Confronting the challenge of student understanding of experimental design with an open inquiry-based approach at a community college

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Background and Rationale:
The Skill: Experimental design is an important skill for students; it facilitates an understanding of how biological knowledge is generated and gives them the critical thinking tools to perform their own investigations. 1,2

The Problem: Students in introductory science often struggle to identify a central hypothesis and define experimental variables.

The Course: Principles of Animal Biology (4 credit lecture/lab) is a mandatory, first-year course in the veterinary technician (vet-tech, n=18) program at Madison College, a diverse community college. The course focuses on general biological principles, cell structure and function, genetics, comparative anatomy and physiology, evolution, and ecosystems. Students observe that this course is difficult and covers a great deal of content. The current laboratory curriculum contains the scientific method; however, many vet-tech students fail to identify experimental design principles and understand the real-world application.

Our Approach: Open inquiry-based activities are used to increase understanding by investigating topic-related questions that are student formulated. 3 In science education, an open-inquiry based approach promotes skill development. We designed an in-class activity to increase student understanding of experimental design by simulating authentic science exposure.

We hypothesized that a group activity would improve understanding of the scientific method to a common student-designed hypothesis; and, that group work would increase student confidence in this course.

Freedom to design lab experiments increased student confidence going into a difficult course:

Incorporation of group work into the first lab improved the learning community of the course:

Students were enthusiastic about lab’s impacts on process of and interest in science:

Lessons Learned & Recommendations:
- Open-inquiry and group work impact a common challenge across science courses, the fundamental understanding and importance of the experimental design process.
- In this project, we demonstrated that an open-inquiry activity paired with group work improves participation and increases student confidence in an introductory biology course.
- Additionally, the community college context of this project suggests a novel way to implement a new experimental design activity and assess its efficacy in a diverse undergraduate classroom.

Experimental design and ability test (EDAT) Implementation:
- EDAT evaluation of performance was largely unchanged (Mann-Whitney U=156.6 p=0.48, n=18)
- Some improvement in identifying main concepts (variables, controls) suggests student increases in learning.
- More guidance on EDAT was needed (including written directions). 1,2
- Other aspects including understanding the placebo effect, and sources of error remain challenges for students.

Project Limitations:
- Sample size should be increased
- Increase repeatability across multiple lab sections
- Add controls by comparing results of EDAT to previous lab activity participants

Table 1: Outline of project. We assessed student gains using the published and validated Experimental Design and Ability Test (EDAT) for use in undergraduate populations as well as a variety of pre- and post-survey tools. The EDAT is an open-ended prompt written to reveal students’ ability to design a simple experiment to test a product claim. Student responses are scored by looking for the presence or absence of nine key elements of experimental design.

Acknowledgments:
We would like to gratefully acknowledge: Dr. Devin Wixon, the Delta Internship Class of Spring 2016 for their insight and advice, Madison College, and Dr. Bethany Lucas.

References: