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A mixed methods study of the challenges for geoscience majors in identifying potential careers and the benefits of a career awareness and planning course

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ABSTRACT

Undergraduates majoring in geoscience are often unaware of their career options beyond traditional resource industries; they need explicit supports to consider their post-graduation options. This mixed methods study sought to fill gaps in the literature related to the overabundance of solely quantitative studies related to career awareness and the dearth of studies on career awareness courses that are guided by theory. The study investigates the challenges geoscience undergraduate students face when considering a career, what resources students use to find career information, and the benefits of a geoscience career awareness and planning course (career course) rooted in cognitive information processing (CIP) theory. Data were collected via our Career Resource Survey (from both career course participants and a comparison group), course assignments, and focus groups. Findings indicate that many students do not know what careers they can pursue in the geosciences, nor what the specific titles of careers mean (e.g., hydrology technician vs. hydrologist). Undergraduate students report using a variety of resources to learn more about careers and to find jobs, but no particular resource stands out as being primarily used. The career course supported students in terms of guidance, tools, and connecting with geoscience careers. Specifically, the course supported students in exploring myriad geoscience-related careers, identifying the specific steps needed to pursue these careers, meeting and connecting with a variety of people in geoscience careers, and seeing the value of their geoscience degrees. Other geoscience programs may consider creating a similar course, or implementing components of the course as connected to CIP theory. Professional geoscientists and organizations may consider being more proactive in connecting with undergraduate students to support their knowledge of, and transition into, geoscience careers. Being deliberate in exposing undergraduates to geoscience career opportunities may help to attract and keep students engaged in the field, and to graduate geoscientists who are more highly-qualified for the workforce.

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Introduction

Undergraduates majoring in geoscience are commonly unaware of their career options beyond traditional resource industries such as mining, oil, and gas. This is a missed opportunity, as those with bachelor's degrees in geoscience can enter a variety of sectors in addition to oil and mining, such as education, agriculture, agencies within the federal and state government, and environmental sciences (Wilson, 2019). The American Geosciences Institute (AGI; Gonzales & Keane, 2020) projects a 4.9% increase in geoscience jobs between 2019 and 2029. However, if geoscience students are unaware of their career options, they may choose to leave the major, or may choose to pursue careers outside the field, rather than contributing to the country's geoscience workforce needs. Consequently, it is imperative that those who enter a geoscience major are explicitly supported in career decision making and career awareness (Schlesinger et al., 2021).

Undergraduate students have noted that they would like more support to pursue employment after graduation. Yet, in one study (Donald et al., 2018) students stated they rarely used campus career centers, citing lack of time and lack of tailored support as barriers. Instead, these students wanted individualized support, advice and insights from faculty, help in narrowing down the options available to them, required participation in career support programming, and advice and insights from alumni (Donald et al., 2018). In consideration of these findings, as well as a desire to meet the needs of our undergraduate geoscience students, this study sought to learn more about students' challenges to finding careers and the benefits of a new career awareness and planning course offered in a geoscience department. Specifically, the research questions guiding this study were:

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1. What challenges do undergraduate students face with respect to understanding geoscience employment opportunities?
2. Where do undergraduate geoscience students typically find career information?
3. What benefits (if any) do undergraduate students derive from a geoscience career awareness and planning course?

This study fills several gaps in the literature. Stebleton et al. (2020) stated that most research in the area of career-focused courses has been quantitative, which may not capture students' full experiences. Therefore, this study had a mixed methods design so that we could hear students' voices more clearly. In addition, Reese and Miller (2010) stated that despite the increase in popularity in career awareness courses, few courses are guided by theory, widening the theory-practice gap. This study—and the career course described here—used cognitive information processing (CIP) theory (Sampson et al., 1992, 1999) as a guide.

Literary context

This study was grounded in the literature of issues related to the geoscience career fields, how undergraduates can be supported to seek out careers post-graduation and the CIP theory of decision making for careers.

Misconceptions about geoscience careers

Sherman-Morris and McNeal (2016) argued that the geoscience career pipeline often suffers from a lack of exposure. That is, students are often not exposed to geoscience role models, their K-12 teachers often lack an in-depth understanding of geosciences (and its possible careers), and as a result, students may harbor misconceptions about what the field and its careers entail. Sherman-Morris and McNeal (2016) found that salary and prestige were drivers for students' college major choices, and geosciences was often ranked low in terms of perception of both salary and prestige, despite the fact that the average geoscientist made $30,000 more per year than life, physical, and social scientists. Bennett et al. (2021) stated that many STEM students choose a STEM major because they want to help society. Although there are many geoscience careers that help the environment and society directly, people often believe that there are more opportunities to help the environment and society in biology and engineering fields than in the geosciences (Sherman-Morris et al., 2019; Sherman-Morris & McNeal, 2016).

Despite the misconceptions around geoscience careers, most geoscience majors find a job within two months of graduation, demonstrating that geoscience graduates are much sought-after (Wilson, 2019). Consequently, it is important to ensure that students understand the options available to them in terms of geoscience careers, consider how their skills align with those careers, and are supported to make decisions about their career options (Schlesinger et al., 2021; Stofer et al., 2021).

Connecting students with career options

The AGI *Status of the Geoscience Workforce: 2018* (Wilson, 2019) found that from 2013 to 2017 those who graduated with a bachelor's degree and were employed in the geosciences had most commonly used personal contacts, faculty referrals, and internet searches to find jobs. Between 2010 and 2016, approximately half of all college graduates had visited their campus's career service center during their undergraduate career, but only 17% of these students said this visit was helpful (Gallup, 2016). Students often report that they will not attend career support programming unless it is required and that they need more personalized support in their job search (Donald et al., 2018). Perhaps because of the challenges related to exposing students to possible geoscience careers (e.g., Sherman-Morris & McNeal, 2016), Stofer et al. (2021) recommended that geoscience programs explicitly support students as they transition from their undergraduate career to the workforce.

Many geoscience faculty incorporate career awareness and planning into their courses. Faculty respondents to the 2016 National Geoscience Faculty Survey (Egger et al., 2019) were asked whether or not they used a variety of specific strategies related to workforce preparation. Survey respondents reporting their practices for a majors-level geoscience course most frequently reported that they "make explicit connections between skills needed in the geoscience workforce and course assignments and outcomes" (64.4%), that they "include information about geoscience and STEM careers and career pathways" (57.0%), and that they "highlight alumni from [their] program who are working in geoscience" (52.4%). However only 9.1% of respondents reported giving "an assignment in which students explore geoscience careers." The strategies faculty most frequently report using may not require any activity on the part of the student (i.e., the instructor is providing career information or making connections between course assignments and workforce skills). While these strategies are valuable and should be continued, a dedicated career awareness and planning course, in which students are actively engaged in the work, can provide opportunities for deeper exploration and learning.

