Biology and Marine Biology Undergraduate Learning Objectives Assessment 2018-2019
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Overview

The Biology Department has previously engaged with institutional data around course completion and graduation rates, and directly assessed upper-level student learning outcomes in the area of molecular biology (2016-2017). At the 2017 annual Biology Department retreat there was call for directly assessing more general biology learning outcomes and doing so in a pre- post-test design. An appropriate peer-reviewed, reliable and valid general biology assessment instrument "GenBio-MAPS" was recently published (Couch et al., 2019). This instrument is directly aligned to our department's learning outcomes through the Vision and Change document that provides a nationally shared vision for undergraduate biology education (AAAS, 2011). We administered this instrument during the 2018-2019 academic year as a pre post-test design for students beginning and completing the honors or general biology sequences. We found evidence of student learning gains on department learning outcomes, and noted that our student test scores were similar to average scores in the nationally published dataset (Couch et al., 2019). The results reveal how the general and honors biology series differ with regards to incoming and outgoing student biology knowledge, and provide a useful reference for curriculum decisions.

Introduction

Nationally the conversation around biology education has been shaped by the Vision and Change in Undergraduate Biology (V&C) (AAAS, 2011) initiative backed by the NIH, NSF, USDA, AAAS and HHMI. V&C outlines core concepts and competencies that were formally adopted as the biology department undergraduate learning outcomes in 2017, allowing us to make use of validated assessment instruments developed and tested by biology education researchers. The GenBio-MAPS instrument is part of a NSF-funded BioMAPS (Biology-Measuring Achievement and Progression in Science) multi-institutional collaborative to develop assessments aligned to the V&C core concepts in different biology content areas (molecular biology, general biology, ecology and evolution, and physiology). The use of validated and broadly used assessment items will allow us to more rigorously evaluate our program, compare our program to other programs that are aligned to V&C, and meaningfully measure student outcomes in response to changes in the curriculum (e.g., quantitative literacy initiative, Learning Biology). The GenBio-MAPS instrument was designed to be sensitive to a range of student achievement levels, and administered before and after an introductory biology series, and before graduation.

Data collection and analysis

The GenBio-MAPs instrument consists of 39 question stems, of which students get a random sample of 15 question stems, each with 4 or 5 True/False (T/F) statements. Non-responses are counted as incorrect. Fractional scores (% correct) are calculated as a sum of correct responses divided by the total number of statements and presented as a percentage (%). GenBio-MAPS was administered as an online qualtrics survey assessment to students enrolled in the general and honors biology series during the 2018-2019 academic year. Students were given a small course credit incentive to complete the survey that was determined by their instructor. Pre-tests were administered in week 1 of Fall 2018 and Winter 2019 Bi211, and Fall 2018 Bi281H. Post-tests were administered in week 10 of Fall 2018 and Spring 2019 Bi214, Winter and Spring 2019 Bi213, and Spring 2019 Bi283H. Student pathways through the general biology series are non-linear as the prerequisite for Bi213 is Bi211, while the prerequisite for Bi214 is Bi211 and Bi212. As such, students exit the general biology sequence at various points or may take general biology courses concurrently, or in different orders. The results below only include students who have completed both Bi213 and Bi214 in the post-test category, however the study design does allow us to further investigate outcomes for students who have taken only Bi213 or Bi214. A large number of students in the intro series are human physiology majors who need only take Bi213 or Bi214.

Results

Students in both the general and honors series showed learning gains on department learning outcomes (Table 1). Although there is large variability among institutions, UO student test scores were similar to average test scores before and after introductory biology in the published national dataset (Table 1, Supplementary Figure 1, Couch et al., 2019). The average pre- and post-test scores for students in the honors series were higher than the general series (Table 1), and this trend held across content areas (Supplementary Figures 2 and 3). All student groups and majors showed learning gains but 1st generation college student gains were notably smaller (Tables 2 and 3). Since the post-test was only administered to students who completed the series these data mask known equity gaps for student success in the series.

Table 1. Pre and post-test scores for UO intro series (general, honors, or all combined) compared with nationally published dataset.

