surveyed semesters (Fall 2020, Fall 2021, Spring 2022).

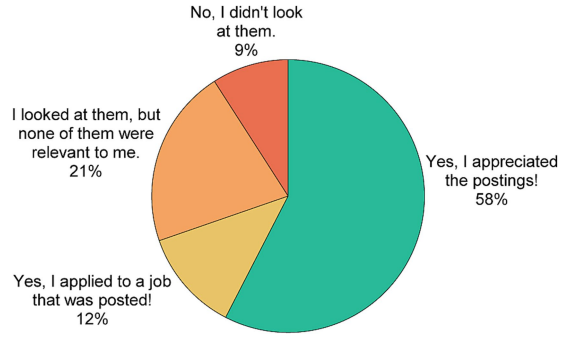

FIGURE 4
Proportion of responses to the question "Did you find the job discussion board posts helpful?" Choices were mutually exclusive and therefore sum to 100%. *n* = 38 (This question was inadvertently omitted from the Spring 2021 survey.)

Q4: What are the challenges faced by course participants in a largely asynchronous online course?

The semesters of this course that were surveyed included several semesters during which all of the students' classes were delivered fully online due to the COVID-19 pandemic. To assess students' ability to cope with taking the course online, a question asking students to identify issues that had arisen during the semester was included (Table 2). Students could select as many or as few of the provided choices as they wanted. This course was offered fully online in all semesters; however, the students' other courses returned to in-person starting in Fall 2021.

Across all semesters surveyed, 50% of students selected "no connectivity issues;" this could indicate that up to 50% experienced connectivity issues at some point, or simply that students did not choose to select that option from the list. 21% indicated they would forget when synchronous events were occurring; this held steady across all semesters. Only 60% overall indicated that they completed all assignments on time, although this improved to 75% in Spring 2022. Due to study design limitations, we are unable to independently confirm if this was the case. Overall, 34% indicated that they struggled to keep up with all of the assignments, including some students who indicated that they completed all assignments on time. This percentage actually increased during the largely in-person semesters (40% in Fall

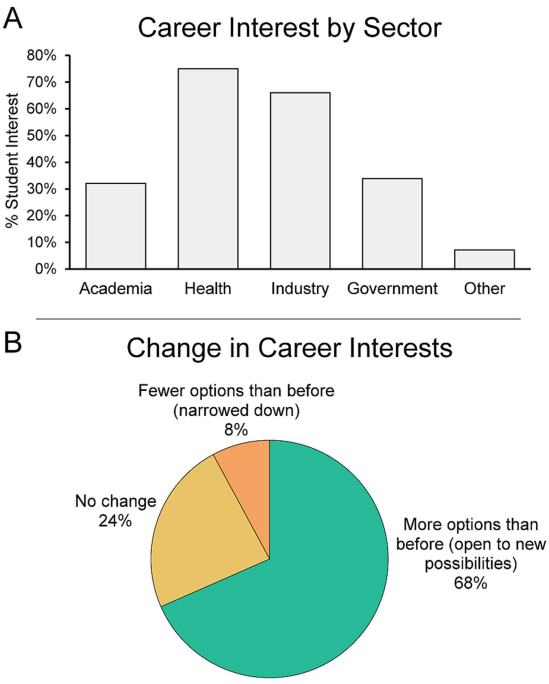

FIGURE 5
(A) Student interest in careers by sector. Note that students could select more than one choice, so the total of the percentages is greater than 100%. *n* = 56. (B) Student self-reported change in career interests after having completed the course. *n* = 38 (This question was inadvertently omitted from the Spring 2021 survey.)

2021 and 42% in Spring 2022), perhaps due to prioritizing their in-person courses over a largely asynchronous online course.

Q5: What was course participants' overall view of their experience in the course?

