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The Fledgling Mindset: Preparing Biology Students to Leave the Academic Nest

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Abstract: As Biology students prepare to complete their undergraduate degrees and continue into either a career or to another degree, the scientific skills learned in the classroom are not enough to secure their professional path. In this study, the soft skills such as the ability to work in a team and to communicate effectively were emphasized within the context of a newly designed Biology course. As a required course for majors within the Department of Biology, students represented a wide array of experiences, skill levels, and motivations. By adopting a guided inquiry approach to teaching and learning, instructors designed a student-centered course that focused on four categories of professional skills: problem solving, communication, teamwork, and career management. Data collected from student surveys were analyzed to determine the effectiveness of these interventions in enhancing student's abilities and attitudes towards professional skills. These data suggest that students increased their proficiency in attributes valued by employers regardless of gender or major; became more likely to recognize those traits sought by employers; and gained confidence in their ability to use these skills in the workplace.

Keywords: mindset; communication; professional development; critical thinking; feedback

The stereotypical image of the mother bird kicking her baby birds out of the nest may be a bit of a misnomer, but there is evidence that mother birds try to motivate their charges to leave the nest by incrementally increasing the distance they need to travel to get their food, eventually requiring them to start flapping their wings and taking the last steps towards full flight (Cornell et al., 2017). Biologists call birds in this liminal state between dependence and independence fledglings. As a metaphor, fledgling share a number of characteristics with undergraduate students who are preparing to take full flight into their chosen career paths. This begs the question of how faculty, as the figurative mother birds, effectively motivate and strengthen the abilities of our students to succeed. This article presents the results of a study of a cohort of fledglings, i.e. Biology majors from a medium-sized, doctoral-granting, STEM-intensive institution, and a group of faculty who endeavored to find new ways to coax them out of the nest.

Learning to fly is an essential skill, indeed a defining characteristic, of nearly all birds. Teaching and learning in STEM fields has traditionally focused on the defining aspects of science, i.e., principles, concepts, and practices necessary to solve scientific problems. This approach has a proven success record that has lasted for decades, but public attention has increasingly focused on what pundits have deemed the "STEM crisis" and dire predictions of large gaps in the number of

college graduates with critical STEM-related skills (Cappelli, 2014; Carnevale et al., 2011; Drew, 2015). In an effort to close this gap, researchers have identified teaching and learning as a critical factors in both student retention and persistence (Fairweather, 2008). This has translated into numerous studies of transformational teaching practices, including several that appear to be particularly compatible with teaching science, including problem-based learning, inquiry-guided learning/POGIL, and flipped classrooms (Borrego & Henderson, 2014; Felder, 2016; Prince & Felder, 2007). That being said, the employer surveys referenced above suggest that teaching transformation should not be limited just to the transmission of disciplinary content, but rather should also include attention to the development of professional skills.

Professional skills, often used synonymously with terms such as soft skills or career-readiness, are those characteristics that employers value in the workplace. They extend well beyond the science curriculum and include such traits as communication, flexibility, sociability, persistence, and professional judgement. Researchers have identified strong correlations between these skills and other markers of student success, such as GPA and, perhaps most relevant to the current study, persistence (Komarraju et al., 2014). Growing recognition of the significance of these skills has led to nation- and institution-wide efforts to find ways to articulate, integrate, and assess the degree to which universities are imbuing students with these essential skills across the curriculum (Baram-Tsabari & Lewenstein, 2013; Brownell et al., 2013; Kulturel-Konak et al., 2013; Mohan et al., 2010; Thiry et al., 2011; White et al., 2013).

In the first stages of this movement, universities engaged in activities such as creating career centers; developing career readiness programming; and providing co-curricular classes. These practices continue to flourish, but the one-size-fits-all approach does have demonstrable limitations, particularly in meeting student needs in specific career paths, especially fields that are highly specialized and/or technical (Feller, 2011). There are different models for providing more field-specific career development; some of the most common include the use of specialized academic advisors or targeted internship opportunities (the latter a long-standing requirement for the students in this study). Another alternative is for departments or programs to take the initiative to integrate professional skills into their disciplinary curriculum, either by incorporating such skills across the curriculum or by offering designated courses devoted to professional skills in the discipline. Successful examples of disciplinary-specific career development courses have been reported for Chemistry, Psychology, Nursing, Communications, and Finance (Lucy, 2017; Peng et al., 2017). Such courses also have their limitations and the question of whether or not the curricular space they fill constitutes time well spent remains open, particularly in light of the limited number of studies that evaluate such courses (Wingate, 2006). Our study aims to address this gap in the literature by looking closely at the development and evaluation of a three-credit, sophomore-level communications and careers course required for all Biology majors and taught by experienced Biology professors.

Beyond the walls of the university, employers have achieved consensus on a range of skills that are increasingly highly valued. Each year, the National Association of Colleges and Employers (NACE, 2016) conducts an employer survey. For 2016, 160 medium to large employers from a representative sample of economic sectors ranked leadership, teamwork, communication skills (written and verbal) and problem-solving skills as the top five most desired in new college graduates (NACE, 2016). Each of these characteristics ranked above those tied to knowledge of disciplinary content, including analytical/quantitative skills, technical skills, and computer skills. It is tempting to downplay these findings as applicable to a broad range of skills, not necessarily those for STEM careers, but 39% of the employers who responded planned to hire math and science majors, and 23% of those planned to hire Biology majors specifically.

The NACE survey encompasses all recent college graduates from a wide range of colleges and universities. This has the potential to do a disservice to higher performing programs, such as the institution covered in this study, a STEM-focused public university. That being said, an employer study conducted by the Learning Assessment Office in 2013 revealed that local and regional employers also identified significant gaps (Ennis, 2014). As Table 1 (below) reflects, employers indicated a need for improvement in the following areas: work ethic, leadership skills, and oral and written communication. Each of these areas ranked among the top twelve critical skills desired by the same employers; and, this list also included ethics, critical thinking, problem-solving, adaptability, technical skills, and diversity. In response to these increasingly evident gaps between what was being taught and what employers were looking for, the Biology department chose to develop an upper division required course for all majors that would integrate these competencies. The current study explores how the activities in this newly designed course affected the development of both professional skills and career efficacy for 150 students enrolled in six sections of BIOL 3920 at Tennessee Tech University (TTU).

Table 1

Employer ranking of career competencies (needed and actual) of recent TTU graduates

Competency	Employer Significance	Recent Graduates	Gap
Critical thinking/problem solving	4.58	3.59	-.99
Professionalism/work ethic	4.56	3.43	-1.13
Oral/written communication	4.43	3.41	-1.02
Teamwork/collaboration	4.43	3.96	-.47
Leadership	3.86	3.38	-.48

Note: Scores are based on a 5-point scale (1=not at all proficient; 5=extremely proficient).