	Pre-test mean ± SD (N)	Post-test mean ± SD (N)	Difference
UO all (Gen. or Hon.)	61.8 ± 8.98 (484)	69.9 ± 11.8 (240)	+8.1
General (211-214)	61.1 ± 8.46 (442)	68.3 ± 11.4 (206)	+7.2
Honors (281H-283H)	68.5 ± 11.4 (42)	79.5 ± 9.76 (34)	+11
National study (Couch et al., 2019)	62.2 ± 10.3 (2425)	68.3 ± 12.0 (1832)	+6.2

Table 2. Pre and post-test scores for all intro series (general and honors) students and various student demographics.

	Pre-test mean ± SD (N)	Post-test mean ± SD (N)	Difference
UO all (Gen. or Hon.)	61.8 ± 8.98 (484)	69.9 ± 11.8 (240)	+8.1
Under-represented minorities	59.4 ± 8.04 (142)	66.1 ± 11.0 (63)	+6.7
English not spoken in childhood home	59.9 ± 7.79 (45)	67.3 ± 11.3 (25)	+7.4
1st generation college	60.0 ± 8.11 (120)	65.6 ± 10.3 (47)	+5.6
Transfer	63.2 ± 9.64 (74)	71.0 ± 11.5 (55)	+7.8

Table 3. Pre and post-test scores for all intro series (general and honors) students by major.

	Pre-test mean ± SD (N)	Post-test mean ± SD (N)	Difference
UO all (Gen. or Hon.)	61.8 ± 8.98 (484)	69.9 ± 11.8 (240)	+8.1
Biology major	61.9 ± 8.66 (115)	71.4 ± 11.6 (85)	+9.5
Marine biology major	62.0 ± 9.42 (36)	70.0 ± 14.3 (17)	+8.0
Biochemistry major (must take honors)	66.0 ± 11.4 (27)	77.6 ± 7.05 (13)	+11.6
Human physiology major	60.6 ± 8.17 (206)	68.2 ± 11.9 (73)	+7.6
General science major	64.5 ± 10.8 (27)	78.4 ± 9.69 (12)	+13.9