Two optional open-ended questions, "Is there anything you would like to add about your experience in BIT 402/502 this semester?" and "Is there anything you would like to add about your experience on the job market this semester?" were also asked on the survey to gather any student thoughts that were not covered in the other sections of the survey. For each of the questions, responses were coded into the four broad categories of Positive, Negative, Course Improvement, and Other (Tables 3, 4; see Methods). Each response could contain more than one code.

The majority of provided comments for both questions were positive (76 and 71%), and these were further subdivided into General appreciation, Specific to instructor, Specific activity, and Specific outcome. Most of the Positive comments fell into the category of General appreciation (71 and 70%), expressing broad thanks for the opportunities provided in the course. There were a few Negative comments (3) in regards to the first question only (about their course experience), characterized by a lack of actionable suggestions, primarily in regards to workload or lack of perceived value of activities. Some students provided actionable Course Improvement suggestions (7), typically for additional course activities; due to the limited time allotment for the 1-credit course, most suggestions are not able to be implemented in future semesters.

TABLE 2 Percent of students who selected the listed responses about course access and completion difficulties.

Statement	Fall 2020 $n = 15$	Fall 2021 $n = 10$	Spring 2022 $n = 12$	All semesters $n = 37$
I was able to complete all of the assignments on time.	60%	50%	75%	61%
I would sometimes forget when synchronous sessions were happening.	20%	20%	25%	21%
I did not experience any connectivity issues.	47%	60%	50%	50%
I struggled to keep up with the various assignment deadlines.	27%	40%	42%	34%

Students could select multiple options, so totals do not add to 100% (This question was inadvertently omitted from the Spring 2021 survey, so data are from the other three semesters).

Discussion

Professional development courses may contain a wide range of activities, but typically include application preparation and career exploration in support of the career decision-making process. Here we describe the impacts of a one-credit biotechnology-themed professional development course. Although not originally designed with these conceptual frameworks in mind, the course activities map well to similar courses covering interview preparation and career exploration (Winters et al., 2018; McCartney et al., 2022; McCartney and Colon, 2023) and to the frameworks of SCCT and CIP (Table 1). Enrolling in this course is an example of a choice action, and course assessments will lead to performance outcomes (grades and affective experiences) that feed into students' outcome expectations about their careers (Lent et al., 1994). The course also covers most parts of the CASVE cycle, with students gaining self-knowledge and occupational knowledge, synthesizing lists of possible careers, reflecting on their values, and formulating a plan for seeking employment (Peterson et al., 2003). Therefore, students' experiences in the course are important to their career journey. We were able to gain valuable perspectives on the course experience from the student perspective, which may help to guide course development at other institutions.

Q1: Students were in various phases of the job search process

Although the course described here is listed as a 400/500-level course, students were at many different stages of the job search process, from sophomores to graduating undergraduate/graduate students. Students were interested in a variety of opportunities, including full-time jobs, internships, and graduate school, with more students actively looking for jobs in the Spring semester than the Fall semester (Figure 1A), which correlates with higher graduation rates in the Spring [in 2021–2022, there were 2,557 Fall graduates and 6,673 Spring graduates from the university (NCSU, 2023)]. Most of the students were also going through the job search process concurrently with taking the course, as indicated by participation in interviews and receiving job offers during the course of the semester (Figure 1B). As this course is optional, it is plausible that it attracts students who want assistance during their job search process to actively complete the CASVE cycle (Peterson et al., 2003). Previously described courses were required for students to take before graduating (Winters et al., 2018; McCartney and Colon, 2023) and therefore no information was provided on students' motivations for taking them. However, it is mentioned that students expressed a desire to have taken a course like this earlier in their careers to benefit from the self-knowledge and occupational knowledge that the class provides (Lent et al., 1994; Winters et al., 2018; McCartney and Colon, 2023).

Q2: Students value course activities that require high instructor workload

The course activities as currently delivered broadly met students' needs and expectations. The vast majority of students felt that all of their questions were addressed, felt confident in approaching the job application process, and found the course helpful (Figure 2). They

TABLE 3 Open-ended responses about the course from all semesters.