The Course: BIOL 3920

Given the evidence from the employer surveys, the Biology department chose to create a course, starting with an intensive design process incorporating evidence-based teaching strategies intended to make the course student-centered and workforce-ready. The newly designed course focused on four thematic areas (drawn from the employer surveys): career management; oral and written communication; teamwork/leadership; and critical thinking/problem-solving. Each of these areas was integrated into an inquiry-guided learning framework that channeled the work of the students not only towards shared course learning outcomes, but also through tailored career pathways (Lazonder & Harmsen, 2016; Lee, 2012). Course activities included scientific writing assignments, a career portfolio, a research project, and group presentations; learning took place primarily through guided activities, instructor feedback, and peer interaction, with little to no lecture delivery.

Career Management

Over the previous 10-year period covered by the employer survey, the department had enhanced its overall curriculum to include a Bachelor of Science in Biology with four options (Botany, Marine Biology, Microbiology, and Zoology) as well as Biology degrees with concentrations in Cellular Biology, Environmental Biology, General Biology, Health Sciences, and a separate BS degree in Wildlife and Fisheries (WFS), the latter with three concentrations (Conservation, Fisheries, and Wildlife). The challenge for BIOL 3920 was not only to encompass each of these focus areas and their distinct career options, but also to support students within each of these

concentrations whose post-baccalaureate aspirations may take them to advanced study, directly to the workplace, or perhaps somewhere in between.

At first, the instructors assumed that career development could be handled through a partnership with the campus-based Career Services office. What they discovered was that such offices are by nature generalists, as they serve students from all over campus, and the students did not view their input as useful. The office was simply not well equipped to offer the specific guidance that upper division students needed to be competitive for positions in laboratories or with the U.S. Parks Service positions, both major employers of graduate from the program. As part of the design process, the instructors chose to outsource broad capabilities (e.g., video interviewing, resume writing) to the Career Services office but otherwise to provide multiple structures, or tracks, within the course to allow for differentiated goals and increased motivation (Wright, 2011). After consulting with the instructors on their skills levels and needs, students could choose between three tracks (graduate/professional school; applied/field position; and general/undecided), each of which had distinctive projects or activities associated with it. Students who chose the graduate school track, for example, would be tasked with development a statement of purpose, while students planning to apply for field positions immediately were tasked with conducting job research. At several junctures in the course, students received feedback from the instructor "coach" including ongoing reviews of their strengths and weaknesses relative to their chosen track.

Oral and Written Communication

Regardless of track, students in the course were expected to complete a significant number of assignments that incorporated oral and written communication, including short papers, abstracts, and class presentations. The instructors also chose to incorporate multiple rounds of feedback and revision, a practice strongly supported in the pedagogical research literature (Besley & Tanner, 2011; Duke, 2003; Jurin et al., 2010; Toit, 2012). Rather than listen to lectures, the students completed most writing assignments during scheduled class time in order for them to be able to ask questions and receive immediate answers and verbal feedback from the instructor, a subject matter expert, or their peers. The instructors also provided written feedback, and students were encouraged to correct and resubmit their work, practices also well supported in the literature (Hernández, 2012; Reynolds et al., 2012; Thompson & Blankinship, 2015). In addition to these in-class assignments, the instructors chose to center the course around a semester-long project, the results of which culminated in a public poster session in which students presented to an audience consisting other students, faculty, university leaders, and community members, a practice that had been implemented with success at other institutions (Tseng et al., 2013).

Teamwork and Leadership

To develop the skills needed to complete this project, the instructors organized the students into teams starting the first weeks. In keeping with best practices in team-based learning, the instructors worked to create teams of four to five students that included a variety of degree concentrations and career aspirations, with the intent of creating a diverse social learning environment that allowed students to practice building teamwork skills in an environment that mirrors many workplaces (Michaelsen et al., 2014; Sibley & Ostafichuk, 2015). The teams had weekly goals and assignments and expectations for sustained group communication both inside and outside of class. They held each other accountable to respective team members (through peer evaluation) and to the instructor (through their team leader). The instructors chose team leaders based on (1) displaying above-average writing skills on the first writing assignment, and (2) having a current resume (Gafney & Varma-Nelson, 2007). Those selected for leadership roles were given additional responsibilities within the team-based assignments, in exchange for which team leaders had fewer individual assignments to complete. As an added incentive, the instructors introduced a level of mild competition, offering recognition to those team leaders whose team project scored most highly with the external judges (Galbraith, 2012).

Critical Thinking and Problem Solving

Team leaders bore particular responsibility to navigate their team through the steps of the major library-based research project, which began with the selection of topics (Scaramozzino, 2010). In keeping with best practices of inquiry-guided learning, the students had the opportunity to provide input on possible research topics for their projects. The instructors led each class section through a brainstorming session in which students were invited to submit relevant, timely, and open-ended research questions and to suggest a minimum of two opposing viewpoints on the topic. From this list, the teams voted on which topics they wanted to tackle and identified roles for each team member, including those who would represent each of the differing perspectives on the issue. Project milestones, spread out across the semester, included the identification of relevant research; evaluation of evidence from multiple perspectives; a synthesis of current understanding (displayed on the poster); and evaluation of future solutions (Gormally et al., 2012). With the completion of each step, the instructors endeavored to give more control over to the students and their teams, allowing them greater freedom, flexibility, and responsibility with each step and a process of graduated self-directed learning that has proven to be effective in other STEM contexts (Ryan, 1993; Scott et al., 2017).

The Study

Our hypothesis was that the design of the course, including the integration of the pedagogical strategies discussed above, would prove to be effective in reaching the

learning outcomes of the course as well giving students career-ready skills and influence their attitudes towards those skills. To assess the impact of these changes on the students, the researchers designed a study, consisting of a pre- and post-assessment survey. The course sections were taught by three non-tenure track instructors each of whom used the same overall teaching strategies and assignments. Consistency was maintained through a shared LMS course shell and regular instructor team meetings. Institutional review board (IRB) approval was obtained to collect data using the surveys. The survey questions related to previous student feedback on the course and the characteristics valued by future employers. The pre- and post-surveys were administered using Qualtrics, an online survey program. Students completed the surveys during class time at the beginning and at the end of each semester. More specifically, students were asked to complete the pre-survey at the beginning of the first class meeting before the instructor discussed the course or its format. The post-survey was completed by students at the end of the last class meeting. Surveys for each of the three sections were completed during that section's scheduled class time, but within 24 hours of each other. The response rates for each survey ranged between 67% and 91%.; even at the low end, considerably higher than most student surveys at TTU.

The pre- and post-survey results were contextualized with supplementary data sources. The researchers also reviewed assignment rubrics to develop clearly stated learning outcomes, along with measurable tasks, that students could reference as assignments were completed. Student peer reviews were incorporated which involved reflection of teammate performance and self-evaluation. The university's teaching and learning resource personnel conducted small group analyses to gather perceptions of students, individually and as a group, regarding not only the course, but about their preparation to meet prospective employers' needs. Finally, institutional data on employer needs and student knowledge was taken into consideration. Comparisons between pre- and post-survey data, as well as those between students who had taken the course and the general student population, were made using *t*-tests.