Conclusions and Future Directions

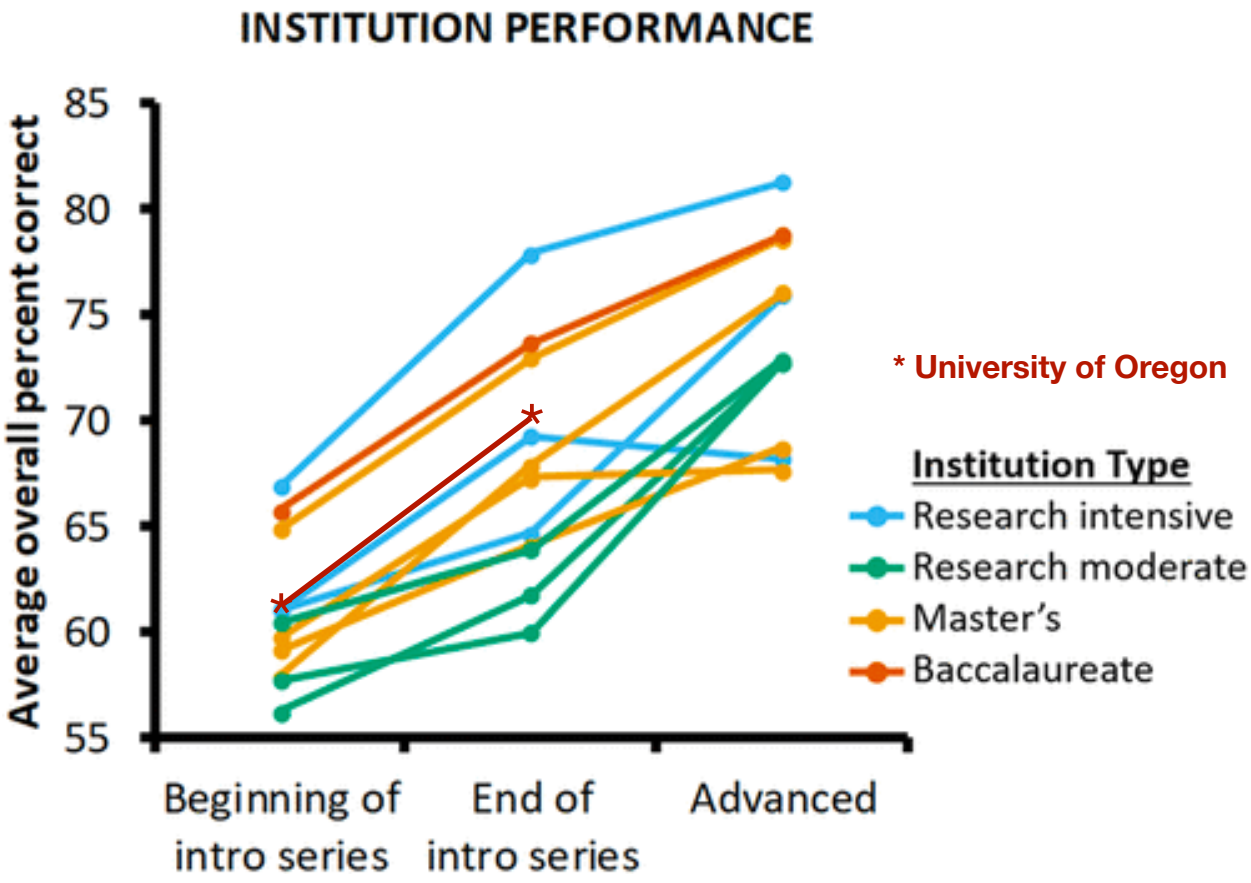
Although all student groups showed learning gains across the intro series, there are small differences among student groups in incoming biology knowledge, outgoing biology knowledge and magnitude of learning gains. First generation college students in particular appear to be underserved in intro series courses. It would be useful to investigate to what extent first generation students enroll in the supplementary learning communities currently offered (Class Encore, and Learning Biology). This assessment data gives us a useful reference to understand our students' biology knowledge and learning in the intro series. Instructors may be interested to investigate student performance on particularly relevant subject areas or test questions. Continuing to collect this data could help inform and evaluate any proposed curricular changes or interventions that might impact student learning.

In November 2019, department assessment strategies were discussed among the general biology instructors, department curriculum committee, and the biology faculty as a whole at the November 20th faculty meeting. There was consensus that it would be informative to use the GenBio-MAPs instrument to collect advanced timepoint data on student biology knowledge prior to graduation. This would also allow us to determine if UO students continue to track with average scores from the national dataset (Couch et al., 2019). Faculty also raised various other ideas for future assessment including assessing skills (eg. written, quantitative, critical thinking) and the impact of undergraduate research. There is also wide support for continuing work to understand equity gaps for minoritized student groups so that we can improve the undergraduate education of all our students.

