

Taming the Testing/Grading Cycle in Lecture Classes Centered Around Open-Ended Assessment

By Jeffrey N. Schinske

Testing strategies centered around open-ended assessments are generally thought to result in deeper learning compared with close-ended questioning. However, the time requirements involved in grading open-ended assessments on exams often limit the feasibility of using such assessments. Here I present an index card questioning strategy designed to mitigate the grading workload associated with using open-ended assessments as a centerpiece of larger courses. This strategy additionally encourages collaborative learning, provides data on class progress, assists in identifying student misconceptions, and helps to align student and instructor expectations.

Challenging students with open-ended assessments allows them to engage in rich discussions, bring forth course content as evidence, and think like scientists. A wealth of published literature has indicated that open-ended assessments (also known as ill-defined problems, authentic tasks, learner-centered assessment, non-rhetorical questions, and challenge statements) result in deeper student learning compared with multiple-choice questioning (Bloom 1956; King and Kitchener 1994; Huba and Freed 2000; Wiggins and McTighe 2005; Slater, Prather, and Zeilik 2006). The use of open-ended assessments that encourage students to freely explore a variety of divergent solutions is additionally considered critical in providing access to traditionally underserved science students (Tobias 1990).

However, most science faculty use open-ended assessments sparingly, if at all, because of the large amount of instructor time required to grade such assessments, especially in lecture courses of greater than 30 students (for discussion of barriers to implementing related strategies,

see Allen and Tanner 2005; Herreid 2007). To create a more manageable testing and grading cycle while maintaining a classroom focus on open-ended assessment, I developed a novel index card questioning strategy, *Cards*. *Cards* maintains the benefits of open-ended assessment while mitigating the grading workload involved in evaluating student responses. Although index cards have a long history in education as memorization aides (flashcards) and sometimes as assessment tools (Angelo and Cross 1993,

pp. 236–239; Devet 1995; Butler, Phillmann, and Smart 2001), *Cards* represents a well-structured, course-wide assessment system. As described in the following section, *Cards* assists in achieving six important classroom goals (see Table 1, Figure 1).

Implementing *Cards*: A how-to guide for instructors

Materials

The instructor using *Cards* includes a note in the syllabus indicating students must purchase one pack of 3" × 5" index cards for use in class. Index cards come in packs of 100, which represents more than enough cards for the term (cost is generally under \$1 per pack). In class, the instructor indicates that students must bring their index cards with them to every course meeting, though the instructor may provide index cards to students during the first week of class.

TABLE 1

Goals of *Cards*.

1.	Promote a more manageable grading load for instructors using open-ended assessments.
2.	Create frequent, structured opportunities for collaborative learning.
3.	Gather information on individual student progress at a higher frequency than generally possible with exams or quizzes.
4.	Encourage students to voice, confront, and revise their misconceptions in a safe environment.
5.	Create opportunities to practice the process of solving open-ended assessments that emulate scientific inquiry.
6.	Assist in creating a clear, common set of expectations between instructor and students.

Surveying student ideas in class

During class, *Cards* roughly follows the “pair–share” format (Lyman 1981). First, the instructor presents students with an open-ended assessment probe (see Table 2), which students discuss in pairs or threes. During this stage, the instructor walks around the classroom and encourages discussion among less talkative students. The discussions continue for about four minutes, though the instructor may allow more time for particularly complex problems.

Next, the instructor asks students to take out an index card and place their name and the question number at the top. The instructor directs students to record their individual responses to the problem on the card, using words or labeled diagrams, and including as much relevant detail as possible. Depending on the complexity of the problem and the instructor’s expectations for student responses, students receive between four and eight minutes to write. The instructor announces the amount of time students will have to write, provides a one-minute warning, and expects students to promptly pass in their cards at the end of the allotted time.

TABLE 2

Sample open-ended assessments used in *Cards*.