Purposefully-designed career courses can help students in their eventual transition to the workforce and keep them motivated and satisfied with their major of choice. For example, Belser et al. (2017) found that students participating in a first-year career planning course for STEM majors were three times more likely to remain in their major for a second year. Likewise, Tomy and Pardede (2019) argued that students will be more satisfied with their education if post-graduation jobs are made visible to them and they are aware of how their courses and skills align with future careers.

Field-specific career courses have been implemented in a variety of majors, such as psychology (Ciarocco, 2018; Peterson et al., 2014), biology (Freeman, 2012), chemistry

(Jones & Seybold, 2016), and engineering (Stebleton et al., 2019), and have been found to be widely successful:

> …there is overwhelming evidence that career courses have a positive impact on the cognitive functioning of students, and these courses also appear to have a positive impact on student outcomes, including satisfaction with career courses, increased retention in college, and improved graduation rate. (Reardon & Fiore, 2014, p. 26).

More general career courses (i.e., non-discipline-specific) have also been found to be effective in increasing students' abilities to make decisions about careers (e.g., Lam & Santos, 2018; Scott & Ciani, 2008). Career courses help combat negative career thinking (negative thoughts that can impede making career-related decisions; Belser et al., 2017) and increase self-efficacy related to career decision-making (Belser et al., 2018).

Best practices for career courses identified in a literature review of 88 career planning courses include structured approaches; individual career exploration; written exercises; individual reflections and feedback; exploration of careers; and, building support for career choices within one's network (Reardon & Fiore, 2014). Other common practices amongst career courses include specific job search strategies (e.g., using LinkedIn), preparing for and practicing interviewing (Ciarocco, 2018), matching requirements and training programs to desired careers, documenting relevant experiences (e.g., volunteering) that relate to career options, creating specific timelines (Freeman, 2012), writing resumes, and having presentations from graduates and/or alumni (Jones & Seybold, 2016).

Cognitive information processing theory

Sampson et al. (1992, 1999) noted that the CIP theory can help people solve problems and make decisions related to careers. CIP theory has two key elements: the Pyramid of Information Processing Domains and the Communication, Analysis, Synthesis, Valuing, Execution (CASVE) Cycle, which is embedded within the Pyramid. The Pyramid includes knowledge of self and career options at the base, knowledge of decision making in the middle, and metacognition related to decision making at the top. These domains are arranged in a pyramid to indicate that making a decision about a career should build on what one knows about themself and their career options, and that reflecting on a decision should occur after a decision is made. Action in the knowledge of decision making domain plays out via the CASVE cycle:

- Communication - knowing one needs to make a (career-related) decision
- Analysis - understanding oneself and the career options available
- Synthesis - exploring all career options and then narrowing down to a few choices
- Valuing - weighing pros and cons of career choices and making a choice
- Execution - the action portion of the decision-making process; includes applying for educational opportunities, applying for jobs, etc. (Osborn et al., 2019)

CIP theory has been used by scholars to support career decision making in students. For example, Reese and Miller (2006, 2010) conducted quasi-experimental studies and found that students in a career course rooted in CIP theory made greater gains in self-efficacy related to career decision making when compared to students in the quasi-control groups. Similarly, Woodman (2008) compared students in a CIP theory-based career course with and without career coaching to a control group and found that students in the career course greatly reduced their career decision-making difficulties. Importantly, Hayden et al. (2021) suggested that the CIP theory could be a useful framework for those seeking employment during times of uncertainty (such as during a pandemic) due to its holistic support and focus on agency that are needed to navigate the impacts uncertainty has on people's career options.

Methods

Setting and population

This study took place at Boise State University, a public four-year university in Idaho. There are approximately 24,000 students enrolled at Boise State, approximately 17,000 of whom are undergraduates. Roughly 73% of the student body identifies as White, with the next largest population identifying as Hispanic/Latine (~13%). The Department of Geosciences at Boise State has approximately 100 majors in the B.S. Geosciences program. Data were collected from two overlapping populations over six semesters. In spring semesters, all undergraduate geoscience majors were invited to participate in our Career Resource Survey (details below). In fall semesters, data were only collected from students enrolled in a geoscience career course (survey data as well as qualitative data).

A total of 30 students completed the career course over three fall semesters. We did not limit the number of times a student could complete the survey, so some students completed multiple surveys during the study. For the purposes of this study, the survey responses from the *first time* any student took the survey serve as our comparison group ($n = 82$) to compare to the post-course surveys from students who completed the career course ($n = 23$). We also compared the pre- and post-course surveys for students who completed the career course and responded to surveys at both the beginning and end of the semester in which they took the course ($n = 22$; note that one student did not complete the pre-course survey, resulting in 22 surveys that could be compared pre- and post-course). Demographic information of the comparison group can be found in Table 1. Demographic information of the 30 students who completed the career course can be found in Table 2. Note that we did not ask students to report their academic level on the Career Resource Survey, but estimated it based on

Table 1. Demographics of comparison group ($n = 69$[a]).

Year	Number of Students	Year in Undergraduate Career	Self-Reported Gender	Self-Reported Race/ Ethnicity	First Generation College Student (Y/N)
2019	38	First Year = 5 Sophomore = 8 Junior = 6 Senior = 19	Female = 19 Male = 10	White = 31 Two or More Races = 5 Asian = 1 American Indian or Alaska Native = 1 Hispanic/Latine = 4	Y = 8 N = 30
2020	17	First Year = 4 Sophomore = 6 Junior = 6 Senior = 1	Female = 9 Male = 8	White = 15 Two or More Races = 2 Asian = 0 American Indian or Alaska Native = 0 Hispanic/Latine = 0	Y = 2 N = 15
2021	14	First Year = 7 Sophomore = 4 Junior = 1 Senior = 2	Female = 4 Male = 10	White = 12 Two or More Races = 2 Asian = 0 American Indian or Alaska Native = 0 Hispanic/Latine = 2	Y = 3 N = 11
TOTALS	69	First Year = 16 Sophomore = 18 Junior = 13 Senior = 22	Female = 32 Male = 37	White = 58 Two or More Races = 9 Asian = 1 American Indian or Alaska Native = 1 Hispanic/Latine = 6	Y = 13 N = 56
PERCENTAGES		First Year = 23% Sophomore = 26% Junior = 19% Senior = 32%	Female = 46% Male = 54%	White = 84% Two or More Races = 13% Asian = 1% American Indian or Alaska Native = 1% Hispanic/Latine = 10%	Y = 19% N = 81%

[a]Note that 13 of the comparison group respondents did not share their demographic information; percent is calculated based on n = 69 rather than the grand total of n = 82 in the comparison group.

Table 2. Demographics of career course participants.

