Student Learning Outcomes Assessment Summary

Biological Sciences, BA

College of Natural Science and Mathematics

2016-17 and 2017-18

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Background

The biological sciences degree programs seek to provide students with the disciplinary knowledge and skills necessary to succeed in the job market or advanced or additional study. The biological sciences BA program contains approximately 35 students. Most BA students report plans for additional, post-baccalaureate education. The majority of our students report that they plan to pursue a health-related advanced or additional degree after graduation (Fig. 1a), and about half plan a career in the field of human or animal health (Fig. 1b). Other areas of interest include research, environment, and wildlife biology.

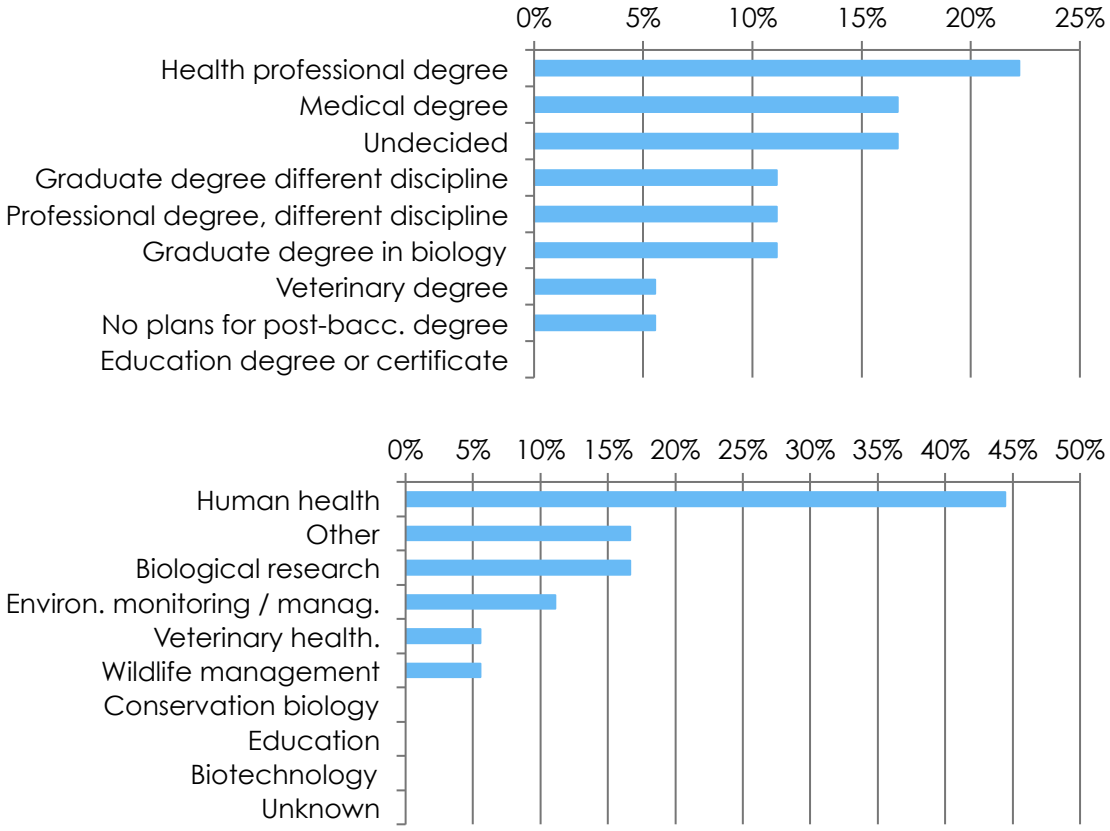

Fig. 1. Plans for post-baccalaureate education (a) and employment (b) reported by BA biological sciences majors in 2016 - 2018 (n = 12). Data were collected using a departmental survey of seniors in a required senior-level course.