Biological course	<i>Cards</i> assessment
Anatomy & Physiology	“Positive feedback loops create <i>good</i> changes in the body, while <i>negative</i> feedback loops create <i>bad</i> changes.” Do you agree or disagree with this statement and why?
Non-Majors General Education Biology	You run into your old friend, Joe, who tells you that he and his identical twin Jim got married to identical twin sisters! He says it’s going to be really crazy, because both couples are pregnant, so <i>his and Jim’s kids will also be identical twins!</i> Using your understanding of meiosis, how do you respond to Joe?
Organismal Biology for Majors	Create a <i>labeled diagram</i> showing the path of a drop of blood traveling from a fish’s heart, to the tip of its fin, and back. What structures and vessels does the blood pass through? How do the conditions of the blood change during the journey?
Non-Majors General Education Biology	“Lizards & Salamanders are <i>basically</i> the same thing, and are <i>very similar to each other compared to birds.</i> ” Do you agree or disagree with this statement and why?

Instructors generally allow students free access to notes and course materials throughout every step of this process. Even with their notes available, many students find it very challenging to collect their thoughts; communicate ideas with peers; and then synthesize their

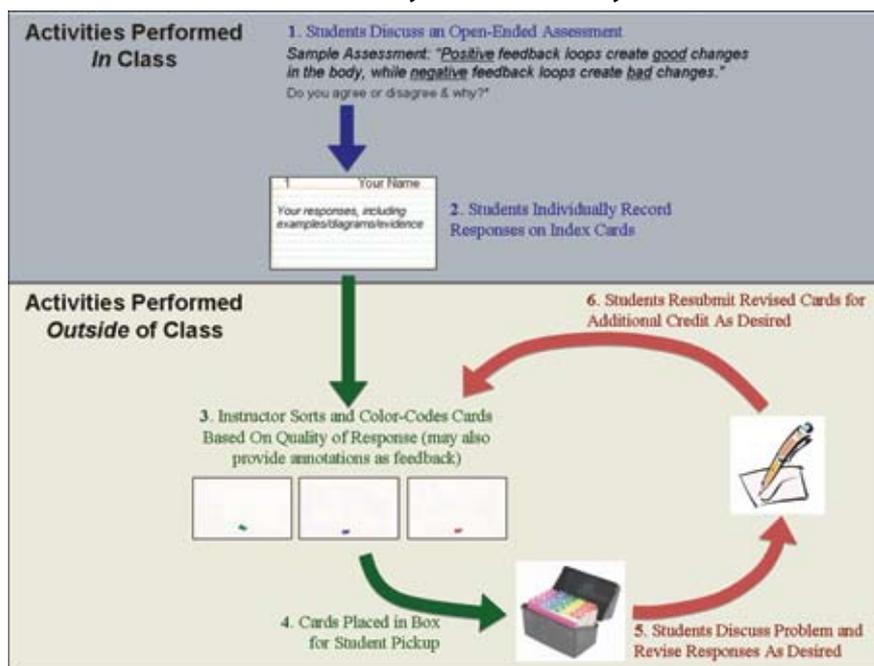
notes, conversations, and memories into a succinct and effective solution to an open-ended problem. However, some instructors choose to facilitate *Cards* with student notes restricted.

Sorting cards and tabulating results outside of class

After class, the instructor reviews students’ index cards with the goal of separating them into three piles. The instructor briefly identifies the concepts that would appear in a complete and well-reasoned student response. The instructor then skims approximately five cards in the stack to get a feel for actual student responses. On the basis of the instructor’s expectations and the initial scan of cards, the instructor mentally settles on the criteria for a near-complete response and a partially complete response. Using those criteria, the instructor scans all the cards and places them in piles corresponding to near-complete, partially complete, and off-track responses. The instructor assigns each stack a color (typically green, blue, and red respectively because markers of those colors come packaged together at office sup-

FIGURE 1

Overview of *Cards* (*assessment by Briana McCarthy).



ply stores) and marks the back of each card to indicate which stack it landed in. Those marks correspond to the different point levels that students receive (e.g., 10 points for green, 6 points for blue, 3 points for red). The instructor may or may not additionally provide short annotations (e.g., strategically placed question marks, underlines, Xs, and short prompts) on the blue and red cards to give students a clue as to the parts of their responses that could use improvement or clarification.