Semester	Identifiers	Year in Undergraduate Career	Self-Reported Gender	Self-Reported Race/ Ethnicity	First Generation College Student (Y/N)
Fall 2019	S1-S14	First Year = 0 Sophomore = 6 Junior = 2 Senior = 6	Female = 7 Male = 7	White = 11 Two or More Races = 3 Hispanic/Latine = 2	Y = 6 N = 8
Fall 2020	S15-S24	First Year = 1 Sophomore = 0 Junior = 2 Senior = 7	Female = 7 Male = 3	White = 8 Two or More Races = 2 Hispanic/Latine = 0	Y = 2 N = 8
Fall 2021	S25-S30	First Year = 0 Sophomore = 1 Junior = 2 Senior = 3	Female = 3 Male = 3	White = 6 Two or More Races = 0 Hispanic/Latine = 0	Y = 2 N = 4
TOTALS	$n = 30$	First Year = 1 Sophomore = 7 Junior = 6 Senior = 16	Female = 17 Male = 13	White = 25 Two or More Races = 5 Hispanic/Latine = 2	Y = 10 N = 20
PERCENTAGES		First Year = 3% Sophomore = 23% Junior = 20% Senior = 53%	Female = 57% Male = 43%	White = 83% Two or More Races = 17% Hispanic/Latine = 7%	Y = 33% N = 67%

respondent self-report of completed geoscience courses. For many students, the number of credits they have earned (university-defined academic level) does not align with their academic standing within the geoscience major, and estimating academic standing based on completed geoscience courses provides a more accurate representation of progress toward graduation.

Intervention: Career awareness and planning course

The design of GEOS 301 Career Exploration and Planning (career course) was based on CIP theory (Sampson et al., 1992, 1999), which prioritizes gaining knowledge about self-interests, values, and career options. The course was offered as a 1-credit elective during the Fall semester of three consecutive years; as an elective, this course was optional and not required for all students. The course was designed for sophomore or junior geoscience majors with the expectation that the course would help guide and inform their choices during the remainder of their undergraduate career. Enrolled students must have completed at least one of three required 200-level courses for geoscience majors, meaning they had completed at least one semester of geoscience coursework beyond a 100-level introductory course. The career course met once per week for 75 minutes and the semester was divided into three sections: 1) Understanding one's own interests and values with respect to careers; 2) Investigating geoscience career options and evaluating how they align with individual interests and values; and 3) Creating a plan for progressing toward a goal related to career preparedness. Table 3 lists the course learning outcomes, associated summative assessments, and their alignment with the CASVE cycle. Note that while the course led students to think about how they would pursue a career of interest and the steps they might take to move toward that goal, the Execution component of the CASVE cycle was not realized as originally described by Sampson et al. (1992, 1999); students were not expected to actually apply for jobs or to make definite career decisions by the end of the course. Some students did apply for jobs or internships or decided on pursuing a specific career, but that was not an explicit goal of the course. For our application of the CASVE cycle, the Execution component refers to the creation of products that will aid in (future) applications.

Key course activities included analyzing and reflecting on personal interests, values, and abilities as they relate to a work environment; an orientation to Department of Labor and job search websites for career research; exploration of desired workforce skills (e.g., Mosher & Keane, 2021; Shafer et al., 2022); interacting with geoscience professionals as part of one or two career panels; an overview of the process for professional licensure in the geosciences; discussions about graduate school admissions and decision making; building strong job applications; and defining a career goal and a plan to achieve it. A more detailed description, and a few examples, of course activities are included as a supplemental document.

The career panels included geoscience professionals representing a variety of industry sectors and job titles. Almost all panelists were alumni from the Department of Geosciences, having earned either a bachelors or graduate degree at Boise State University. Students generated questions for the panelists during a class discussion prior to the career panel, and the course instructor synthesized these questions and acted as the panel moderator. Questions tended to focus on what panelists did day-to-day, what skills they found most valuable, and what they liked/disliked about their job. The formal panel discussions took approximately 45 minutes, and during the remaining 30 minutes of class, students met with panelists individually or in small groups to ask additional questions.

Research design

This study was undertaken with a mixed methods design, as Johnson and Onwuegbuzie (2004) note that mixed methods research can "draw from the strengths and minimize the weaknesses of both" (pp. 14-15) qualitative and quantitative research methods. Further, we sought to address the gap noted by Stebleton et al. (2020) that most research in the area of career-focused courses has been quantitative. Specifically, we took a concurrent mixed methods approach, with both qualitative and quantitative data collection strategies used simultaneously. The strength of this approach is that both confirmatory and exploratory questions - such as our research questions - can be investigated at the same time (Teddlie & Tashakkori, 2006).

Quantitative data collection and analysis

Quantitative data were collected via our self-created Career Resource Survey. Respondents were asked to rate 13 different resources for learning about geoscience careers on a 3-point

Table 3. Career course outcomes and aligned CASVE cycle components.

Course Outcome (At the end of the course, you will be able to…)	Class Sessions	Summative Assessment	Alignment to CASVE Cycle
Analyze your interests, values, and abilities as related to potential careers	2	Reflective essay	Communication and Analysis
Describe career options in the geosciences that match your interests, values, and abilities	4	Reflective essay and example job advertisements	Analysis, Synthesis, and Valuing
Evaluate the skills and experiences needed to pursue careers of interest	2	Summary of skills from job advertisements	Synthesis and Valuing
Tailor your job/internship applications so that they are competitive	5	General (networking) resume and targeted resume for job of interest	Execution
Write a career development plan	2	Career development plan	Execution

scale (Do not plan to use = 0; Have not used, but might in the future = 1; Have used = 2). Listed resources included university courses, networking at conferences, professional societies, faculty mentors, and family members. There was also the option for respondents to type in a resource if it was not one of the resources listed.

To establish content validity, the survey was piloted during the Spring 2017 and Fall 2018 semesters with geoscience majors in single courses at the sophomore, junior, and senior levels. Based on the pilot survey results ($n = 31$) and follow-up conversations with pilot survey participants, language used in the list of resources for learning about geoscience careers was updated, several additional options were added to the list of resources, and "unsure" was removed from the response scale for the career resources.

Non-career course students (comparison group) were invited via email to take the survey each spring semester; students enrolled in the career course took the survey at the beginning (a pre-measure) and end (a post-measure) of the fall semester. We performed unpaired t-tests (between-subjects t-tests) to compare responses for use of each of the 13 career resources from students in the comparison group and from students who took the career course (both pre- and post- course). Similarly, we performed a paired t-test (within-subject t-test) to compare the means of student responses for use of each career resource before and after taking the career course. Because the comparison group was not asked about using the career course as a resource, that resource option was removed from the un-paired t-tests between the comparison group and the students who took the career course. Prior to running the t-test, we performed a Shapiro-Wilk normality test to confirm the samples were normally distributed for both student groups ($p > 0.05$). After performing the unpaired and paired t-tests, we used Wilcoxon Rank Sum tests to identify which specific resources were statistically different in their use between the comparison group students and the students who took the career course as well as between pre- and post-responses of the students who took the career course. All statistical analyses were performed in R (RStudio Team, 2020).