1. Assessment information collected

1.1. Knowledge

Graduates of the Biological Sciences program should possess knowledge of core biological concepts, including evolution, inheritance and the expression of genes, cellular and organismal structure and function, and biologically-relevant pathways and transformations of energy. The Biology & Wildlife Department assesses knowledge acquisition using the Educational Testing Service's Biology Major Field Test (Biology MFT) (https://www.ets.org/mft/about/content/biology), which consists of 150 multiple-choice questions covering the major subject areas. The test has been administered every semester since 2010 to majors enrolled in a required, senior-level course, Principles of Evolution (BIOL F481). Our aim is to score above the 50th percentile of participating institutions across all major subject areas.

1.2. Communication and Information Literacy

Graduates of the Biological Sciences program are expected to communicate clearly and accurately about biological science in both oral and written form. In particular, the department aims to produce graduates who can read and interpret the published biological literature, argue convincingly from evidence, and write a report describing the findings of a biological study in the format of a scientific paper.

Teaching and learning about science communication takes place in required courses (BIOL F115X and 116X Fundamentals of Biology I and II, BIOL F260 Principles of Genetics, and BIOL F481 Principles of Evolution). These courses assign oral and written reports and provide feedback for improvement. Additionally, students are required to take a minimum number of elective upper division biology courses, many of which are communication-intensive.

We also assess our students' ability to communicate science in the required capstone project, which is described in more detail in section 1.5. Briefly, all students are required to perform an original research project and communicate the results to specialists and the public.

1.3. Quantitative Skills

Biological Sciences majors must be able to apply quantitative approaches to problem solving in biology. As with biological knowledge, the quantitative proficiency of Biological Sciences majors is assessed using the Biology MFT. Approximately 25% of the exam's 150 questions provide information on a student's analytical skills. Content covered by the test includes: experimental design; inductive reasoning; application of data to problem solving; units of measure; probability theory and statistics; and interpretation of graphs, tables, and statistical analyses.

The ability to successfully apply quantitative analysis to a particular scientific problem is assessed as part of the capstone project. Analysis and interpretation of data is a required component of the capstone project and is formally assessed as part of the standard evaluation (section 1.5; Table 1, assessment point 5).

1.4. Technical Skills and Collaboration

Biological Sciences majors are expected to be competent in basic laboratory skills and techniques. Instruction on the use of essential biological tools and practices is integrated into the laboratory exercises of three required lower division courses: Fundamentals of Biology I and II (BIOL F115X and F116X) and Principles of Genetics (BIOL F260). The instructors and TAs in these courses provide informal, formative assessment of technical proficiency. The only aspect of technical skill that is currently subject to summative assessment is biochemical lab work by within Principles of Genetics students, which is assessed in lab assignments, quizzes, and exams.

Biological Sciences majors are expected to collaborate effectively, leading to a productive outcome. Training in effective collaboration begins in the Fundamentals of Biology series (BIOL F115X and F116X) and continues in Principles of Genetics BIOL 260. Within BIOL 115X and 116X, students complete a total of three collaborative research projects. For each, students develop a group contract as part of their project plan in which they formalize their expectations. TAs review the plan, track the collaborative skills of the students, and provide formative assessment in the form of feedback. At the end of the project, students enforce their group contracts and have the option to impose penalties on group members who did not collaborate effectively, adding a summative component to the assessment. In Principles of Genetics, students conduct two major collaborative projects, one of which culminates in an oral presentation within which the quality of collaboration is scored.

1.5. Synthesis: The Capstone Research Project

The best evidence that a biologist can integrate knowledge and skills gained in coursework to solve problems using critical and creative thinking is the successful completion of a research project. The capstone project is an original, faculty-mentored research project chosen by the student and communicated within three assignments: a formal written report in the format of a scientific paper, a non-technical summary written for the public, and an oral presentation. All aspects of the project must be evaluated as "adequate" or better in order to fulfill this requirement. Students receive feedback from the instructor on all aspects of the assignment and may revise their work. Student projects are assessed with a standard rubric (see forms on the capstone website). Evaluation criteria for the final written report are listed in Table 1.

Students in the BA program are encouraged to incorporate their social science and humanities interests into their capstone projects.

Table 1. Evaluation criteria for capstone projects in the biological sciences. All twelve elements must be evaluated "adequate" or better in order to pass the capstone project.

