Is formative assessment an effective way to improve learning? A symposium at Experimental Biology 2008

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Cliff W, Freeman S, Hansen PA, Kibble JD, Peat M, Wenderoth MP. Is formative assessment an effective way to improve learning? A symposium at Experimental Biology 2008. Adv Physiol Educ 32: 337–338, 2008; doi:10.1152/advan.90175.2008.—Formative assessment is designed to provide information about students’ learning to help them and their teachers to identify deficiencies and misconceptions. It differs from summative assessment, which aims to rank students according to their achievements to determine which students pass or fail or to assign grades to students. This article reports on a symposium concerned with evidence for the effectiveness of formative assessment in improving learning. It was presented by the Teaching of Physiology Section of the American Physiological Society at the Experimental Biology Meeting of 2008.

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The purpose of this symposium was to provide examples, analysis, and evidence of effects of formative assessment on students’ learning. Formative assessment aims to inform learners about their progress toward achieving the goals and objectives of a program. It is intended to foster learning, helping students to develop under conditions that are nonthreatening. It can give teachers information that allows them to identify and better assist students with academic deficiencies. The concept of formative assessment is firmly established in higher education, and the United States Liaison Committee on Medical Education (LCME) has a standard that states the following: “The directors of all courses and clerkships must design and implement a system of formative and summative evaluation of student achievement in each course and clerkship.” In this symposium, we showcased different approaches to formative assessment, with emphasis on the key properties of a successful formative assessment system and on research that evaluates whether or not formative assessment helps students perform better.

Penelope Hansen introduced the concept of formative assessment and differentiated it from summative assessment. William Cliff described how a review of student-generated concept maps can be used to provide meaningful formative assessment. Mary Pat Wenderoth described an approach combining the use of clickers and online homework to provide formative assessment and the impact of this system on student performance. Jonathan Kibble discussed the impact of providing incentives on student participation and performance when using unsupervised web-based quizzes and the relationships between formative and summative assessment outcomes. Mary Peat reported evidence that self-assessment and online modules, writing to learn, and virtual exercises enhance student learning.

Concept Mapping as a Window Into Student Understanding

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Concept mapping is a graphical means for students to make visible their understanding of conceptual relationships within a domain of study. As a learning tool, concept mapping encourages students to logically organize concepts and to appropriately interconnect them using labeled linking lines. An examination of student concept maps offers instructors the opportunity to 1) gain insight into the way that students structure knowledge, 2) identify both conventional and alternative conceptions, and 3) evaluate the complexity and validity of the conceptual ecology depicted in the maps. As such, concept mapping is a particularly useful tool for assessing student learning of physiology since mastery of body function requires considerable dexterity with conceptual interconnectedness. Concept maps can also serve as a means for the instructor to provide helpful feedback once assessment has been accomplished. Furthermore, when used in successive iterations, concept maps can document conceptual change as declarative knowledge is restructured and new concepts are progressively integrated. Thus, concept mapping can provide periodic displays of what students know about physiological systems and how knowledge is reorganized in meaningful ways as students grow in understanding.

Prescribed Active Learning Increases Performance in Introductory Biology

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We tested five course designs over two quarters of instruction in an attempt to lower the traditionally high failure rate in a gateway course for Biology majors. Prescribed active learning strategies included daily multiple-choice questions, which were answered with personal response devices (clickers) or cards. The questions covered the daily reading assignment, the previous class material, and three to four questions on current course material. Questions were written to test higher-order cognitive skills. In one section, one “clicker” question was randomly selected to be graded for each class period, whereas in the other section, no questions were graded but points were earned for just answering. As exams in the course were short answer, students were given weekly timed (30 min) written
exercises of exam-type questions done alone online or in a study group. Study groups were assigned so as to include one low, two moderate, and one high-risk (of failing) student. After turning in the assignment, students were given an additional 20 min to use an instructor-constructed rubric to peer grade a classmate’s work. Spot checking of peer grading showed reasonable adherence to the rubric. We found that the use of clickers in either a graded or nongraded format resulted in a high rate (95%) of class attendance and that increased attendance resulted in a significant decrease in the fail rate from 16% to 11%. There were no significant differences between exam scores of students who did weekly written homeworks alone online or in groups. The results from this study indicate that undergraduates starting their academic careers in biology benefit from a highly structured learning environment that provides incentives to attend class daily and that offers daily opportunities to practice, with immediate feedback from both peers and instructor, the scientific thinking required to gain a meaningful understanding of the material. This finding held true for both high- and low-risk students (2).

Using Unsupervised Online Quizzes as Formative Assessment

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Online quizzes are an efficient means of providing formative assessment tools that are well suited for use with large classes, where direct teacher-student interaction is limited. In a recent study of medical physiology students (3), I used a learning management system to deliver online quizzes to classes of ~350 students. Quizzes consisted of single best answer-type multiple-choice questions, which were designed to reflect the style, content, and difficulty of summative examinations. This study had two major goals: 1) to determine if unsupervised online quizzes have predictive validity with respect to the outcome of summative examinations and 2) to determine the effects of giving credit on student participation and performance.

A significant correlation was consistently observed between online quiz scores and subsequent examination scores. However, if no credit was given, only around one-half of students elected to use online quizzes as requested. Students who elected not to take online quizzes scored significantly lower on summative examinations than those who did use quizzes. Offering credit for taking quizzes in the range of 0.5–2.0% per quiz dramatically increased the rate of participation to almost 100%. However, there was evidence of widespread inappropriate use of quizzes; many students were able to score 100% using a single attempt at a quiz but subsequently performed poorly on the summative evaluation.

A followup study is currently underway at Memorial University in an undergraduate Human Physiology course. Preliminary data confirm that unsupervised online quizzes have predictive validity and that students electing not to take them do less well in summative examinations. However, by consistently encouraging student participation, it was possible to achieve 90% participation rates without offering incentives.

In conclusion, online quizzes provide students and teachers with a convenient and valid formative assessment tool. The decision by students not to take quizzes appears to be an indicator of likely lower academic performance. However, offering incentives is not recommended because it may foster inappropriate use of quizzes, which does not enhance examination outcomes.

Enhancing Student Learning: Evidence From “Down Under”

Mary Peat, University of Sydney, Sydney, New South Wales, Australia

From down under, I want to present some recent findings on how we have been supporting student learning by the provision of both online and offline resources with formative assessment opportunities. While we have investigated the ways in which students use our resources, and their perceptions of the usefulness of them (5, 7), we are now interested in whether the use of resources enhances student learning, as indicated by their performance.

We provided students with virtual biology (field trips, experiments, microscopy, and dissection) in some cases as opt outs but in all cases to provide revision “any time.” A study on real versus virtual dissections disclosed interesting commentary from students who identified the virtual experience as being most useful at helping with understanding functional anatomy but the real experience was essential in providing a three-dimensional experience, even though many students found the material distasteful to handle (1).

Research projects into the use of online formative assessments, including the impact they may have on student performance, have shown us that use of these resources has an impact on the final performance of students (6, 8). We have subsequently encouraged an increase usage of these by embedding appropriate exercises into the curriculum, by strong marketing of the resources during teaching sessions, and by handouts about what our research is showing.

More recent work is looking at how well we have blended our face-to-face teaching (lectures and laboratory classes) with the online materials and whether this is leading to more meaningful learning and conceptual understanding (4). While prior research indicated students viewed online resources as “add ons” (i.e., useful for revision), students are now reporting that the resources are central to their learning.

REFERENCES