Qualitative data collection and analysis

Qualitative data were collected via 1) four open-ended questions on our Career Resource Survey; 2) student assignments from the career course; and 3) focus group discussions. These are further described below.

Four questions on the Career Resource Survey were open-ended:

1. What jobs have you considered pursuing after graduation?
2. What are the characteristics of your ideal job?
3. What skills are required to be successful in that job?
4. What steps do you need to take to get those skills?

The data from responses to these questions were analyzed by question using the constant comparative method (Glaser, 1965). After themes were generated, data were grouped in two different ways to compare and contrast responses. First, comparison group responses were compared to the post-course responses of students who completed the career course. Then, to look specifically at students who enrolled in the career course, the pre- and post-course responses were compared. This analysis allowed us to learn more about how the career course may have provided support in terms of career resources.

Three assignments from the career course were collected from students. First, students were asked in their first week of the course to write an essay describing where they were in the career planning process with respect to these steps: 1) Knowing who you are and what you want in a career; 2) Knowing what career options are available; and 3) Planning how you will get the skills and experience you need for your desired career ($n = 20$). The second assignment was a reflective essay about what students learned from the career panel ($n = 16$). The final assignment, at the end of the course, asked students to write a career plan ($n = 22$) that included a long-term goal; at least four sub-goals that would help them reach their long-term goal; possible obstacles to the sub-goals and ways to overcome those obstacles; a detailed timeline; and a summary narrative of the plan. These assignments were analyzed in a constant comparative method (Glaser, 1965), with attention given to challenges related to job searching, resources students use to find information about jobs, and benefits of the career course.

Focus groups were conducted by the second author with the career course students in Fall 2019 and Fall 2021; the Fall 2020 focus group did not happen due to course challenges related to the COVID-19 pandemic. Breen (2006) notes that focus groups are more desirable than individual interviews when wanting to know about the impacts of a pedagogical intervention, as social interactions during focus groups can spur new ideas. The Fall 2019 focus group was held in person with 10 students; the Fall 2021 focus group was held via video conference with 6 students. The focus group questions asked students to describe why they became geoscience majors, their career choices, how prepared they felt to pursue their career goals, and the impacts of the career course on their feelings of preparedness for the job search. The Fall 2019 focus group lasted 39 minutes while the Fall 2021 focus group lasted 71 minutes. Each focus group was audio-recorded and transcribed verbatim; individual student speakers were not identified in the 2019 focus group but were in 2021. The focus group transcripts were analyzed in a constant comparative method (Glaser, 1965), with attention given to challenges to job searching, resources students use to find information about jobs, and benefits of the career course. Alignment between research questions and data sources is summarized in Table 4.

Positionality statements

The first author is a geoscientist, with degrees in geology, who specializes in geoscience education. As an

Table 4. Alignment of research questions and data collection.

Research Question	Data Source	Reasoning
1. What challenges do undergraduate students face with respect to understanding geoscience employment opportunities?	Career Resource Survey	Open-ended questions may provide information related to challenges in knowing about careers or understanding the steps to take toward a particular career.
	Course Assignments	May provide information related to challenges in knowing about careers, understanding the steps to take toward a particular career, or feelings of frustration related to particular challenges.
	Focus Groups	Questions asked explicitly about career goals and perceived preparedness.
2. Where do undergraduate geoscience students typically find career information?	Career Resource Survey	Quantitative questions asked students if they had used or intended to use particular resources.
3. What benefits (if any) do undergraduate students derive from a geoscience career awareness and planning course?	Career Resource Survey	Quantitative questions compared pre- and post-course for students in the course
	Course Assignments	May provide information related to benefits of the course.
	Focus Groups	Questions asked explicitly about perceived benefits of the course

undergraduate and graduate geology student, she received little to no guidance with respect to careers outside of academia. For approximately fifteen years, the first author has served as the primary academic advisor for students in the B.S. Geosciences program at Boise State University, and has talked extensively with students about their educational choices and post-graduation plans. Listening to students' questions about what they could do with their degree, and recognizing that most students were not thinking about careers until they were ready to graduate, the first author developed and taught the career course. Collectively, these experiences make the first author an "insider" in this research study (Dwyer & Buckle, 2009) and color her views on the importance of career awareness in the geosciences, which could have introduced bias into data analysis. However, the second author's distance from the geosciences provided an outside perspective to reduce bias.

The second author is a science teacher educator and educational researcher, specializing in science/STEM education. Distance from the geoscience field allowed the second author to serve as an "outsider" (Dwyer & Buckle, 2009) to the research, with no vested interest in the success of the course or the outcomes of the study, but rather a goal to learn more about students' perspectives. As such, the second author conducted the focus groups and led the data analysis. However, it was important for the first two authors to code data together so the nuances known only to an "insider" in the geosciences were made visible.

Study quality

Onwuegbuzie et al. (2011) put forth frameworks for considering the quality, or legitimation, of mixed methods research studies. In a "continuous iterative, interactive, and dynamic process," (p. 1257), we have taken up the concept of multiple validities to support the quality of this study. This means that we have considered the quality standards for qualitative, quantitative, and mixed methodologies to ensure "high quality meta-inferences" (p. 1264).

To enhance the trustworthiness (Lincoln & Guba, 1985) of the qualitative components of the study, we employed multiple techniques. We triangulated data sources by source (e.g., survey, focus group, etc.) as well as by different iterations (multiple iterations of the course, or multiple iterations of the survey administration) to ensure consistency of findings. Given that the first author was the instructor of the course, the second author (outside of the Geosciences department) conducted the focus groups so students would feel more able to speak freely. During data analysis, the first two authors went through three iterations of coding qualitative data independently and meeting to discuss any discrepancies until codes were consistently agreed upon and clearly defined. Finally, while writing the findings, we used thick descriptions (in-depth illustrations and concrete examples) with extensive quotations to provide a clearer picture of the findings (Creswell & Creswell, 2017).

The quality of the quantitative components of the study was also addressed via multiple techniques. To support internal and external validity of the research design, we have provided details about the context and participants, ensured that the instruments and data collection methods remained consistent over time, and allowed for a random sampling of students to create our comparison group. To support content validity of Career Resource Survey, the quantitative question was revised based on pilot results and conversations with pilot survey participants. Finally, all data were anonymized so researchers could allow the data to speak (Creswell & Creswell, 2017).

In terms of mixed methods quality, both qualitative and quantitative quality criteria must be taken into consideration, but also researchers are urged to acknowledge when there may be unequal sample sizes between quantitative and qualitative data as this could cause inaccurate interpretations. In this study, the comparison group ($n = 82$) that yields primarily quantitative data is larger than the career course population ($n = 30$) that yields primarily qualitative data; this has the potential to prioritize interpretations based on the quantitative data alone. However, there are several sources of qualitative data from the career course population, allowing researchers to value both qualitative and quantitative data similarly.