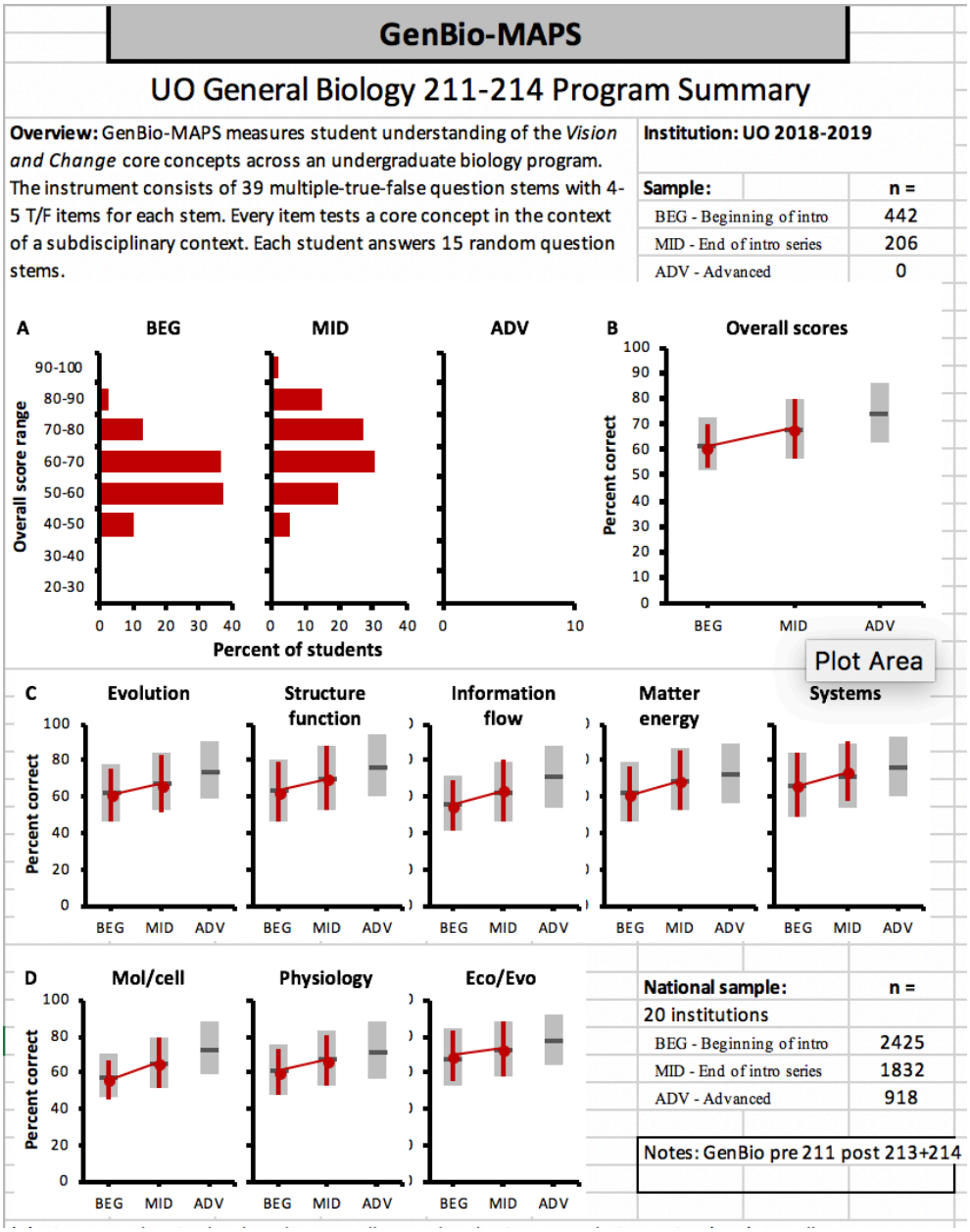
References

Couch, B. A., Wright, C. D., Freeman, S., Knight, J. K., Semsar, K., Smith, M. K., ... & Brownell, S. E. (2019). GenBio-MAPS: A programmatic assessment to measure student understanding of vision and change core concepts across general biology programs. CBE—Life Sciences Education, 18(1), ar1.