The participants for this study included undergraduate students from the same university. Two semesters of data were collected from fall 2016 and spring 2017, which included a total of six sections and 150 students, all of whom were majoring in either Biology or WFS (see Table 2). "Pre" columns display data from surveys at the beginning of the semester; "Post" columns display data from surveys at the end of the semester, i.e., after students have completed the course.

Table 2

BIOL 3920 Student survey respondent demographics

	Pre Count	Pre %	Post Count	Post %
Total	137		101	
Gender				
Male	57	41.6	41	40.6
Female	69	50.4	47	46.5
Major/Concentration				
Biology/Biology	22	16.1	16	15.8
Biology/Environmental	3	2.2	1	1.0
Biology/Health Science	38	27.7	24	23.8
Biology/Cellular & Molecular	17	12.4	16	15.8
Wildlife & Fisheries/Wildlife	28	20.4	22	21.8
Wildlife & Fisheries/Fisheries	10	7.3	6	5.9
Wildlife & Fisheries/Conservation	9	6.6	8	7.9
Other	10	7.3	8	7.9
Career Track				
Graduate/Professional School	36	26.3	45	44.6
Applied/Field Position	13	9.5	35	34.7
General/Uncertain	17	12.4	20	19.8

Findings

Taken collectively, the survey results affirmed changes in the perceived value of the four components of the course: career management, communication skills, leadership/teamwork and critical thinking (see Appendix 1). That being said, the survey also showed that the students placed a relatively high value on these attributes prior to taking the course; as a result, the goal was not to change their minds, rather to find ways to help them reach these goals as effectively as possible.

Teamwork/Leadership

Employers seek employees who have strong teamwork abilities. For this reason, the design of this course placed particular importance on building team skills. According to students' responses on the survey (see Appendix 1), they perceived strong teamwork skills as valuable. Over the course of the semester, this perceived value increased from 91% to 98% among students. As part of an effective team, students were asked if they would be able to accept and provide constructive feedback. While both responses to these questions showed gains from the pre-test to the

post-test, students' ability to provide constructive criticism revealed 12% growth from 83% to 95%. The steepest gains related to teamwork came when students were asked to rank their current leadership skills. In the pre-test, students 78% ranked themselves as having very strong or fairly strong leadership skills. In the post-test, 92% of students reported having very strong or fairly strong leadership skills. This 14% gain demonstrates an increase in student confidence in leading a group. Female students reported having stronger teamwork abilities than males, especially at the beginning of the course, a finding which affirms other research that suggests females in STEM areas place high value on teamwork skills (Vaz et al., 2013).

Table 3

BIOL 3920 Student Survey: Responses by genders (questions related to teamwork)

	Male		Female	
Survey Item	Pre%	Post%	Pre%	Post%
Like competitive element of assignments (agree)	38	37	35	27
Strong leadership skills: self (agree)	86	95	74	89
Strong teamwork skills: self (agree)	89	98	94	98
Provide constructive criticism: self (agree)	82	94	83	96
Accept constructive criticism: self (agree)	89	95	94	96

As reflected in Table 3, strong leadership skills increased by 9% for males and 15% for females during each semester, as indicated by respondents. Male students experienced a greater increase in teamwork skills by 9% compared to 4% for females. Females also showed a drop in their support for competitive elements, a result which affirms behavioral studies of gendered preferences (Niederle & Vesterlund, 2007). The ability to provide and accept constructive criticism to peers also improved by 12% and 6%, respectively, for males and 13% and 2%, respectively, for females. From these results, it would appear that efforts to enhance students experience with and appreciation for teamwork skills were successful.

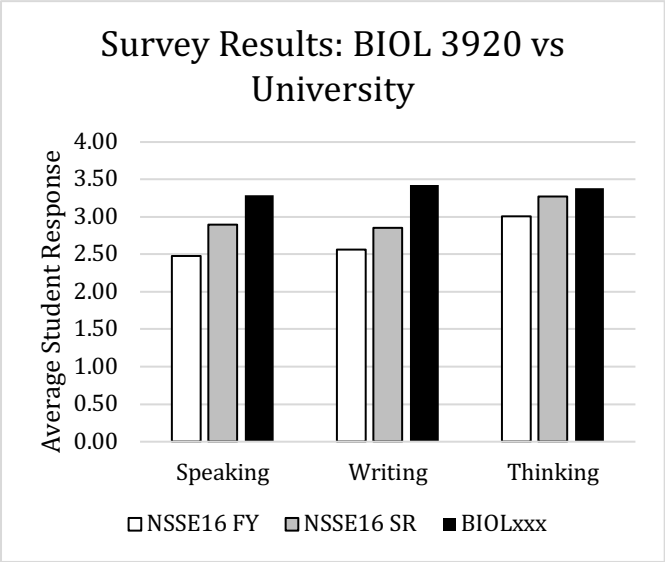
Communication and Critical Thinking/Problem Solving

The BIOL 3920 instructors sensed that the quality of student achievement in the areas of communication and critical thinking/problem solving had improved, but this assumption was difficult to test in the absence of a control group. One possible indicator came in the form of ongoing institutional assessment. Students at TTU participate in the National Study on Student Engagement (NSSE), which provides multiple questions focused on student perceptions of communication and critical thinking. BIOL 3920 was selected to be part of a campus-wide course redesign program focused on inquiry-guided learning; and part of the obligations for participating in that grant-funded program were to administer a separate course-

specific student survey that mirrored the NSSE survey questions. When compared to NSSE data for the institution as a whole, it appears that students enrolled in BIOL 3920 reflected significant gains in those areas associated with oral communication and critical thinking (see Figure 1 below).

Figure 1

Comparison of survey results among BIOL 3920 *students, university freshmen (FY), and university seniors (SR) for three categories (speaking, writing, and critical thinking)*



Note: Scores are based on a 4-point scale (1: Never, 2: Sometimes, 3: Often, 4: Very often), and averaged within category.

It should be noted that the NSSE is administered in alternating years to first-year students (FY) and graduating seniors (SR). Both sets of data are included for comparison (above) because of the wide range of students enrolled in the course. Although BIOL 3920 is intended to be a sophomore level course, the department had struggled to get students to enroll prior to their senior year, often resulting in logistical and enrollment log jams. Through increased efforts at advertising the course (including data collected in this study) and working closely with academic advisors, the instructors have succeeded in reversing this trend.

There are also potential implications of these findings for student recruitment and retention. A handful of exploratory studies have noted that a lack of emphasis or integration of communication skills (or perception thereof) has acted as a barrier to enrollment in STEM courses or majors, especially for students with backgrounds in the humanities and social sciences (Tobias, 1990). Similarly, inquiry-guided learning, and its emphasis on critical and independent thinking, has proven to be a factor in the retention of increased numbers of students from underserved

populations in STEM fields (Grandy, 1998; Mau, 2003). It could be interesting to conduct a follow-up study in which we track demographics with the long-term academic and professional trajectories of students who have completed this course.

