Tested Studies for Laboratory Teaching
Proceedings of the Association for Biology Laboratory Education
Vol. 34, 287-289, 2013

Authentic Assessment Using Biology Laboratory Practicals

Kathy Winnett-Murray and Lori Hertel

Hope College, Department of Biology, Holland MI 49423 USA
(**winnetmurray@hope.edu; hertel@hope.edu**)

Extended Abstract

Authentic assessment tasks use real world contexts and are aligned with the assessment and content standards we create (Doran et al., 1998). In the context of gathering data to better understand the strengths and weaknesses of student learning (Angelo and Cross, 1993), the assessment cycle that the instructor employs becomes directly analogous to the process that scientists themselves employ in scientific research (D'Avanzo, 2000). Biology laboratory practicals present a great opportunity to authentically assess individual student achievement of laboratory and field skills and, where multiple lab sections characterize the institution, lend themselves well to the collection and analysis of data on student learning. Yet, lab practicals seem to have become less common over the past few decades while science education reform, and most of our colleges and universities, have indicated an increasing need for documenting our assessment strategies over the same time period.

Concerned by the challenges of individual accountability among students typically working in lab groups, and by poor retention of skills needed for more advanced biology courses, our department implemented an extensive, integrated program of skills assessment in 1998. We did this primarily by "resurrecting" the lab practicals that had fallen out of vogue decades ago, with a new twist: instead of evaluating student learning of (solely) content-based material, we created practicals in which we directly evaluate each student's ability to do pre-selected skills that we have collectively identified as being the most important things that all biology majors should be able to do (Table 1). For example, instead of evaluating students' ability to use a microscope with a fill-in-the-blank quiz on microscope parts, we have an instructor or undergraduate Teaching Assistant observe each student making a simple microscope slide preparation (e.g. a live mount of a *Paramecium*, or a cheek cell slide), and then we ask each student to focus on a particular cell at a certain magnification and show the grader for confirmation. This basic process is adapted to a wide range of skills (Winnett-Murray, 2007).

Best practices we have identified after more than a decade of skills assessment are: 1) intentional assessment of some of Skill Items 1,2,3 and 9 (Table 1) to allow "tracking" of student performance on skills in which the expectations are deliberately raised each semester; 2) designation of a departmental assessment coordinator, a faculty member who works with our departmental Administrative Assistant in the construction and maintenance of the assessment database, instructs colleagues on the skills to be assessed in each of the 3 introductory courses and submits Pass/Fail criteria to the Administrative Assistant (normally, a student is scored as "passing" a particular skill item when s/he earns a minimum of 75% of the points allotted to that particular skill; 3) requiring a departmental consensus to change, add, or delete a skill item in any course; 4) students receive a regular practical exam score (points scored out of points possible) to compute their grade, but the skills Pass/Fail notes are not used directly to compute the grade; 5) extensive preparation and planning including instructors sharing the task of writing, reviewing, and writing rubrics for the practical questions and being prepared with extra question set-ups where bottlenecks may develop; 6) extensive use of supervised undergraduate Teaching Assistants to deliver practice lab practicals, to proctor and participate in "on the spot" observational evaluation of students on the actual practical exams, and assistance with post-exam grading; 7) promoting consistency in grading through the use of detailed grading rubrics (both for "on-the-spot" grading and post-exam grading); 8) minimization of student stress via fun "break" stations, practice exams, and space use that prevents crowding and maintains security; 8) deliberate training of Teaching Assistants in the grading and marking of lab practicals.

We explored preliminary answers to the following questions using data derived from our Skills Assessment program: 1) Is skills performance correlated with grades? 2) Do students master some skills better than others? 3) Is there longitudinal variation (across years) in skill performance? 4) Is there latitudinal variation (among lab sections/instructors) in skills performance? 5) Do we make changes in our curriculum based upon feedback from the skills performance? 6) Do we provide feedback to students on their skills performance and do students use this information to improve their skills (e.g. in subsequent courses)?

The number of skills passed on lab practicals was positively correlated with student final GPA in the same course

(Spearman r = 0.642, df = 165, P < 0.01; sample analysis from Biology 260, Spring 2012) and with the total percent of course points earned by the student (Spearman r = 0.650, df = 165, P < 0.01; Biology 260, Spring 2012).

Our students master some skills better than others; in fact, throughout all exploratory analyses, Skill Item Number (Table 1) was consistently the most important predictor of pass rate. For all years and courses combined, there are some consistent differences in how well students perform on different skills (F = 7.73; df = 17, 255, P < 0.00001). Our strongest Skill Items (pass rates are typically more than 80% of students) were for Skills 2, 7, 8 and 12 (Table 1), whereas our weakest skill pass rates (often under 60% of students passing) were Skill Items 5, 6, and 15 (based on post-hoc Tukey tests in which P < 0.05). Communication skills were recorded "Pass" if a student achieved at least 75% of the points possible on that assignment; but these items were assessed via reports done independently of the lab practicals.