"Is there anything you would like to add about your experience in BIT 402/502 this semester?"		
Code	# Responses	Example
Positive a. General appreciation b. Specific to instructor c. Specific activity d. Specific outcome	28* a) 20 b) 5 c) 8 d) 1	a. "I enjoyed this class and found it very useful!" b. "This was a great class-thank you for being such great professors!" c. "…having the resume/CV building was unbelievably helpful as I truly had no clue what I was doing beforehand" d. "My experience was fantastic, this course helped me get three job/internship offers and helped me secure a place working in the lab I want to work in for the Fall."
Negative	3	"I would say that (at least with online instructions case) that this is a 2cr a week class. I spent more like 3 averaged out a week. I also found the reflections to feel a bit like busy work."
Course improvement	6	"I think it'd be nice to incorporate a presentation from the career development center/ CALS Career Services/ etc. to provide more hands on, one-on-one attention, for reviewing application materials."
Other	5	"N/A"
Total	$n = 37$*	

Student comments could contain more than one code, so total coding does not add up to total student comments.

valued the experience of the mock interviews and learned a lot about careers from the career panels (see further discussion below). This indicates that the course is well designed to meet students' needs.

As most of the students have the perspective of concurrently going through the job search process (see Q1 above), it is not surprising that preparation of application materials was the top-ranked course activity, followed very closely by mock interviews (Figure 3). Preparation of application materials involves finding an appropriate job posting followed by iterations of the students' accompanying résumé, cover letter, and LinkedIn profile. Due to the many assignments and careful instructor feedback, this represents a large portion of the course and the instructor's time and effort, which scales with the number of students enrolled in the class. However, application materials are absolutely crucial to any job or internship search, and this may be one of the few chances students get to receive specific feedback from peers and professionals.

To implement the mock interviews, which were ranked second in value, between 20 and 30 faculty and professionals (≥1 per student in the class) are recruited and coordinated by the instructors to interview the students each semester, with each student participating in two interviews. Similarly, the third highest ranked item, career panels, also requires extensive instructor coordination to bring in 16 biotechnology professionals (four professionals on each of the four panels) throughout the course at designated times. While these activities represent a significant coordination load on the course instructor(s), these data show that the students' value in these activities justifies the effort required to offer these opportunities.

The lowest ranking items, the Myers-Brigg personality test (Humanmetrics, 1998) and MyIDP questionnaire (Fuhrmann et al., 2011), are third-party software tools used by the instructors. Many students mentioned that they had previously taken the MBPT, and the MyIDP is aimed for PhD students, which may have decreased their perceived value. These activities represent low effort for the instructors, and also hold low value to the majority of students. Therefore, these activities should not be a priority in an undergraduate-level professional development course.

Students were required to complete reflections after several course activities, including the design thinking video and MBPT assessment, each of the career panels, the mock interviews, and their interview of a professional, providing their personal thoughts on what they had learned. The reflections were invaluable to the instructors for gaining insight into the thought process of the students, who were completing the course remotely and largely asynchronously. Metacognition is also a key component of the CASVE cycle of career preparation (Peterson et al., 2003). However, students themselves did not seem to recognize the value of these reflections, as they were ranked 8th out of ten class activities (Figure 3) and one student said they "felt like busy work" (Table 3). While there are many previous studies on the value of reflection and metacognition to students' learning (Dangremond Stanton et al., 2021), few capture the students' feelings about completing these activities. High school biology students recognized the value of and enjoyed active learning that included built-in reflection, but did not specifically comment on the reflection component (Collier, 2021). Undergraduate students in a sustainability course saw value in reflections, with some students enjoying them, but many more indicating that repeated reflection assignments caused them stress (Whalen and Paez, 2020). Medical students who were asked to reflect daily on their two-week clinical rotations recognized a positive impact on their learning and awareness (Larsen et al., 2016), possibly due to the immediacy of using the feedback from one day to the next. Due to their importance to the instructor in gaining insight into the students' thought processes, we strongly recommend keeping the reflection assignments, despite students' dislike of the assignment.