	Final paper rubric
1.	Is the capstone project the product of data collection and/or analysis by the student?
2.	Does the capstone paper make a compelling argument for the significance of the student's research within the context of the current literature?
3.	Does the capstone paper clearly articulate the student's research goals?
4.	Are the methods appropriate given the student's research agenda?
5.	Is the data analysis appropriate and accurate?
6.	Does the author interpret the results skillfully and accurately?
7.	Are the tables and figures clear, effective and informative?
8.	Is there a compelling discussion of the implications of findings?
9.	Is the literature review appropriate and complete?*
10.	Are the citations presented consistently and professionally throughout the text and i list of works cited?
11.	Is the writing appropriate for the target audience?
12.	Is the paper clearly communicated and free of language errors?

2. Conclusions drawn from the information summarized above

2.1. Knowledge

Between fall 2016 and spring 2018, 12 students in the biological science BA program took the Biology MFT. The results are reported relative to students at >300 domestic institutions taking the exam during the same period (Fig. 3). Overall, students in the BA program scored poorly during 2016-17 (25th percentile), and better in 2017-18 (61st percentile) (Fig. 3). Scores tended to be highest in ecology and evolutionary biology (perhaps not surprising since the exam is administered within the evolution course) and lowest in organismal biology (physiology).

Fig. 3. Total biology MFT institutional percentiles of biological sciences BA students during the 2016-17 (n = 4) and 2017-18 (n = 8). The dotted line shows the department's benchmark for success.

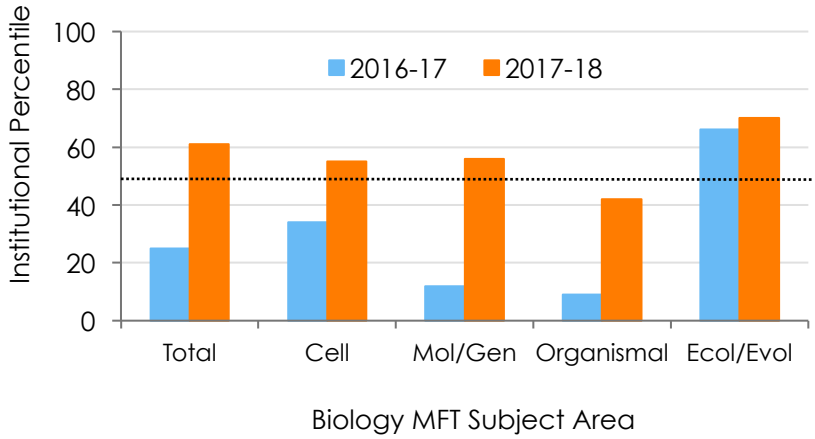

Fig. 3. Total biology MFT institutional percentiles of biological sciences BA students during the 2016-17 (n = 4) and 2017-18 (n = 8). The dotted line shows the department's benchmark for success.

BA students scored much lower than BS students during the period of record (total institutional percentile across the two years, BA: 44th, BS: 80th). As a consequence of their degree requirements, students in the BA program take fewer science and mathematics courses than their counterparts in the BS program; this may play a role in explaining the difference in their performance relative to the BS. It is also possible that students with less interest in, or aptitude for, math and physical science tend to choose the BA over the BS. However, there has been extreme variation in BA student performance over time (Fig. 4), which suggests that individual students have a strong influence on BA scores due to small sample sizes (Fig. 4).

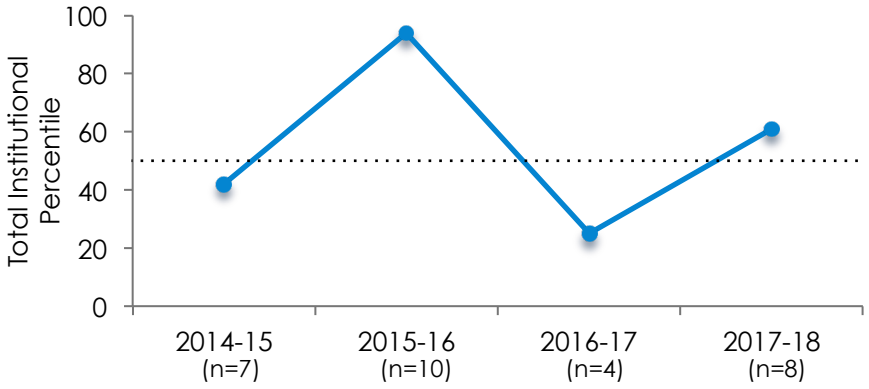

Fig. 4. Total biology MFT institutional percentiles of BA students across four years. The dotted line marks our benchmark for performance.