Career Management

Speaking of long-term awareness, the researchers looked for indications that students not only had experience in developing professional skills, but that they understood the value of these skills in the marketplace. One survey question asked students to rank the attributes they believed were most desired by employers (see Table 4), and the post-tests showed students placing higher priority on skills related to leadership, team-building, and communication (three core course components) than they had prior to the course. Critical thinking, another of the core components of the course, showed no change in rank from pre- to post-, but remained the highest ranked of any attribute.

Table 4

BIOL 3920 Student Survey: Perception of attributes sought by employers

Most Important Pre Survey	%	Most Important Post Survey	%	Change in rank pre to post
Critical thinking	27.0	Critical thinking	26.5	0
Work experience of any type	15.6	Work experience of any type	13.3	0
Willingness to learn	10.7	Willingness to learn	10.8	0
Grade point average (GPA)	9.0	Professional references	7.2	+3
Positive Attitude	9.0	Team player	7.2	+4
Problem-solving ability	5.7	Grade point average (GPA)	6.0	-2
Professional references	4.9	Written communication	4.8	+3
Internships or co-ops	4.1	Internships or co-ops	4.8	0
Team player	3.3	Leadership	4.8	+7
Written communication	2.5	Positive Attitude	4.8	-5
Relevant technical knowledge	1.6	Self-motivation	3.6	+1
Self-motivation	1.6	Relevant technical knowledge	3.6	-1
Public Speaking	1.6	Problem-solving ability	1.2	-7
Ethics	0.8	Ethics	1.2	0
Data analysis & visualization	0.8	Volunteer work	0.0	+2
Leadership	0.8	Public Speaking	0.0	-3
Volunteer work	0.0	Computer literacy	0.0	+1
Computer literacy	0.0	Data analysis & visualization	0.0	-3

This value was reaffirmed by survey questions asking students to rank the usefulness of the course assignments. Rankings of assignments related to professional skills, especially those that incorporated team activities, rose over the course of the semester (p=0.029), indicating a shift in perceived value from 77.4% to 88.6% of assignments categorized as very or somewhat useful. Of the specific assignments (see Table 5), students perceived greater value in assignments related to professional development and team activities at the end of the semester (p≤0.026) with the exception of résumé writing and interview Q&A, both of which were facilitated by the University's Career Center.

Table 5

Usefulness of assignments as indicated by percentage of BIOL 3920 *students responding "Very Useful" or "Somewhat Useful"*

Assignment	"Very Useful" or "Somewhat Useful"	
	Pre %	Post%
Resume	96.8	98.9
Cover Letter	89.4	100.0
Interview Q&A	96.0	90.8
Team Presentation	69.4	87.5
Team Poster	44.3	70.9

At the beginning of the semester, pre-survey results showed that students strongly preferred having options when completing assignments and choosing topics for team projects at a rate of 89% and 85%, respectively. This is perhaps not surprising, as other studies have affirmed that the availability of choices fosters a sense of efficacy (Pintrich & Schunk, 2002; van Blankenstein et al., 2018). The BIOL 3920 students echoed that sentiment in the post-semester survey with an increased preference for choices at 94% for assignment options and 87% for topic flexibility, with noted increases for males (8–9% increase) and WFS Majors (14% increase). This latter is likely a reflection of the intended career outcomes for WFS majors, which are often less oriented towards advanced study but do include multiple types of employment, including work in both the public and private sectors.

These findings suggest a further inference about the students' locus of control. The inquiry-guided learning model posits that students should become increasingly self-directed over time, leading towards increasingly independent work and less guidance from the instructors (Adedokun et al., 2013). BIOL 3920 was structured this way, culminating in the final project over which the student teams bore large degrees of individual and collective responsibility for identifying, analyzing, and presenting their research findings. That being said, it was not known what influence this experience would have on students' confidence in their broader abilities to navigate the world beyond college. At first, the survey results appeared puzzling, as the remaining percentages (see Table 6) largely remained stable or showed only slight increases across the different majors and concentrations. When further correlated with career track, however, the most noteworthy gains were for students who were previously undecided, an outcome that indicates these students had found an increasing sense of direction through the course structure. This conclusion that affirmed in the written responses to formal course evaluation.

Table 6

BIOL 3920 *Student Survey: Options responses by major/concentration and career track*

	I would like to have options for assignments when fulfilling requirements for the course.		I would like to have flexibility in choosing my team's project topic.	
Major/Concentration	Pre-survey %	Post-survey %	Pre-survey %	Post-survey %
Biology/Biology	34.4	31.9	31.8	31.0
Biology/ Environmental	3.2	0.0	3.5	1.5
Biology/Health Science	52.5	49.6	57.8	47.7
Biology/ Cellular & Molecular	25.2	27.6	26.7	24.4
Wildlife & Fisheries/Wildlife	36.8	46.3	28.8	42.9
Wildlife & Fisheries/Fisheries	14.2	11.2	11.4	15.5
Wildlife & Fisheries/ Conservation	11.6	14.4	15.8	18.5
Other	22.1	19.1	24.4	18.5
Career Track				
Graduate or professional school	49.6	46.0	31.4	29.2
Applied or field position	21.2	20.4	21.9	22.6
General/Uncertain	23.4	22.6	3.6	11.7

Limitations and Discussion

This study was intended to explore how the design of this new course affected students' abilities and attitudes towards professional skills. Our findings suggest that the students increased their proficiency in four of the primary attributes valued by employers (career management, communication, critical thinking, and teamwork/leadership), regardless of gender or major. In addition, they became more likely to recognize those traits sought by employers and gained confidence in their ability to use these skills in the workplace.

These results should not be overstated. This study focuses on one course offered at a single institution over a three-year period, a circumstance which presents distinct limitations, challenges, and opportunities. The impetus to developing the fledglings program started with employer perceptions of career-readiness of recent graduates.

However, it will take more than three years to determine whether or not the program has made an impact outside of the classroom. The first cohort of Biology majors who participated in the new course graduated in spring 2016, but TTU conducts its employer surveys every three to five years, with the next iteration expected in spring 2018. Further, the survey results are reported in aggregate, and it can be difficult to pinpoint specific gains from a single program or major. NACE has recently conducted several STEM-specific surveys, and it might prove fruitful to follow their lead and develop a version of their work that could be administered in the primary service region of BIOL 3920 and/or to major employers of TTU graduates in STEM fields. Compelling evidence of success for the fledgling program will depend on our ability to capture the often-elusive prey of longitudinal data.

The study design also faced distinct challenges. The absence of a control group, a frequent challenge for scholarship of teaching and learning studies, was compounded by the fact that the course had no clear antecedent, as students were previously expected to acquire such skills largely in either extra- or co-curricular ways. We have used the institutional-specific employer survey as a proxy, but similarly to the issues with the NACE data referenced above, it is not possible to specifically map its findings directly onto the students covered in this study. In keeping with best practices for research of this kind, we did choose a pre- and post-test design to capture gains made throughout the course; but in the absence of a control, we are unable to state definitely whether or not similar gains could have been made with different instructional strategies. In the case of BIOL 3920, though, the primary issue at stake is not to choose between different methods of instruction per se, but whether or not such a course should be offered at all. In other words, the alternative would not be to change the instruction, but rather to change the curriculum to not include the course and to integrate the desired skills in other ways. We believe our study does make a strong case for including such a course in the curriculum.

The study also has limitations in its representation. TTU is a public STEM-focused institution—the only one in the state—and, as such, tends to draw students primarily from within and across the state. The majority of its graduates go on to work in the surrounding economic region, which includes Nashville and Oak Ridge, Tennessee. It is not yet known the degree to which this model may be replicable in other geographical and institutional contexts, but we hope that the promise of our preliminary results may serve to inspire others to do so. That inspiration may come from several sources. Biology is not the only discipline seeking to address the challenge of integrating professional skills into its curriculum, and it may also be possible to replicate these results by adapting the model not just into other STEM or STEM-related fields (Borzi & Mills 2001; Hannah et al., 2004), but perhaps many others. We encourage an open discourse across disciplines in order to prepare students for employers' expectations.

We recognize that it may take more than inspiration to replicate the fledgling model. Space in the curriculum is valuable real estate and the sacrifice of content- or disciplinary skill-focused curriculum to make room for a three-credit course on

professional skills may be more than some programs are able to accommodate. At several junctures, other faculty in the Biology department openly questioned the continuation of the course, particularly in light of increased priorities and employer demand in targeted disciplinary areas, such as health science. The U.S. Bureau of Labor Statistics (2015) indicates that healthcare is the fastest growing occupational field, projected to increase 19% from 2014–2024. While technical skills are fundamental, soft skills such as communication, teamwork, and time management heavily impact the satisfaction of employers, co-workers, and patients (Brookes & Baker, 2017; Oberlin et al., 2015). Part of the motivation for this study stemmed from the impetus to justify the need for time spent on these skills and provide demonstrable outcomes from the course. Similar conversations are likely going on across campuses as other disciplines are wrestling with adjusting the balance between career readiness and content knowledge within and across their curriculums.

This resistance from faculty was particularly pronounced after the first year, when the newly designed course garnered considerable negative feedback from the students. The instructors knew that the learning gains accrued through the design process, as reflected in the findings from this study, would be a moot point if these negative first impressions led to the course being canceled. Their strategy was to support the change with evidence. Researchers have posited the existence of an innovation curve, in which redesigned courses frequently undergo a dip in student evaluations followed by a subsequent rise over previous levels—a cycle which takes place over an approximately two-year period for regularly offered courses (Allen et al., 2001; Hodge et al., 2011; McCrickerd, 2012). Several studies have speculated on reasons why this occurs, with no single factor emerging as fully convincing, but the pattern appears to be impervious to differences in instructor, instructional methods, discipline, institution, level, or student population. BIOL 3920 affirmed this pattern, so the instructors were able to use the existence of the innovation cycle to counter both student and faculty pressure to discontinue the course.

The ability of the instructors to overcome resistance from both students and faculty is all the more remarkable when you take into consideration that none of the three instructors are tenured or even on tenure-track. The plight of adjunct faculty continues to make headlines (Green, 2007; Jolley et al., 2014), but there is an often-overlooked middle tier of faculty, those who teach full-time but have little or no research responsibilities (Baldwin & Chronister, 1996; Kezar & Sam, 2010; Levin & Shaker, 2011). All three of the faculty involved in the fledglings' program are full-time instructors on three-year renewable contracts; they are teaching faculty. On one hand, the contractual nature of their employment may pose a disincentive for them to lead potentially disruptive changes in teaching practice; on the other hand, teaching is their primary focus, which provides them with both the insight and motivation to lead the way in bringing evidence-based teaching and learning practices into their department and the field (Christodoulou, 2017). The fledgling project suggests that these faculty can serve as significant agents of change and that perhaps more could be done to empower others in similar roles to do so.

The fledgling project presents a potential model for the integration of disciplinary-focused professional skills into the Biology curriculum. This study largely affirms the efficacy of the curricular structure and strategies used to enhance not only those skills, but students' perceptions of the efficacy of such skills. This emphasis on perception may be related to an emerging thread of education research that focuses on the significance of non-cognitive factors, such as persistence, self-efficacy, judgement, and sociability, and their connection to improved academic and professional outcomes (Brinkmann et al., 2016; Burtner, 2005; Estrada et al., 2011; Hunter et al., 2007; Kreber, 2003; Mendez et al., 2008). In a related vein, advanced research has been conducted to identify and assess the degree to which students in STEM majors have developed an identifiable "scientific mindset" or way of thinking about science (Adams et al., 2006). This articulation of a disciplinary mindset can easily be extended to other fields, replacing them word "scientific" with the appropriate adjective. In some sense, though, this mindset may be more generalizable. The experience of the BIOL 3920 course, now having been taught over a three-year period, with its highly responsive pedagogical approach, suggests the possibility of the existence of an integrative mindset that brings together the traits associated with a growth mindset (such as persistence, self-efficacy, judgment, and sociability) with a distinctively disciplinary, in this case, scientific, way of thinking.

This fledgling mindset posits that a student can assimilate a set of discipline-based skills and then utilize those same skills in order to successfully navigate a long-term professional career for themselves. Because a mindset is a belief that precedes and underlies formal learning, it is often elusive to capture or assess. Our survey-based study examines different facets of the development of a fledgling mindset over the course of a one semester, discipline-specific career development course, but more work remains to be done to confirm the construct validity and replicability of our results. If the fledgling mindset can be identified through further practice and research, then perhaps it can also be learned and fostered through the guidance of many other mother birds, i.e., instructors. It may just be possible that if we teach them to believe that they can fly, they will.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

References

Adams, W. K., Perkins, K. K., Podolefsky, N., Dubson, M., Finkelstein, N. D., & Weiemann, C. E. (2006). New instrument for measuring student beliefs about physics and learning physics: The Colorado learning attitudes about science survey." *Physical Review Special Topics - Physics Education Research, 2*(1). doi:10.1103/PhysRevSTPER.2.010101

Adedokun, O. A., Bessenbacher, A. B., Parker, L. C., Kirkham, L. L., & Burgess, W. D. (2013). Research skills and STEM undergraduate research students' aspirations for research careers: Mediating effects of research self-efficacy. *Journal of Research in Science Teaching, 50*(8), 940–951.

Allen, G. K., Wedman, J. F., & Folk, L. C. (2001). Looking beyond the valley: A five-year case study of course innovation. *Innovative Higher Education, 26*(2), 103–119.