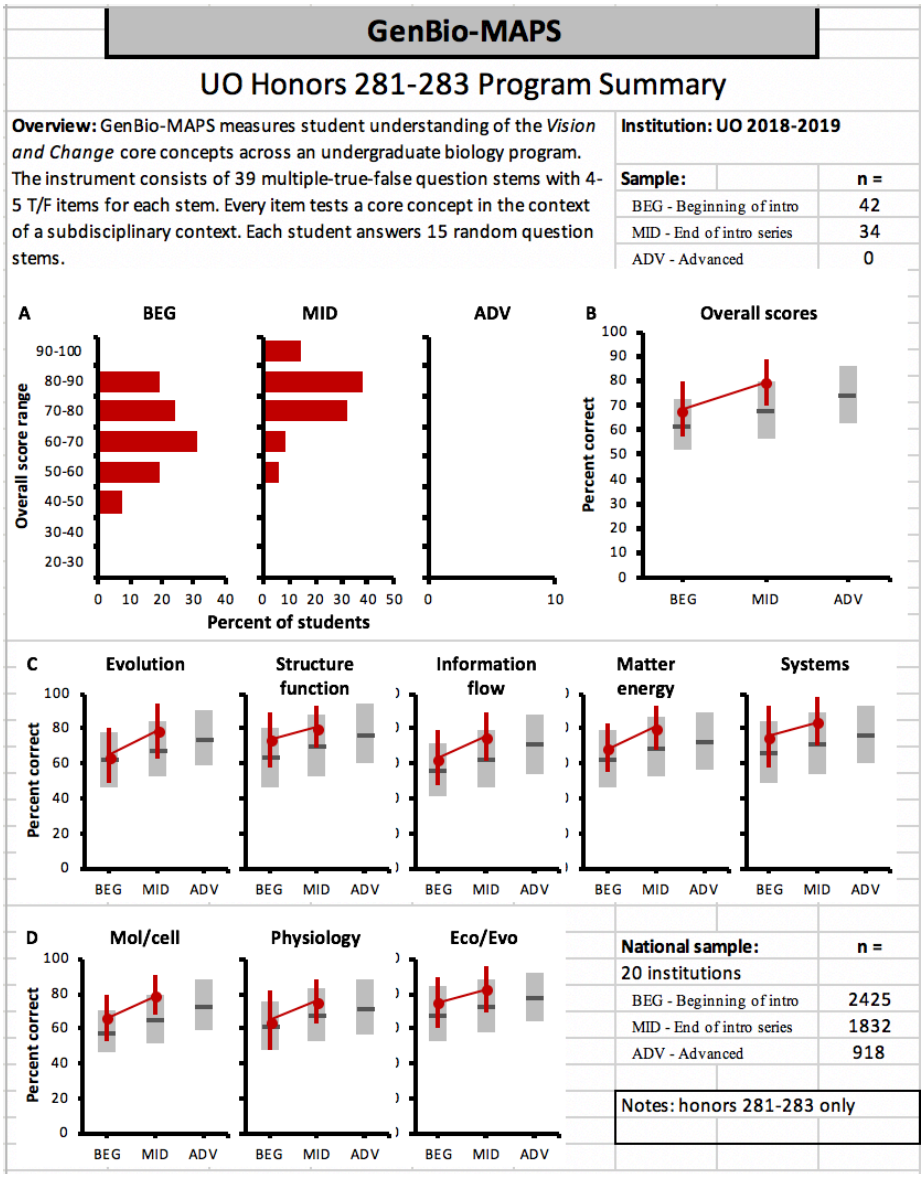
American Association for the Advancement of Science (AAAS). (2011). Vision and change in undergraduate biology education: A call to action, final report. Washington DC. http://visionandchange.org/files/2013/11/aaas-VISchange-web1113.pdf



Supplementary Figure 1. Adapted from Couch et al., 2019 Figure 4.
Student performance at different institutions across time points. Points represent average raw overall percent correct at the beginning of the introductory series, end of the introductory series, or advanced time points. Each colored line connects data from a single institution, and each series is colored based on institution type: blue, doctoral universities: highest research activity; green, doctoral universities: higher or moderate research activity; orange, master's colleges and universities: larger or medium programs; red, baccalaureate colleges: arts and sciences focus. (note: Our 2018-2019 biology assessment did not collect data at the advanced time point.)



Supplementary Figure 2. University of Oregon General Biology (Bi211-214) sequence GenBio-MAPS scores compared to national dataset (Couch et al., 2019). (A) Histogram showing UO general biology student overall score distributions at each time point. (B-D) Overall, core concept, and subdiscipline scores at each time point. Round dots and thin error bars represent UO means ± SD. Grey point lines and thick error bars in background represent national means ± SD. Advanced timepoint data not collected for 2018-2019 assessment.



Supplementary Figure 3. University of Oregon Honors Biology (Bi281H-Bi283H) sequence GenBio-MAPS scores compared to national dataset (Couch et al., 2019). (A) Histogram showing UO honors biology student overall score distributions at each time point. (B-D) Overall, core concept, and subdiscipline scores at each time point. Round dots and thin error bars represent UO means ± SD. Grey point lines and thick error bars in background represent national means ± SD. Advanced timepoint data not collected for 2018-2019 assessment.