Assessment of Scientific Reasoning Skills Learned from Lab Modules with Varying Degrees of Inquiry

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Extended Abstract

In addition to learning the facts and concepts of biology, we hope that our students are learning how science works as a process. This includes the reasoning skills required to form hypotheses, analyze data, and design experiments to test a given question. These skills are best learned in laboratory classes, where students can engage in the scientific process. Recent calls for reform in biology undergraduate education have urged a change to more inquiry-based laboratory classes. It is logically assumed that students learn scientific reasoning better from inquiry-based classes, however there are few controlled studies that have examined this. Furthermore, the degree of inquiry used in published lab modules ranges considerably. In guided inquiry labs, the instructor provides the question and experimental methods, whereas in open inquiry labs the question and methods are determined by the students, although both are considered inquiry-based. The assessment of most published inquiry lab modules has been uncontrolled or has made comparisons to labs with no inquiry. We have designed an assessment to measure scientific reasoning skills, and administered it to students before and after completion of our biochemistry lab course. Two versions of the main course module were rotated through the class in different terms, a low-inquiry version where instructor provided the experimental question and design, and a high-inquiry version where the students determined the hypothesis/question and designed the experiment.

The scientific reasoning skills assessment was able to measure pre to post-class gains across multiple classes taught by different instructors. Three of 5 classes assessed showed a statistically significant increase for the average score. The two high-inquiry classes showed statistically significant increases in student learning of scientific reasoning skills, with a small effect size as measured by Cohen's *d*. Two of the three low-inquiry classes showed no improvement or small, non-significant improvement in average score. However, the third low inquiry-class showed strong, significant improvement with a moderate effect size.

Keywords: science process skills, inquiry-based labs, scientific reasoning, assessment

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