2.2. Communication

On the whole it appears that seniors in the BA biological sciences program can communicate science effectively. Instructors report wide variation in basic writing skills among students, which slows completion of the capstone for some students. Most students revise their project reports several times in response to feedback from the mentor or instructor, which provides an opportunity for learning. A possible shortcoming of our current approach is that the research instructor alone evaluates the project, and therefore differences in expectations among instructors may affect the assessment.

The five BA students successfully completing a capstone project during the period of record each delivered an oral presentation to the students and instructor in their capstone class. Students are also encouraged to present at UAF Research Day and at regional and national meetings, but these students did not choose to do so.

2.3. Quantitative skills

Overall, students across the biological sciences programs scored well on the analytical skills portion of the Biology MFT in both years: 89% in 2016-17 and 80% in 2017-18. This level of performance is similar to the previous reporting period. Because of sample size requirements, fine-scale indicators of performance on the Biology MFT such as analytical skills are not provided in a form that allows us to separate BA from BS students. Because the majority (88%) of test-takers were in the BS program, we have low confidence that these scores represent performance by students in the BA program.

2.4. Technical skills and collaboration

Instructors of Fundamentals of Biology I and II and Principles of Genetics report that students master the basic technical tools of biology within required lab classes. Summative assignment grades relating to biochemistry techniques within Principles of Genetics indicate that most students master that aspect of the course.

With regard to collaboration, coursework in required courses indicates that Biological Sciences majors are collaborating effectively on the whole. In Fundamentals of Biology I and II, student and TA evaluations of student group work indicate that students are generally successful collaborators. Students were able to identify what led to a successful or problematic collaboration, indicating the ability to identify successful collaboration and, in general, to achieve it. Over the past 3-4 years, >98% of students reported successful collaborative experiences. Rarely, collaborations were less than successful due to an individual student's disengagement from the course and failure to meet his or her obligations to the group, increasing the workload for others. In Principles of Genetics, the instructor reports that collaborative projects have also been generally

successful, albeit occasional problems caused - again - by the disengagement of an individual within a group.

2.5. Synthesis: The Capstone Research Project

Between fall 2016 and spring 2018, 5 students in the BA program completed capstone projects. All completed their projects within a designated capstone course, rather than working individually with faculty mentors. Four students studied mental health-related conditions using a mouse model. Two of these students were psychology minors, and thus the project integrated the major and minor areas of study. Two others pursued projects apparently unrelated to the minor. A fifth student, a double major in biology and elementary education, studied the efficiency of a local wastewater plant at removing pollutants. This small sample shows that BA students are choosing socially-relevant topics in for their capstone research, and that some students are choosing projects that integrate their major and minor areas of study. A list of capstone project titles is linked on the capstone website.

The capstone research project is proving to be an effective way to engage students in biology and assess their knowledge and skills in a synthetic way. Informally, students report that the project is a source of pride and accomplishment. We intend for the project to enhance our students' preparedness for graduate studies and professional positions in the discipline. However, we currently do not have the resources to track the professional fates of our undergraduates.

3. Curricular changes resulting from conclusions drawn above

Students in the biological sciences BA program are meeting the department's expectations for learning in some years, but performance on the Biology MFT was highly variable over time. Robust evaluation of trends is complicated by the small size of this student population.

A new capstone course in animal physiology is planned for the future, and may provide an opportunity to improve student understanding of organismal biology.

Students pursuing a BA should continue to be encouraged to integrate their social science and humanities interests into their biological capstone project, in order to improve the integration of their overall degree program.

4. Identify the faculty members involved in reaching the conclusions drawn above and agreeing upon the curricular changes resulting

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