Results and discussion

The results are organized by research question. Additionally, we discuss emergent findings not related to the research

questions yet salient to the topic of career support for geoscience students.

Challenges to considering geoscience careers

The most significant challenge to considering geoscience careers came from a lack of knowledge and exposure. Specifically, students reported 1) not knowing what career possibilities exist for geoscience majors; and 2) not understanding the specific job titles for the types of work that interested them.

In their first assignment of the career course, one student commented succinctly, "Right now, I am…very unsure about what career options I have" (S6). Similarly, a student in the 2019 focus group said, "I had zero idea [what careers exist in geosciences]. I knew that mining was an option but I knew I didn't really want to do that." The sentiment "I didn't even know what was out there" (S26, 2021 focus group), was commonly expressed.

Uncertainty about career options is also evident in responses to the Career Resource Survey. In their responses to the question "What jobs have you considered pursuing after graduation?" 17% ($n = 14$) of comparison group students provided no answer (which we interpreted as the student had not considered or thought about post-graduation employment), and a second 17% ($n = 14$) of comparison group students reported something like "unsure" or "I don't know." Both no response and responses indicating uncertainty were found across students at all academic levels. For example, a first-year student responded, "I feel like I still don't know enough about possible careers to have seriously considered any job ideas," a junior-level student responded, "I have my mind open to other options because I am not aware of what kind of work that would be available in my field," and a senior-level student responded, "I have unfortunately only learned about most of the jobs available to geoscience majors only within the last year or so." Of comparison group respondents who did write about particular jobs they have considered, many, even among junior- and senior-level respondents, were vague. For example, several students mention applying to graduate school without any indication of what field they wish to study or what job they will pursue after completing the degree, or provide a general response like "federal employment" or "something in the field of geology." In contrast, 78% ($n = 18$) of survey respondents who had taken the career course responded with one or more job titles or a description of a desired job.

Many students in the career course report that before taking the course they were able to name a few common career options, but found over time there were more possibilities: "When I entered the geoscience program my knowledge of careers within the field was limited to petrologist, hydrologist, and geologists who make geologic maps. I have come to realize there are hundreds of fields of study within earth science" (S13). A sentiment often repeated was, "I thought that you graduate with a degree in geology and you become a geologist," demonstrating that students often did not have a strong grasp on the careers that one can pursue with a geoscience degree. Perhaps the most telling statement occurred when the second author (an educational researcher outside the geoscience department) was conducting the 2021 focus group and thanked a student for a clarification, saying, "I had no idea what happens in geoscience careers," and S30 quipped, "Neither did we."

The majority of students in our study had vague ideas of what they would like to do, or had general areas of interest, but often did not have specific job titles. This is problematic, because not knowing a particular job title can make job searches difficult to impossible. For example, S25 shared in the 2021 focus group that he did not know what to enter into job search engines, so he entered "geoscience jobs," resulting in meteorology jobs that were not of interest. In a similar situation, once S28 was able to describe the difference between a hydrology technician and a hydrologist and noted that she would prefer one over the other due to specific job duties, her job search became easier. Another difficulty for students was that some had misconceptions about what particular jobs entailed. For instance, S2 said that he liked the sound of "exploration" but, "To be honest I really didn't know what…exploration was. I had the idea of an Indiana Jones lifestyle in the back of my head." S4 shared that prior to the career course, she did not want a job in the oil industry and did not actually understand what was involved in such a job; after the course, she still did not want an oil industry job but had a better idea of why it was not a good fit for her.

Where students find geoscience career information

Despite the obstacles described above, students did report either knowledge or use of different resources to look for geoscience careers. Responses to the Career Resource Survey (Table 5) indicate that comparison group students were most often using their academic advisors and faculty, online job searches or listservs, and geoscience courses to learn about possible geoscience careers. Resources that were reported to be used less, or not at all, include the campus career center, alumni, and campus recruiting events or job fairs. Two write-in responses for "other resources" indicated use of a seminar in another science department and participation in an internship as sources of career information. The *Status of Recent Geoscience Graduates 2021* (Keane et al., 2022) similarly reported limited use of campus career centers by recent graduates of bachelor's programs, but, in contrast to our findings, also reported limited use of the internet as a job-seeking resource. Bachelor-level students responding to the same survey, however, indicated that the internet was the most frequently used method for identifying internship opportunities (Keane et al., 2022). The most frequently reported job-seeking resource reported by Keane et al. (2022) was "personal network." In comparison, respondents to our Career Resource Survey did not indicate extensive use of alumni, friends, or family (our interpretation of personal network) for learning about careers (Table 5).

Students who enrolled in the career course reported similar behaviors at the beginning of the course to those who did not enroll in the course; means of student responses to

Table 5. Means, standard deviations, and Wilcoxon Rank Sum test results for student responses to the Career Resource Survey question, "Which of the following resources have you used to learn about possible geoscience careers?" [a]

	Comparison Group		Pre-Course		Post-Course		Wilcoxon Rank Sum test p-values and effect size			
Resource	*M*	*SD*	*M*	*SD*	*M*	*SD*	Comparison vs post-career course[b]	Effect size	Pre- vs post-career course[c]	Effect size
Campus recruiting event of job fair	1.05	0.64	1.10	0.30	1.27	0.63	0.1713	0.16	0.0726	0.27
Campus Career Center	0.96	0.65	1.10	0.44	1.27	0.46	0.0521	0.22	0.1294	0.20
Internet job board, listserv, online search	1.57	0.62	1.68	0.48	1.91	0.29	0.0161*	0.27	0.0719	0.24
Networking at a conference	1.21	0.59	1.19	0.60	1.45	0.51	0.0982	0.19	0.0411*	0.24
Department classes	1.38	0.67	1.55	0.51	1.73	0.55	0.0243*	0.25	0.2273	0.22
Career Planning Course	n.d.	n.d.	1.38	0.50	1.91	0.29	n.d.	n.d.	0.0026*	0.54
Department seminars	1.28	0.65	1.29	0.46	1.36	0.49	0.7340	0.04	0.7656	0.05
Department faculty or academic advisor	1.67	0.47	1.64	0.49	1.59	0.50	0.5018	0.08	0.7768	0.05
Professional society	1.11	0.49	1.14	0.35	1.45	0.51	0.0069*	0.31	0.0107*	0.36
Student organization	1.32	0.69	1.18	0.59	1.18	0.59	0.3363	0.11	0.7656	0.04
Alumni	1.05	0.64	0.91	0.53	1.05	0.50	0.9525	0.01	0.1294	0.19
Friends	1.45	0.68	0.95	0.79	1.32	0.57	0.2769	0.12	0.0425*	0.29
Family	1.14	0.81	0.86	0.91	0.77	0.75	0.0693	0.21	0.6600	0.04

*Significant change measured.
[a]Responses were measured on a 3-point scale (Do not plan to use = 0; Have not used, but might in the future = 1; Have used = 2).
[b]Statistical difference in which resources are used between the comparison group and students who took the career course.
[c]Statistical difference in which resources are used by students prior to and after taking the course.
n.d. – no data.

questions about resource use prior to taking the career course were not statistically different from the comparison group ($p = 0.45$)). However, student responses after taking the career course were statistically different ($p = 0.01$) from the comparison group. This was confirmed by the paired t-tests (within-subjects t-tests) of students who took the career course; pre-and post-responses of individuals were statistically different ($p = 0.003$).