Baldwin, R. G., & Chronister, J. L. (1996). Full-time non-tenure-track faculty. *NEA Higher Education Research Center Update, 2*(5).

Baram-Tsabari, A., & Lewenstein, B. V. (2013). An instrument for assessing scientists' written skills in public communication of science. *Science Communication, 35*(1), 56–85.

Besley, J. C., & Tanner, A. H. (2011). What science communication scholars think about training scientists to communicate. *Science Communication, 33*(2), 239–263.

Borrego, M., & Henderson, C. (2014). Increasing the use of evidence-based teaching in STEM higher education: A comparison of eight change strategies. *Journal of Engineering Education*, *103*(2), 220–252.

Borzi, M. G., & Mills, T. H. (2001). Communication apprehension in upper level accounting students: An assessment of skill development. *Journal of Education for Business, 76*(4), 193–198.

Brinkmann, D., Harvey, J. E., Zou, C., Crosthwait, R. J., Elrod, C. C., & Flachsbart, B. B. (2016). Putting a business mindset into STEM education and career planning. *Issues in Information Systems*, *17*(2), 242–249.

Brookes, G., & Baker, P. (2017). What does patient feedback reveal about the NHS? A mixed methods study of comments posted to the NHS Choices online service. *BMJ Open, 7*(4). doi:10.1136/bmjopen-2016-013821

Brownell, S. E., Price, J. V., & Steinman, L. (2013). Science communication to the general public: Why we need to teach undergraduate and graduate students this skill as part of their formal scientific training. *Journal of Undergraduate Neuroscience Education*, *12*(1), E6E10.

Burtner, J. (2005). The use of discriminant analysis to investigate the influence of non-cognitive factors on engineering school persistence. *Journal of Engineering Education, 94(3),* 335–338. Retrieved from http://faculty.mercer.edu/Burtner_J/documents/08-EE025-04-5010.pdf

Cappelli, P. (2014). Skill gaps, skill shortages and skill mismatches: Evidence for the US. *IRL Review, 68*(2), 251–290. Retrieved from http://www.nber.org/papers/w20382

Carnevale, A. P., Smith, N., & Melton, M. (2011). STEM: Science technology engineering mathematics. *Georgetown University Center on Education and the Workforce*. Retrieved from https://cew.georgetown.edu/report/stem/

Christodoulou, A. (2017). Engaging in and with research to improve STEM education. *Research Papers in Education, 32*(4), 1–3.

Cornell, A., Gibson, K. F., & Williams, T. D. (2017). Physiological maturity at a critical life-history transition and flight ability at fledging. *Functional Ecology, 31*(3), 662–670.

Drew, D. E. (2015). *STEM the tide: Reforming science, technology, engineering, and math education in America*. JHU Press.

Duke, J. M. (2003). A web-based interface for student peer review, problem-based learning, and peer pressure. *Journal of Natural Resources and Life Sciences Education*, *32*, 52–56.

Ennis, T. (2014) *TTU Internal Employer Survey*. Tennessee Tech University.

Estrada, M., Woodcock, A., Hernandez, P. R., & Schultz, P. W. (2011). Toward a model of social influence that explains minority student integration into the scientific community. *Journal of Educational Psychology, 103*(1), 206–222.

Fairweather, J. (2008). Linking evidence and promising practices in science, technology, engineering, and mathematics (STEM) undergraduate education. *Status report of the National Academies National Research Council Board of Science Education.* Retrieved from https://nsf.gov/attachments/117803/public/Xc--Linking_Evidence--Fairweather.pdf

Felder, R. (2016). Rethink traditional teaching methods to improve learning and retention. *Journal of STEM Education*, *17*(1).

Feller, R. (2011). Advancing the STEM workforce through STEM-centric career development. *Technology and Engineering Teacher*, *71*(1), 6–12.

Gafney, L., & Varma-Nelson, P. (2007). Evaluating peer-led team learning: A study of long-term effects on former workshop peer leaders. *Journal of Chemical Education, 84*(3), 535–539.

Galbraith, J. (2012). Using student competition field trips to increase teaching and learning effectiveness. *Journal of Natural Resources and Life Sciences Education, 41*(1), 54–58.

Gormally, C., Brickman, P., & Lutz, M. (2012). Developing a test of scientific literacy skills (TOSLS): Measuring undergraduates' evaluation of scientific information and arguments. *CBE-Life Sciences Education*, *11*(4), 364–377.

Grandy, J. (1998). Persistence in science of high-ability minority students: Results of a longitudinal study. *The Journal of Higher Education*, *69*(6), 589–620.

Green, D. W. (2007). Adjunct faculty and the continuing quest for quality. *New Directions for Community Colleges, 2007*(140), 29–39.

Hannah, A., Millichamp, C. J., & Ayers, K. M. (2004). A communication skills course for undergraduate dental students. *Journal of Dental Education*, *68*(9), 970–977.

Hernández, R. (2012). Does continuous assessment in higher education support student learning? *Higher Education, 64*(4), 489–502.

Hodge, D. C., Nadler, M. K., Shore, C., & Taylor, B. A. P. (2011). Institutionalizing large scale curricular change: The top 25 projects at Miami University. *Change: The Magazine of Higher Learning, 43*(5), 28–35.

Hunter, A. B., Laursen, S. L., & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education, 91*(1), 6–74.

Jolley, M. R., Cross, E., & Bryant, M. (2014). A critical challenge: The engagement and assessment of contingent, part-time adjunct faculty professors in United States community colleges. *Community College Journal of Research and Practice, 38*(2-3), 218–230.

Jurin, R. R., Roush, D., & Danter, J. (2010). *Environmental communication: Skills and principles for natural resource managers, scientists, and engineers*. NY: Springer Netherlands.

Kezar, A., & Sam, C. (2010). Special issue: Understanding the new majority of non-tenure-track faculty in higher education–Demographics, experiences, and plans of action. *ASHE Higher Education Report, 36*(4), 1–133.

Komarraju, M., Swanson, J., & Nadler, D. (2014). Increased career self-efficacy predicts college students' motivation, and course and major satisfaction. *Journal of Career Assessment*, *22*(3), 420–432.

Kreber, C. (2003). The relationship between students' course perception and their approaches to studying in undergraduate science courses: A Canadian experience. *Higher Education Research & Development, 2*(1), 57–75.

Kulturel-Konak, S., Konak, A., Esparragoza, I. E., & Kremer, G. E. O. (2013, March). Assessing professional skills in STEM disciplines. *Integrated STEM Education Conference (ISEC).* Symposium conducted at the meeting of Institute of Electrical and Electronics Engineers, Princeton, NJ. doi:10.1109/ISECon.2013.6525216

Lazonder, A. W., & Harmsen, R. (2016). Meta-analysis of inquiry-based learning: Effects of guidance. *Review of Educational Research*, *86*(3), 681–718.

Lee, V. S. (2012). What is inquiry-guided learning? *New Directions for Teaching and Learning*, *2012*(129), 5–14.

Levin, J. S., & Shaker, G. G. (2011). The hybrid and dualistic identity of full-time non-tenure-track faculty. *American Behavioral Scientist, 55*(11), 1461–1484.

Lucy, C. A. (2017). Experiences and benefits of a career development course for undergraduate chemistry students. *Analytical and Bioanalytical Chemistry*, *409*(22), 5185–5190.

Mau, W. C. (2003). Factors that influence persistence in science and engineering career aspirations. *The Career Development Quarterly*, *51*(3), 234–243.

McCrickerd, J. (2012). Understanding and reducing faculty reluctance to improve teaching. *College Teaching, 60*(2), 56–64.

Mendez, G., Buskirk, T. D., Lohr, S., & Haag, S. (2008). Factors associated with persistence in science and engineering majors: An exploratory study using classification trees and random forests. *Journal of Engineering Education, 97*(1), 57–70.

Michaelsen, L. K., Davidson, N., & Major, C. H. (2014). Team-based learning practices and principles in comparison with cooperative learning and problem-based learning. *Journal on Excellence in College Teaching, 25*(3-4), 57–84. Retrieved from http://www.lhthompson.com/uploads/4/2/1/1/42117203/team_based_learning_-_group_work.pdf

Mohan, A., Merle, D., Jackson, C., Lannin, J., & Nair, S. S. (2010). Professional skills in the engineering curriculum. *IEEE Transactions on Education*, *53*(4), 562–571.

Niederle, M., & Vesterlund, L. (2007). Do women shy away from competition? Do men compete too much?. *The quarterly journal of economics*, *122*(3), 1067–1101.

NACE: National Association of Colleges and Employers. (2016). *Job outlook 2016: The attributes employers want to see on new college graduates' resumes.* Retrieved from http://www.naceweb.org/career-development/trends-and-predictions/job-outlook-2016-attributes-employers-want-to-see-on-new-college-graduates-resumes/

Oberlin, S., Chapman, S., Waneka, R., & Spetz, J. (2015). *Impact of the 2010 affordable care act on the California health care labor force*. Report from The Regents of the University of California. Retrieved from https://healthforce.ucsf.edu/publications/impact-2010-affordable-care-act-california-health-care-labor-force

Peng, H., Lin, Y. H., & Lin, C. J. (2017). Satisfaction evaluation of the effectiveness of the two models of specialty-oriented career planning course. *International Journal of Psychological Studies*, *9*(3), 51–63.

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation in education: Theory, research and applications* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall Merrill.

Prince, M., & Felder, R. (2007). The many faces of inductive teaching and learning. *Journal of College Science Teaching*, *36*(5), 14–20.

Reynolds, J. A., Thaiss, C., Katkin, W., & Thompson, R. J., Jr. (2012). Writing-to-learn in undergraduate science education: A community-based, conceptually driven approach. *CBE-Life Sciences Education*, *11*(1), 17–25.

Ryan, G. (1993). Student perceptions about self-directed learning in a professional course implementing problem-based learning. *Studies in Higher Education*, *18*(1), 53–63.

Scaramozzino, J. M. (2010). Integrating STEM information competencies into an undergraduate curriculum. *Journal of Library Administration, 50*(4), 315–333.

Scott, P. H., Veitch, N. J., Gadegaard, H., Mughal, M., Norman, G., & Welsh, M. (2017). Enhancing theoretical understanding of a practical biology course using active and self-directed learning strategies. *Journal of Biological Education*, *52*(2), 1–12. doi:10.1080/00219266.2017.1293557

Sibley, J., & Ostafichuk, P. (2015). *Getting started with team-based learning*. Sterling, VA: Stylus Publishing, LLC.

Thiry, H., Laursen, S. L., & Hunter, A. B. (2011). What experiences help students become scientists? A comparative study of research and other sources of personal and professional gains for STEM undergraduates. *The Journal of Higher Education*, *82*(4), 357–388.

Thompson, L., & Blankinship, L. A. (2015). Teaching information literacy skills to sophomore-level biology majors. *Journal of Microbiology & Biology Education, 16*(1), 29–33.

Tobias, S. (1990). They're not dumb. They're different.: A new "tier of talent" for science. *Change: The Magazine of Higher Learning*, *22*(4), 11–30.

Toit, E. (2012). Constructive feedback as a learning tool to enhance students' self-regulation and performance in higher education. *Perspectives in Education*, *30*(2), 32–40.

Tseng, K. H., Chang, C. C., Lou, S. J., & Chen, W. P. (2013). Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PjBL) environment. *International Journal of Technology and Design Education*, *23*(1), 87–102.

U.S. Bureau of Labor Statistics. (2015). *Occupation outlook handbook*. Retrieved from https://www.bls.gov/ooh/

van Blankenstein, F. M., Saab, N., van der Rijst, R. M., Danel, M. S., Bakker-van den Berg, A. S., & van den Broek, P. W. (2018). How do self-efficacy beliefs for academic writing and collaboration and intrinsic motivation for academic writing and research develop during an undergraduate research project? *Educational Studies, 2018*, 1–17.

Vaz, R. F., Quinn, P., Heinricher, A. C., & Rissmiller, K. J. (2013, June). Gender differences in the long-term impacts of project-based learning. *American Society for Engineering Education Annual Conference and Exhibition*. Symposium conducted at the meeting of American Society for Engineering Education, Atlanta, GA. Retrieved from https://www.asee.org/public/conferences/20/papers/6899/view

White, H. B., Benore, M. A., Sumter, T. F., Caldwell, B. D., & Bell, E. (2013). What skills should students of undergraduate biochemistry and molecular biology programs have upon graduation? *Biochemistry and Molecular Biology Education*, *41*(5), 297–301.

Wingate, U. (2006). Doing away with 'study skills'. *Teaching in Higher Education*, *11*(4), 457–469.

Wright, G. B. (2011). Student-centered learning in higher education. *International Journal of Teaching and Learning in Higher Education*, *23*(1), 92–97.

Appendix 1

Topic-Related Responses in Agreement with Statement by Major/Concentration

	Pre % Agree							
Statement	B/GB	B/EB	B/HS	B/CMB	WFS/W	WFS/F	WFS/C	Other
Career Management								
I would prefer resume workshops provided by experienced Biology professionals.	33.6	3.6	53.9	26.3	32.2	16.0	13.2	21.2
Prior to taking BIOL 3920, did you have previous professional work experience?	30.9	20.0	44.2	22.4	38.8	10.3	12.1	21.2
Communication								
I would like to work on writing and presentation assignments in class and getting immediate feedback.	27.6	3.2	46.5	26.3	41.9	22.4	13.6	18.6
I would have been better prepared if more feedback was received on writing and presentation assignments in other courses.	29.6	0.0	40.0	31.3	46.8	15.7	15.7	20.9
Teamwork/Leadership								
I would like to have an element of competition added to the assignments.	20.0	4.4	40.0	37.8	44.4	13.3	17.8	22.2
I would rate my current leadership skills as very/fairly strong.	26.2	4.3	61.6	23.8	42.6	11.6	12.3	17.6
I would rate my current teamwork skills as very/fairly strong.	33.5	3.1	56.7	23.1	37.1	12.2	10.7	23.5
I am able to provide constructive criticism to a peer about their work.	30.9	5.1	53.3	22.0	40.1	11.6	13.6	23.4
I am able to accept constructive criticism about my work.	30.0	3.7	55.9	21.9	39.3	14.2	14.2	20.8

Critical Thinking								
I would like to have options for assignments when fulfilling requirements for the course.	34.4	3.2	52.5	25.2	36.8	14.2	11.6	22.1
I would like to have flexibility in choosing my team's project topic.	31.8	3.5	57.8	26.7	28.8	11.4	15.8	24.4

Key: *B/GB: Biology/General Biology; B/EB: Biology/Environmental Biology; B/HS: Biology/Health Science; B/CMB: Biology/Cellular and Molecular Biology; WFS/W: Wildlife and Fisheries Science/Wildlife; WFS/F: Wildlife and Fisheries Science/Fisheries; WFS/C: Wildlife and Fisheries Science/Conservation.*

Topic-Related Responses in Agreement with Statement by Major/Concentration (Cont'd)

	Post % Agree							
Statement	B/GB	B/EB	B/HS	B/CMB	WFS/W	WFS/F	WFS/C	Other
Career Management								
I would prefer resume workshops provided by experienced Biology professionals.	40.9	1.6	50.5	19.4	45.0	12.8	17.7	12.1
Prior to taking BIOL 3920, did you have previous professional work experience?	33.7	6.7	44.5	41.0	29.1	8.2	10.7	26.1
Communication								
I would like to work on writing and presentation assignments in class and getting immediate feedback.	31.0	2.3	44.5	31.2	46.5	11.6	17.6	15.3
I would have been better prepared if more feedback was received on writing and presentation assignments in other courses.	39.3	2.6	54.3	34.1	41.8	8.8	11.4	7.7
Teamwork/Leadership								
I would like to have an element of competition added to the assignments.	47.1	0.0	20.7	24.1	31.0	3.4	36.8	36.8

I would rate my current leadership skills as very/fairly strong.	28.2	0.0	57.6	33.6	42.1	13.9	11.8	12.8
I would rate my current teamwork skills as very/fairly strong.	33.3	2.2	47.0	30.6	44.4	11.9	16.5	14.1
I am able to provide constructive criticism to a peer about their work.	31.0	1.9	46.1	33.7	41.6	12.5	16.6	16.6
I am able to accept constructive criticism about my work.	33.9	1.4	49.0	30.1	47.4	9.6	12.3	16.3
Critical Thinking								
I would like to have options for assignments when fulfilling requirements for the course.	31.9	0.0	49.6	27.6	46.3	11.2	14.4	19.1
I would like to have flexibility in choosing my team's project topic.	31.0	1.5	47.7	24.4	42.9	15.5	18.5	18.5

Key: *B/GB: Biology/General Biology; B/EB: Biology/Environmental Biology; B/HS: Biology/Health Science; B/CMB: Biology/Cellular and Molecular Biology; WFS/W: Wildlife and Fisheries Science/Wildlife; WFS/F: Wildlife and Fisheries Science/Fisheries; WFS/C: Wildlife and Fisheries Science/Conservation.*

Appendix 2: Student Survey Questions

1. In this course, what percentage of assignments have you heard were "busy work"?
    a. 0-25% b. 26-50% c. 51-75% d. 76-100%
2. Pick, drop, and rank the assignments by how useful you think they would be in preparing for your career.
    a. Online quizzes
    b. Technical writing
    c. Annotated bibliography
    d. Title and abstract
    e. Reference list
    f. Individual presentation or facilitated discussion
    g. Resume
    h. Cover letter
    i. Interview Q&A
    j. Group PowerPoint
    k. Technical communication
    l. Peer review of writing (resumes, cover letters, abstracts)
    m. Peer review of presentations (individual or group)
    n. Group poster
    o. Storyboard
3. In this course, I would like to have an element of competition added to the assignments.
    a. Strongly agree
    b. Mildly agree
    c. No opinion
    d. Mildly disagree
    e. Strongly disagree
4. In this course, I would have been better prepared if more feedback was received on writing and presentation assignments in other courses.
    a. Strongly agree
    b. Mildly agree
    c. No opinion
    d. Mildly disagree
    e. Strongly disagree
5. In this course, I would prefer resume workshops provided by experienced biology professionals.
    a. Strongly agree
    b. Mildly agree
    c. No opinion
    d. Mildly disagree
    e. Strongly disagree
6. In this course, I would like to have options for assignments when fulfilling requirements for the course.

   a. Strongly agree
   b. Mildly agree
   c. No opinion
   d. Mildly disagree
   e. Strongly disagree
7. In this course, I would like to have flexibility in choosing my team's project topic.
   a. Strongly agree
   b. Mildly agree
   c. No opinion
   d. Mildly disagree
   e. Strongly disagree
8. What is your major and concentration?
9. What is your grade point average (GPA)?
10. Prior to taking this course, did you have previous professional work experience?
   a. Yes, in a wage-earning position
   b. Yes, in an internship or co-op
   c. No
11. Which career path best describes your intentions after graduation?
   a. Graduate or professional school
   b. Applied or field position
   c. General (considering more than one option)
   d. Uncertain
   e. Other (please describe)
12. To the best of your knowledge, rank the importance of the following skills sought be employers when recruiting undergraduate students (most important skill= 1).
   a. Critical thinking
   b. Written communication
   c. Grade point average (GPA)
   d. Professional references
   e. Internships or co-ops
   f. Work experience of any type
   g. Volunteer work
   h. Willingness to learn
   i. Problem-solving ability
   j. Leadership
   k. Positive Attitude
   l. Team player
   m. Self-motivation
   n. Technical knowledge relevant to discipline
   o. Public Speaking
   p. Ethics
   q. Computer literacy

r. Data analysis & visualization
s. Click to write Item

13. I would rate my current leadership skills as:
    a. Very strong
    b. Fairly strong
    c. No experience
    d. Fairly weak
14. I would rate my current teamwork skills as:
    a. Very strong
    b. Fairly strong
    c. No experience
    d. Fairly weak
    e. Very weak
15. I am able to provide constructive criticism to a peer about their work.
    a. Strongly agree
    b. Mildly agree
    c. No opinion
    d. Mildly disagree
    e. Strongly disagree
16. I am able to accept constructive criticism about my work.
    a. Strongly agree
    b. Mildly agree
    c. No opinion
    d. Mildly disagree
    e. Strongly disagree