Uncovering student learning in courses for non-science majors
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Introduction
Courses for non-science major students provide critical opportunities to share the value of science and promote a scientifically literate populace. To understand the content and goals of these courses, we looked at syllabi and final summative assessments of 15 non-science majors courses affiliated with the University of Oregon’s (UO) Science Literacy Program (SLP). SLP courses emphasize creating active learning environments where science is interesting, engaging, and relevant to students. Faculty hope to create opportunities for students to engage critically with complex topics so students can grow as scientifically literate global citizens.

We determined the emphasis of these non-science majors courses by coding syllabus learning goals and final assessments based on 1) Bloom’s cognitive levels (2,3,5,6); 2) NGSS Science Practices (7,8); 3) NGSS Crosscutting Concepts (7,8); and 4) Science Literacy Behaviors (1).

Method
Three raters scored each item on summative assessments from 15 non-science majors courses affiliated with UO SLP in the following categories: 1) Bloom’s taxonomy (2,3,5,6); 2) NGSS Science Practices (7,8); 3) NGSS Crosscutting Concepts (7,8); and 4) Science Literacy Behaviors (1). After practicing reaching consensus on one assessment, two raters scored each assessment independently. A weighted mean Bloom’s score for each assessment was calculated based on the average Bloom’s level between raters and relative point value of each question (5). Nominal data was weighted to reflect percent of assessment points that aligned to each category and then averaged among raters. Intraclass correlation (ICC) or Fleiss’ Kappa revealed moderate inter-rater reliability (Table 1). All syllabus learning goals and objectives were coded by at least two raters together to reach consensus.

Which cognitive levels are assessed in SLP courses?

Science Practices, Crosscutting Concepts, and Science Literacy Behaviors
The Framework/NGSS Science Practices and Crosscutting Concepts were developed through an iterative process with public review by an expert panel of scientists and science educators as the foundation for K-12 science education and standards (7,8). We used these two dimensions because they were designed to capture science literacy across the scientific disciplines and are now integral components of non-science majors prior science education. There are frequently multiple overlapping Science Practices and Crosscutting Concepts in assessment items and learning goals and objectives and items were coded for the top three categories for each dimension. The Science Literacy Behaviors were developed by an iterative process with UO science faculty and graduate students who contributed potential science literacy behaviors (1). The list of behaviors was further refined through student confidence surveys. The Science Literacy Behavior list was analyzed through a principal component analysis so each of the individual items is representative of science literacy as a whole.

Which Science Practices are assessed in SLP courses?

Which Crosscutting Concepts are assessed in SLP courses?

Science Literacy Behaviors

Use of science practices associated with Bloom’s levels

Limitations
This analysis only captures final, summative assessments. Other Science Practices, Crosscutting Concepts, and Science Literacy Behaviors may be emphasized in other course assessments.

Although we found a moderately high level of interrater reliability for the Bloom’s analysis, the interrater reliabilities for the Science Practices, Crosscutting Concepts, and Science Literacy Behaviors were moderately low.

Conclusions
SLP instructors have reasonable alignment between cognitive level on syllabi and final assessments. Greater alignment than published data (5).

Questions incorporating multiple science practices are associated with higher cognitive levels, which could be useful for future assessment development.

Life Sciences and Physical Sciences have similar distributions of cognitive levels with a larger fraction of application questions.

Science Practices are similarly distributed across Life and Physical Sciences with the exception of more math and computation in Physical Sciences and a lack of questions related to energy and matter in Life Sciences courses.

Science Literacy Behaviors are emphasized in syllabi but less so in final summative assessments.

Future Questions
What cognitive levels, Science Practices, Crosscutting Concepts, and Science Literacy Behaviors do students experience across all course summative assessments not captured in the final exams?

How do different types of questions (MC, T/F, long answer) align with cognitive levels and content?

Are there Science Practices, Crosscutting Concepts, and Science Literacy Behaviors that are often emphasized in particular disciplines within Life Sciences and Physical Sciences?

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References