The Wilcoxon Rank Sum tests identified statistical differences in responses to three resources between the comparison group and students post-career course (internet job board, listserv, or online searches; department classes; professional society), with small effect size (Table 5). Reported use of these resources was higher for post-career course students than for students in the comparison group. The Wilcoxon Rank Sum test also identified a significant difference between pre- and post-career course students in the use of professional societies as a resource, with post-course students reporting higher use of professional societies. The use of department classes and the internet was not significantly different for pre- and post- career course students, although it was different for comparison group and post-career course students. The discrepancy for use of department classes could be attributed to differences in the number of courses that students in the comparison group have taken relative to the students in the career course (i.e., students in the comparison group have taken, on average, fewer geoscience courses). The discrepancy for use of the internet is minor; both comparisons were close to the boundary for significance, with one being slightly below, and the other being slightly above, the p value 0.05. The Wilcoxon Rank Sum tests also identified statistical differences in pre- and post- career course student responses to three additional resources (networking at a conference; Career Planning Course; friends), with increased use of these resources by post- career course students. The effect size is small for networking at a conference and friends; the effect size for the career course is large (Table 5).

Benefits of geoscience career awareness and planning course

Students' comments about the career course were overwhelmingly positive. The benefits they saw largely fell into three broad categories: guidance, tools, and connecting themselves to geoscience careers.

Guidance

The course was intentionally structured to begin with gaining knowledge (about self-interests, values, and career

options), and then moving through a step-by-step (CASVE) process such that students could identify concrete goals and steps to attain those goals. Students appreciated being guided through these steps, as they had not always known what steps they needed to take, and breaking the process into smaller steps kept students from feeling overwhelmed. S18 stated,

> In the beginning of the semester, my goal was to just get a job post-graduation and never really thought of the steps that I needed to take to get to that point. Now after taking this course, I feel like I have a better idea of what steps I need to take in order to reach this ultimate goal.

Likewise, other students commented that after taking the career course, their plans were "less floaty" (S26), "more understandable, [which] really helped with that overwhelmingness" (2019 focus group), and "clearer and more goal-oriented" (S11).

Comparing the post-surveys of the career course students to the comparison group, it was evident that students who completed the career course had a better understanding of the skills they would need to be successful, and a better grasp on specific steps they needed to take to reach their career goals. In the comparison group, when asked "What skills are required to be successful in [jobs they considered pursuing]?" the most common responses included general or non-technical skills such as communication or teamwork ($n = 25$; 30%), or no response or an indication that they were unsure ($n = 23$; 28%). Only 17% ($n = 14$) of comparison group respondents mentioned geoscience-specific or technical skills (e.g., field skills, GIS, analytical skills) in response to this question. In contrast, 65% ($n = 15$) of respondents who completed the career course mentioned geoscience-specific or technical skills. Students in the comparison group were also uncertain about steps they could take to gain the skills needed to be successful in their desired job; comparison group students most commonly left this survey question blank ($n = 23$; 28%), or indicated that they needed to complete their degree, be a good student, or work hard ($n = 18$; 22%). Only 4% ($n = 3$) of the comparison group students mentioned participating in research and/or an internship in a specific field or environment as a step toward their ideal job, whereas 37% ($n = 11$) of the career course students mentioned these options. Finally, when looking at the specificity of students' answers and providing multiple steps toward reaching their goals, only 10% ($n = 8$) of the comparison group provided these types of responses versus 39% ($n = 9$) of the career course students doing so. Collectively, these findings indicate that the career course did, indeed, provide support and guidance for students to define specific steps to obtain a desired job.

Connected to the step-by-step nature of the course, many students appreciated that the course made clear actions they could take *right now* that would help them in their eventual job search. Seven students noticed that many of the speakers on their career panels stated that learning R and Python would be beneficial to their careers. In particular, S6 made a plan to enroll in a course where she could learn these skills because they were not covered in her coursework. Others strengthened their resolve to find and apply for internships or student-level jobs in the field to gain experience prior to graduation (e.g., S7, S10, S13). Still others (e.g., S5, S11, students in the 2019 focus group) declared that they would invest more time in attending local professional organization meetings, as it was made apparent that networking is a key component in the job search:

> I found out early this year that SME [Society for Mining, Metallurgy, and Exploration] was looking for a new student liaison and I was recommended for the position. I realized that this would be a good opportunity to start mingling with people in the mining industry especially since I'm graduating in a year and I'm still not entirely certain what I want to do yet. (S4)

The concept of networking was mentioned extensively by students when describing the benefits of the career course. For many, the concept of networking seemed "abstract" (S29), but after the course, students felt more comfortable with the concept. S26 commented that networking is not "even that big of a deal really. You really just have to talk to people and I didn't really understand that before." Additionally, prior to the course, students commonly did not know how or with whom to start networking. The career panel structure within the course (hearing from the panel as a group and then having small-group time to chat with each speaker) supported the students in making initial contacts:

> The guest panel was very good on a lot of levels because [in class] we talked about networking and about reaching out to people…[T]he guest panel was not only a good chance to talk about careers, but to actually start that process of connecting with people we might be interested and learning from. I'm in contact with one of the panelists. (S26)

Career panelists also encouraged networking, as one student in the 2019 focus group remembered, "They were like, 'You just need to go [to organization meetings]'. Whether you're the wallflower that just sits in the corner…just show up and you'll start talking to people or people will come up to you." Finally, almost all career panelists were graduates of Boise State, which made a positive impression on the students:

> You felt on even footing with them…It was people who are doing those things coming out of the same place that we are in. It gave me hope that I can also get to that spot…And then just talking to them, it's like they're just another person. It made it much easier to go up to them. (student in the 2019 focus group)

Overall, students felt well-guided to achieve their career goals via the career course. The step-by-step nature of the course, the concrete actions they could take, and the illumination of and practice in networking guided students in ways that made sense and felt do-able.

Tools

While students found many of the tools in the career course to be beneficial, such as supports to create a resume or conduct career research, the most valuable "tool" in the course (if we consider a tool as something that assists students in identifying and planning to attain a career goal) was the ability to learn from the career panels. Key take-aways from the panels included coursework to take (e.g., computer programming) or experiences to gain (e.g., internships), and details relating to time spent doing fieldwork. The latter point was of particular interest, as some students stated they chose geoscience because they *wanted* to work in a field environment for their job, while others were relieved that they had so many options open to them that did not involve fieldwork.