Longitudinal variation (variation in Skill Item pass rates among years) was generally very pronounced. In particular, we wanted to know if students improve their skills on those items (1,2,3, and 9) which were deliberately re-assessed in all three introductory courses. For these items only, we tracked the average skills performance of student "cohorts" as they entered their first fall semester class (Biology 240), their second class (Biology 260, spring semester), and their third biology class (Biology 280, fall semester), generating 9 such "matched" cohorts. Only Skill Item 2 "Computer Graphics" provided evidence in support of the predicted improvement in pass rate from the first through the third course (Friedman X^2 = 7.00, df = 2, P = 0.030). Our inability to document similar improvements in the other three skills assessed in all three courses probably derives from the different way in which we ask the questions each semester, as well as from the increased rigor with which we do so, which is often intentional. In addition, the types of instruments used to assess Skill Item 9 (Instrumentation) are different in each course.

Preliminary analyses exploring latitudinal variation (among lab sections) cautioned us to be particularly wary of concluding that differences in the average skills performance of students among lab sections are due to differences in the teaching effectiveness of the instructors, because we found some cases in which there were significant among-section differences even though course, semester and instructor were held constant. We speculated that non-random enrollment patterns of sections meeting on different days and at different times could account for some of these patterns. Support for this is also suggested by an independent analysis showing a significant correlational relationship between student total earned points in lab vs. lecture sections of the same class, in which all lab and lecture instructors were different individuals (F = 7.28, df = 1,6, r^2 = 0.548, P = 0.036; Biology 260, Spring 2012).

We have made several changes in the introductory biology lab curriculum as a result of the skills assessment, most notably in the way we have worked towards greater consistency in the way that we ask questions and grade them. Sometimes we have targeted improvements in a particular skill. For example, pass rates for Skill Item 10 Microscopy generally improved over the past several years as we deliberately devoted more time to develop those skills in the first semester lab. In another case, the pass rates for Skill Item 15 Plant Identification averaged less than 40% for several years prior to 2008, but have been over 60% annually since then as a result of directing more attention to consistency in grading those questions.

Perhaps our weakest response to the Skills Assessment is in providing individualized feedback to students. Although students normally receive information on their exam cover sheet for the skills they passed or not, we have not yet developed a mechanism to use individual performance data to assist students in improving skills where they have weak performance. Our assistance mechanisms remain generally aimed at opportunities for all students, rather than individually-directed.

Table 1. The Skills Assessment List

1. Hypothesis Testing*	10. Microscopy
2. Computer Graphics*	11. Dissection/Anatomy
3. Statistical Analysis*	12. Fruit Flies
4. Genetics Problems	13. Live Animal Handling
5. Dilution	14. Invertebrate Identification
6. Electrophoresis	15. Plant Identification
7. Weighing	16. Written Lab Report
8. Pipeting	17. Oral Presentation
9. Instrumentation*	18. Poster Presentation

*Items marked with an asterisk are assessed in all 3 introductory biology courses.

The departmental teamwork required to carry out this coordinated assessment plan, both within and across the three introductory courses, is immense, but in the end, we are confident that we know if each individual student can or cannot perform a certain task. Overall we feel that this has provided a greater level of authenticity to what we know about each student's abilities and performance in a lab setting that emphasizes group work.

Keywords: lab practical, assessment

Acknowledgements

All of our colleagues in the Biology Department at Hope College have assisted in collecting these data, and our Chair, Tom Bultman, has been instrumental in keeping us on task. Christopher C. Barney and K. Greg Murray assisted with certain statistical tests, and participants of the 2012 ABLE workshop at the University of North Carolina provided abundant helpful feedback.

Literature Cited

Angelo, T.A. and K. P. Cross. 1993. *Classroom assessment techniques: A handbook for college teachers* (2nd Edition). San Francisco, CA: Jossey-Bass. 448 pp.

D'Avanzo, C. 2000. Evaluation of course reforms: A primer on what it is and why you should do it. *Bulletin of the Ecological Society of America*. 81 (3): 206-209.

Doran, R., F. Chan and P. Tamir. 1998. *Science educator's guide to assessment.* Arlington, VA: National Science Teacher's Association. 210 pp.

Winnett-Murray, K. 2007. Resurrecting the Lab Practical, *in*: Mezeske, R.J. and B.A. Mezeske (Eds). *Beyond Tests and Quizzes: creative assessments in the college classroom*. San Francisco, CA: Jossey-Bass. 225 pp.

Mission, Review Process & Disclaimer

The Association for Biology Laboratory Education (ABLE) was founded in 1979 to promote information exchange among university and college educators actively concerned with teaching biology in a laboratory setting. The focus of ABLE is to improve the undergraduate biology laboratory experience by promoting the development and dissemination of interesting, innovative, and reliable laboratory exercises. For more information about ABLE, please visit **http://www.ableweb.org/.**

Papers published in *Tested Studies for Laboratory Teaching: Peer-Reviewed Proceedings of the Conference of the Association for Biology Laboratory Education* are evaluated and selected by a committee prior to presentation at the conference, peer-reviewed by participants at the conference, and edited by members of the ABLE Editorial Board.

Citing This Article

Winnett-Murray, K. and L. Hertel. 2013. Authentic Assessment Using Biology Laboratory Practicals. Pages 287-289, in *Tested Studies for Laboratory Teaching,* Volume 34 (K. McMahon, Editor). Proceedings of the 34th Conference of the Association for Biology Laboratory Education (ABLE), 499 pages.http://www.ableweb.org/volumes/vol-34/?art=16