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Design of Inquiry-Oriented Science Labs: Impacts on Students' Attitudes

John M. Basey
University of Colorado-Boulder, John.Basey@colorado.edu

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Problem. What are the differential impacts of problem-based (PB) vs. guided inquiry (GI) lab styles on students' attitudes toward lab?

Background. Research indicates lab styles impact student learning; in particular, inquiry-oriented labs out-perform their traditional counter-parts (Hand et al. 2004, Luckie et al. 2004, Tamir et al. 1998). But how do different designs of inquiry-oriented labs impact student learning? Several styles of inquiry-oriented labs have been delineated and these lab styles may be a leading design-factor impacting student learning (Domin, 1999, Mohrig, 2007). Few studies have experimentally compared these inquiry-oriented lab styles, and no studies have experimentally evaluated relative influences of lab style in general versus other components of lab design (e.g. level of difficulty, coordination of lab with lecture, how exciting a lab is and how much students learn for the time they spend).

Sample/Location. The study was performed at the University of Colorado at Boulder (CU), USA in 2007 and 2008. The sample was primarily freshmen and sophomore science majors in introductory General Biology Lab – a one-credit-hour lab class associated with a three-credit-hour lecture. The lab had approximately 800 total students, taught by 24 graduate student teaching assistants who taught two sections of approximately 18 students each.

Treatments. Baseline labs were run in 2007. Between 2007 and 2008, I systematically altered several labs. Two were changed from GI to PB – Osmosis and Cell Phys. One was changed from PB to GI – Mendelian Genetics which was a computer simulation (Table 1). I attempted to equalize time and effort allocation of students by adding additional questions to the lab reports of GI labs.

Results and Discussion. When labs were not changed between years (control labs), student ratings did not change for any parameter (Table 2). Thus, the validity of a study design that changes lab styles between years is supported for a sample this large.

In 2 of 3 cases, students significantly preferred the GI format to the PB format (Figure 1). For the case in which students did not show a preference (Cell Phys.), level of difficulty and time efficiency were not significantly different (Table 3). Upon review of the Cell Phys. lab, the GI version had a challenging extension question designed specifically to improve understanding of lecture material. Students rated lecture help significantly higher for the GI version (Table 3). Thus, lab style (PB vs. GI) appears to have an influence on students' attitudes, however, other lab characteristics (i.e. time efficiency and difficulty) associated with lab style may be the cause rather than lab style itself.

When lab style (PB vs. GI) changed difficulty and/or time efficiency, students rated the less difficult and more time-efficient version significantly higher (Table 3). In 2 of 3 cases students found the PB version significantly more difficult and significantly less time efficient than the GI version, and level of difficulty was the factor that exhibited the greatest change in PB vs. GI labs.

In 2 of 3 cases, students found lecture help for the GI version to be significantly greater than for the PB version. Interestingly, in all three cases, the change between a PB and GI lab did not significantly influence excitement for the students. This indicates that excitement may be more related to characteristics other than lab style.

Conclusions. Lab style has an impact on students' attitudes toward lab. Reliability and validity of the survey were well supported (Bazy et al. 2008). In the survey students rated the following on a scale of 1 – 10 with 10 as the best: the overall lab, how much the lab helped with lecture (lecture), how exciting the lab was (exciting), how much they learned for the time they invested (time efficiency) and how easy the lab was (difficulty).

Observations in 2008 indicated TAs were not all implementing PB labs as they were intended. So I utilized a questionnaire for the TAs to determine the extent that PB labs were implemented as PB and not GI.

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Literature Cited