A final valuable take-away from the career panels was that students were able to see the variety of jobs one can have with a geoscience degree, pointing both to the myriad career opportunities as well as to the value of a geoscience degree. A student in the 2019 focus group commented, "It was just really interesting to hear what I consider a whole breadth of what you can do with your degree." Similarly, S13 observed, "I'm beginning to realize that a geoscience degree can be utilized for more than geoscience, as long as you can show you know how to solve problems and communicate. I feel like you can apply a geoscience degree to a lot of technical career paths," and S6 said, "From an educator to an accountant, I was pleased with how very different their careers were and how they meet their needs."

On the whole, students found several tools of the career course to be useful, but the career panels appeared to resonate the most with students, providing both concrete ideas about careers, points to consider, and a structured opportunity to practice networking.

Connecting to geoscience careers

Finally, students saw benefits from the career course in terms of connecting to geoscience careers. By this, we mean that students considered the more personal and emotionally-linked outcomes of this course. To begin, the course required students to reflect on their skills, strengths, and opportunities for growth in order to consider career options. Because many students entered the course with no or vague career plans, this was a key starting point. S10 shared,

> At the beginning of the semester…I didn't really know what my skills were, what I wanted to do, or where I was going. Over the course of the semester, I actually learned that I was much further than I had previously thought. I have a firm awareness of my skills, I know the skills I need, I know how I am going to acquire those skills, and I have a picture of what my passions are. I have progressed much further than I could have ever imagined 14 weeks ago.

For some students this self-reflection confirmed or clarified their values and what was important to them in terms of their job, whether it be public service, work-life balance, doing research, or working in a particular setting. For other students, this self-reflection revealed things they need to work on, such as interpersonal communication, obtaining particular certificates, or being patient with oneself when making big (career) decisions.

As students gathered knowledge about themselves, they also conducted geoscience career research to consider different job possibilities. This was an enormous "ah-ha" moment for students because, as noted earlier, many students had no idea what careers one can pursue with a geoscience degree (aside from mining or oil). Identifying the possibilities—both specific and general—was incredibly exciting to students. A student in the 2019 focus group commented,

> When you get into geology, you really think you're going to go into geology and be a geologist…Then you get into geology and it is huge and you're just like, "Wow. There's so much. I have no idea what it is I want to do." And [the career course] really focused it down to a point of, "OK. Here's my path. This is the part of geology I want to do."

Similarly, S28 shared, "I get excited now, knowing all of the opportunities that are out there."

Overall, course participants appreciated learning how interdisciplinary and "expansive" geoscience is, opening up a variety of career possibilities.

Last, the career course generally increased students' self-efficacy for planning steps to find a job and getting the job they want. This increased self-efficacy was voiced as relief by S4: "There were a lot of people from my classes that graduated before me and they had no idea what they were going to do. I was worried that that was going to be me, and now it's not." S29 described gaining confidence in himself, as he was able to acknowledge the skills he possesses and recognize that having skills in a geoscience major makes one valuable. S26 summarized many students' responses by stating,

> Since the start of the semester, I have gone from feeling unfocused and a little lost to having a reasonable plan of action. I didn't even know if I had made the right choice of major, and I was afraid that there was only one path that geosciences could take me on. I thought the only work I could do would be out in the field and that my work would inevitably take me far away from [home]. These fears have been assuaged now.

These findings align with the studies reviewed by Reardon and Fiore (2014) in that career awareness courses can support increases in career decision-making self-efficacy and decreases in negative career thinking.

Emergent findings

There were four significant themes that arose in the data that were not specifically tied to a research question yet are relevant to supporting geoscience undergraduate students in pursuing careers in the field. The first two themes are

related to the career course itself: the timing of the course and whether it should be a required course. Overwhelmingly, students noted that they found the career course to be useful, but several students stated that they wished the course would have happened earlier in their undergraduate career so that they could have sought out various opportunities before graduation. For example, S26 argued that the course should be taken at end of the sophomore or beginning of the junior year:

> …that sweet spot where you've taken enough geoscience to commit to the major…[The course can] inform your decisions going forward for what other classes to take and who to talk to…I would have been…a lot more intelligent about those moves much earlier on, if I had a class like this, or something similar, early in my career.

Although the course was designed for students at the sophomore/junior level, many students did not enroll, or were unable to enroll, until their senior year, at which point the course felt less useful to them than it could have been. Students mentioned that they would have liked earlier help with resumes, more time to learn about various career choices, and more time to take advantage of targeted internships or jobs; they agreed that when one is in their last semester, it is too late. A student in the 2019 focus group asserted that if offered at the right time, when one has enough foundational geoscience knowledge and can take strategic steps toward a career, the career course "will help you save time and money instead of doing a class when you think you need it [but don't]…as the price keeps rising for school, it's helpful early on to know where you don't want to waste time in."

Although the literature has not purposefully explored the timing of career preparation courses, it could be inferred that courses offered earlier in students' undergraduate careers are more impactful. For example, in Belser et al., (2017, 2018) studies, students took a career planning course during their first year of their undergraduate career, and this became a significant predictor (although not the only predictor) of student retention in STEM majors. Likewise, Pawloski and Shabram (2019) offered a career awareness course in a community college and encouraged both first- and second-year students to take the course. Student outcomes were positive, with students being better informed about internships and coursework they could take during the remainder of their undergraduate career. Similar to our findings, some students in Freeman's (2012) career awareness course requested that the course be offered at the sophomore rather than the junior level so students would have more time to act on their learning. However, Freeman believes that even at the junior level, many students are not ready to think about their career, leading him to believe that a second-year course may be too early to be useful.

Because students found the career course so valuable, many argued that it should be required rather than elective. Highlighting the value of a dedicated career course, S25 shared that he had been told to do things to prepare for a career (e.g., create a resume, research careers) many times before, but because the activities were part of a class this time, it made him take the activities seriously:

> You're so caught up in school as a student that it's [job searching] not at the forefront of what you're trying to do…[B]ut now that it's incorporated into a class assignment, you're forced to do it for a grade. So it forces you to put effort and attention into something that's going to help you out later.

S29 agreed, stating that activities guided by an instructor were more impactful than trying to do these things on his own: "[I]t's one thing to say, 'Go find a job.' It's a whole different thing to say 'Look here.' Having the resources…[and] process laid out helps collapse all those vague what-ifs into 'Here's something actionable you can do.'" Reardon and Fiore (2014) note that there is a great deal of variability in career awareness courses in terms of credit, timing, structure, and whether the course is required. Nevertheless, over 90% of the career courses examined benefited students in terms of outcomes such as career decision making and retention in college (Reardon & Fiore, 2014). Such positive outcomes support the idea of having required, rather than elective, career courses.