Participants were also asked specifically about their use of the optional job board, a forum on the learning management system where instructors would post opportunities that arose during the course of the semester. The majority of students appreciated the postings with several even applying to posted positions (Figure 4). A significant minority of students indicated that none of the postings applied to them; since the postings were opportunities that randomly came to the instructors, this is not too surprising. On average, 20–30 opportunities are posted to the forum per semester, including job fairs, graduate school recruitment, lab technician positions, and company job postings. These postings require minimal instructor effort to copy and paste into the forum and are therefore well worth including in any career preparation course setting. Although students were technically also allowed to post to the job board, none ever did; this could be further encouraged to crowd-source opportunities for the students if desired. Instructors could also poll students about what they are looking for and tailor the postings, although this may prevent

TABLE 4 Open-ended responses about the job market from all semesters.

"Is there anything you would like to add about your experience on the job market this semester?"		
Code	# Responses	Example
Positive a. General appreciation b. Specific to instructor c. Specific activity d. Specific outcome	10* a) 7 b) 0 c) 3 d) 1	a. "I graduate in the spring and this class helped me explore new paths I had not considered before." b. None c. "It was very helpful to look a [*sic*] job postings to see what they are looking for in regards to skills I could develop for possible future career directions I am interested in." d. "I had several job interviews during this course and got multiple job offers thanks to the materials in this course."
Negative	0	None
Course improvement	1	"I would elaborate on what job titles to search for in the Biotech. For example explaine [*sic*] the difference between a research associate and a lab tech."
Other	3	"N/A"
Total	$n = 14$*	

Student comments could contain more than one code, so total coding does not add up to total student comments.

students from hearing about opportunities that they did not know would interest them.

Q3: Career exploration affects career interests

As the course was composed primarily of students in the life sciences, it is not too surprising that Health is the sector most students are interested in, followed by Industry, with Academia and Government close together in third place (Figure 5A). Interestingly, most students (>75%) selected more than one, with some selecting up to four, indicating a broad interest.

The occupational knowledge provided through participation in the course helped students explore their post-graduation options, with almost 70% indicating that they were open to more options than previously (Figure 5B). This is also in line with the large number of agreement responses to the statements "I learned new details about biotech careers from the career panels" and "During the semester I changed my mind about the career that I want to pursue" and with the spread of agreement ratings to the statement "I am undecided about my future career path" (Figure 2). Together, these indicate that the career exploration activities included in the course are helping students to broaden their perspectives and helping them along the CASVE cycle (Peterson et al., 2003).

Q4: Students struggle with time management during fully online courses

Although originally designed to be taught face-to-face with 1 weekly in-person meeting, the COVID-19 pandemic forced the course to go fully online. Since many of the activities do not require live instructor time, the majority of the course (9 out of 15 weeks) was converted to an asynchronous format, with students watching a short tutorial video made by the instructor followed by completion of a related assignment within one week (e.g., students watch a video on résumé best practices and then compose a draft of their personal résumé). To get a better idea of the student experience after this change in format, students were asked about their experiences with the online format in a series of statements on the exit survey.

For this question, students had to actively select each statement by clicking it, rather than having yes/no or Likert options for each statement individually, so lack of a response does not necessarily indicate that the student did not experience that situation. However, if we assume that students selected all relevant responses, a large proportion of students across all semesters did not complete all assignments on time (39%), forgot when synchronous sessions were happening (21%), had connectivity issues (50%), and struggled to keep up with assignments (34%). We believe that these issues directly relate to the course being fully online and largely asynchronous. Previous studies have shown that students find time management to be the most challenging aspect of asynchronous online learning (Han et al., 2023) and the lack of face-to-face interactions can lead to students feeling less motivated (Roper, 2007; Jiang, 2017). While some of these studies, like ours presented here, include the COVID-19 pandemic as a contributing factor, there is also pre-pandemic research that supports this phenomenon, so it is likely to continue into the post-pandemic environment. To address this in the future, the first week of the semester will involve a synchronous get-to-know-you meeting and students will be encouraged to set aside time in their calendars to work on the assignments for the course. While it is also possible to institute weekly required meetings, most of the assignments, like producing a résumé and providing peer review, benefit from the more flexible asynchronous schedule.

Q5: Students overall had a positive impression of the course

The final questions of the survey were optional and broadly asked students if there was anything they would like to add about their course experience or job market experience during the course of the semester. Responses to both questions were overwhelmingly positive and indicated an appreciation of the course material and instructors (Tables 3, 4). Several students explicitly mentioned receiving offers or jobs due to the materials and activities provided. The few complaints about the course typically centered around the workload, specifically being higher than expected for a 1-credit course. However, the assignments in this course are not limited to the course context and are expected to be used by the student to advance their career in the future, making it well worth the time investment, which many students seemed to appreciate.

Suggestions for implementation

Due to the COVID-19 pandemic, this previously in-person course was taught online for the iterations surveyed here. In general, the online format worked well. The following suggestions are highly recommended for smooth implementation of an online professional development course:

- Weekly reminder emails were critical for keeping students on track with assignments, as most weeks were delivered asynchronously with recorded lectures and reading materials provided for the students to work at their own pace throughout the week (Table 1) and many students indicated that they would forget when synchronous sessions were happening or struggle to keep up with assignment deadlines (Table 2).
- The use of an online meeting tool (Zoom) allowed for guest career panelists and mock interviewers from across the world, which was previously not possible when panelists were asked to physically come to the classroom. This has allowed us to invite panelists from remote locations such as Sandia National Labs and the CDC, as well as begin a collaboration with Nagoya University in Japan.
- The use of assigned breakout rooms within one shared Zoom meeting for the mock interviewers to meet with their assigned students decreased the logistics for instructors, students, and interviewers, compared to having students meet interviewers in their offices at a time scheduled by the interviewer, as was done previously. This has lowered the effort for the invited interviewers to participate, which helps the instructors to recruit interviewers and handle course logistics, thus somewhat lowering instructor effort (Figure 3).
- The online job board, implemented as a forum on the course learning management system, was an easy and effective way for instructors to communicate job options and opportunities in an ongoing way throughout the course (Figure 4). Students could be encouraged to share out opportunities that they find as well.
- Course activities that had both low student value and low instructor effort, such as Design Thinking, MBPT, and myIDP, could be exchanged for other items that provide a framework for discussing a student's career path/search. High value student items should be included, assuming that instructors have the resources to accomplish them. Student reflections are a high value instructor item that we suggest keeping while adding an additional explanation to the students of why metacognitive reflection is valuable for students and instructors, per Universal Design for Learning Consideration 8.1 "Clarify the meaning and purpose of goals" (CAST, 2024).

Limitations

There are some limitations within the current study.

- First, the survey itself was not designed from a specific analysis framework, although the topics can be mapped to SCCT and CIP theory.
- Second, the course has limited enrollment (20 seats per semester) and not all students granted consent (80% for 56 total study participants), so trends may not be representative of a larger population.
- Third, this study surveys multiple cohorts of students about their experiences during the course; alumni of the course were not surveyed for longitudinal data on the impact of the course on their careers.
- Fourth, due to study design limitations, we were not able to correlate student perceptions with student grades in the course as an indication of student performance and learning.
- Finally, we recognize that perspectives from a discipline-specific biotechnology professional development course may not be broadly applicable to similar courses in other areas, although our students do come from a variety of STEM majors.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material; further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by NC State University Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

SC: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Supervision, Visualization, Writing – original draft, Writing – review & editing. JD: Data curation, Formal analysis, Methodology, Visualization, Writing – review & editing. AH: Data curation, Formal analysis, Methodology, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2024.1464387/full#supplementary-material

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