The next relevant emergent finding from the data was the importance of demystifying the purpose of attending graduate school and the graduate school application and admission process. Although the data only showed this finding for the 2021 cohort of career course students, it was quite prevalent across all students and qualitative data sources for this cohort. During the course, a graduate student came to talk about his experiences of what graduate school is "really like," and made graduate school more approachable for many students. S28 shared,

> Prior to this class, graduate school had never really been on my radar because I had no understanding of what it would entail, no clue how to get there, and no idea why I would even try to. Now, I get really excited talking about it with people… Graduate school would really give me good leverage when applying for jobs down the line…

Likewise, several others shared that the application process seemed less daunting after it had been explained, and they had increased confidence that they could find a program that would suit their needs and take the appropriate steps to apply and enroll. Additionally, a number of students had never considered graduate school as a possibility but hearing from the graduate student made it seem "something that's not so out of reach for me" (S30). There were also students who commented that their desired career did not require a graduate degree. Given the expression from S30 and other students of the value of being exposed to the idea of going to graduate school, we see this exposure as beneficial to all students, even if it only affirms some students' plans to not pursue a graduate degree. This focus on graduate school is not uncommon in career awareness courses. For example, Peterson et al. (2014) included graduate school exploration along with career exploration in their career course while students in Pawloski and Shabram (2019) career course requested a seminar specific to graduate school options.

This is a good reminder to instructors to present a broad array of post-graduation options.

A final important emergent finding was the students' realization that as a geoscience major, they possessed many marketable skills that could be applied in a number of careers. These realizations were often due to components of the course providing space for students to name and notice the skills they had or were developing. A student in the 2019 focus group shared,

> …we had that second career panel where one of the panelists said to me, "You…have skills that 90% – even in your early education – 90% [of people] don't have. You are extremely valuable." That kind of confidence would not have come to me if I didn't have this [course].

Another student from the 2019 focus group agreed, "It was just really interesting to hear what I consider a whole breadth of what you can do with your degree…You're very valuable. It was good to hear that kind of stuff." Students commented how the career course helped them identify the skills they had (e.g., critical thinking, an ability to serve society via their areas of interest) and raised their awareness of how to "sell" their skills to potential employers. As noted earlier, Sherman-Morris and McNeal (2016) see the geosciences as having an "exposure problem" in that people may not fully understand what types of careers one can have with a geoscience degree. Similarly, students needed support in seeing the skills learned in a geoscience major make them valuable in a number of fields and careers.

Limitations

The career course was not required for all geoscience majors; therefore, the students who opted into the course may have been more ready or open to considering career exploration. Additionally, the scope of this study does not extend to confirming how many students follow their career plans, apply for particular jobs, and/or gain those jobs, so the long-term impact of this course and these findings are unknown. However, the decreases in negative career thinking and increase in decision-making self-efficacy seen in career course participants are a solid first step toward positive career outcomes.

Implications

This study sought to learn more about students' challenges to finding geoscience careers and the benefits of a geoscience career course. In alignment with the findings of Reese and Miller (2006, 2010) and Woodman (2008), our findings demonstrate the value of CIP theory when creating and implementing a career course. Students appreciated the individualized, step-by-step guidance of progressing through the CASVE cycle during the course as well as the opportunity to clarify misconceptions specific to geoscience careers. The most common challenge students in this study voiced (prior to taking the career course) was lack of information and exposure to what was possible and what different geoscience careers entailed, confirming the value of devoting time to work through the Analysis and Synthesis phases of the CASVE cycle. After gaining awareness of what geoscience careers entail, students were better positioned to consider other components of preparing for a career, such as gaining particular skills, building strategic networks, and knowing where or how to look for jobs. We see fruitful areas of future research on career courses rooted in CIP theory and using the CASVE cycle as investigating the longitudinal impacts of such courses. For instance, does working through this type of career course provide students with advantages when applying for jobs? Do these students feel more satisfied with their career choices, perhaps making them more likely to stay in their field/career? Additionally, we concur with Stebleton et al. (2020) in that researchers should consider conducting more qualitative and mixed-methods studies in this area, because, as demonstrated in this study, hearing students' (or graduates') voices can provide vital information about supporting students' career awareness.

Importantly, working through the CASVE cycle in the career course gave students increased confidence that they could find and attain a fulfilling career in geosciences. Negative career thoughts (about one's self-efficacy for, or the prospect of, gaining a satisfying job), can predict career indecision (Belser et al., 2017). Scholars have found that discipline-specific career courses can increase self-efficacy in career decision-making and decrease negative career thoughts (Prescod et al., 2019). The results of the current study confirm these previous findings, as the combination of learning more about oneself and possible careers, hearing from others in the field, and crafting a step-by-step plan for attaining their career goals supported students in feeling that they could be well prepared and successful in their post-graduation job search. Future research might investigate key components of career awareness courses that support students across disciplines. Further, researchers may want to investigate if there are components of career awareness courses that may be particular to certain fields. For example, perhaps students in different majors need different types of scaffolds to consider their respective career options.

This study describes a dedicated career planning course, however, similar activities could be incorporated across existing courses as long as students take those courses in a known sequence so that activities are scaffolded, and the CASVE cycle is preserved. The Supplemental Document provides descriptions of key course activities as an example for interested instructors, but is not intended to imply that exact course replication is necessary. Our course provides one example of career planning activities that align with the CASVE cycle; we hope that other programs and instructors will consider adopting similar activities or modify existing practices to align with the CASVE cycle. Future research could compare the outcomes associated with CASVE-aligned career planning activities that are distributed across several courses versus delivered as part of a single course.

While this study is based at one institution, we expect that our students are not unique in terms of their lack of geoscience career awareness. Resources provided by professional societies, the Department of Labor, alumni networks, and campus career centers make it relatively easy to learn

about geoscience careers, but these resources are not widely used by students. At the national scale, many instructors of geoscience courses report making explicit connections between course activities and workforce skills, and report including information about careers (Egger et al., 2019). These activities are likely not doing enough to support students in investigating geoscience careers or in helping students recognize and claim the workforce skills they are developing. Career preparation is not the only goal of undergraduate degree programs, but the widespread use of activities to promote workforce preparation suggests that faculty think workforce preparation is important; certainly, we can recognize that most students will seek employment in the future. Students enter the geoscience major with only vague ideas about possible career options. If we want to support existing students and attract new students to maintain and grow a strong geoscience workforce, the geoscience community will need to invest more effort into increasing student awareness of, and planning for, the breath of geoscience careers available to them. Such efforts could include requiring students, especially early in the major, to participate in career planning and preparation activities (including reflection), encouraging professional geoscientists and professional societies to seek connections with undergraduate degree programs, and organizing opportunities for students to meet and interact with professionals in a variety of geoscience careers.

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