The instructor then places students' index cards into boxes available during all class sessions and office hours. At any of those times, students may retrieve their cards and see the color of the mark they received. The color-coded marks appear on the bottom, back side of each card, such that students cannot easily see each other's scores when looking for their card.

Reviewing students' revised responses outside of class

At the beginning of the course, the instructor assures students that they

will each likely receive some blue and some red marks during the term, but that should not cause them concern. This is because every student can revise blue and red cards for additional credit (up to 8 points total in the system outlined previously). This provides a clear incentive to encourage students to reflect on their work and revise their understanding when necessary. Blue and red cards initially receive a relatively low number of points specifically in hopes that students will wish to raise those scores through revision. After collecting an index card in class, the corresponding question is posted online for students to refer to while considering their revisions. Figure 2 shows examples of actual students' revised/resubmitted index cards.

In revising their cards, the instructor encourages students to talk with each other and to consult with the instructor directly during office hours if desired. Because open-ended assessments often have more than one defensible solution, students cannot

simply copy a classmate's card for additional credit. Their classmate's viewpoint might not match their own and likely contains subtleties that will appear awkwardly out of place when directly transcribed over their previous response. Because students may have lingering misconceptions on certain topics, some students' index cards must be resubmitted and revised more than once prior to awarding of additional credit. The iterative process of revision creates a nonthreatening and gradual process for aligning student and instructor expectations throughout a course.

Additional benefits and logistical considerations

Using students' ideas to adapt instruction

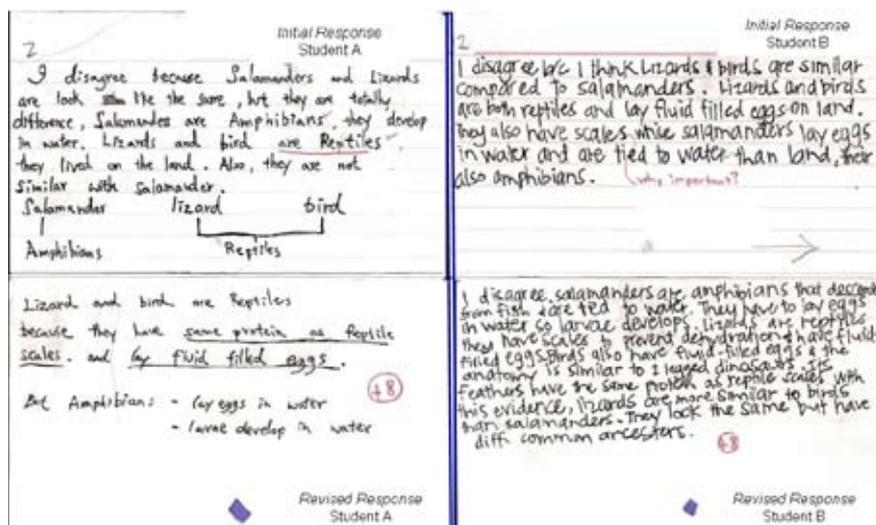
Qualitatively noting the number of cards sorted into each pile during the sorting/tabulation phase previously described provides instructors with quick and valuable information on student understanding. If the instructor finds very few cards in the near-complete response (green) pile, he or she might review the related concepts in the next class using a different strategy than the first time. The cards allow the instructor to project anonymous quotes from students in class, which student pairs/groups can critique. In this way, students have the opportunity to view and confront common misconceptions stated in their own language. If the instructor finds a sufficient number of cards in the near-complete pile, the instructor can feel confident that students understood the assessed topics.

Cards as a tool for scoring student attendance/participation

When performed regularly throughout a course, *Cards* eliminates the need for an attendance sheet. If a student fails to hand in a card on a given day, the instructor has proof of that student's absence at that time. The instructor simply notes the date of each

FIGURE 2

Two students' initial (partially complete) and revised responses to the challenge statement, "Lizards & salamanders are basically the same thing, and are very similar to each other compared to birds." The concept of birds as reptiles is accepted as a "correct" response in this assessment. Though we sometimes discuss modern reptiles separately from modern birds, birds are considered reptiles in the broader evolutionary context and in the textbook used for this class (see example in Reece et al. 2011, Figure 34.25 and surrounding text).



index card in the grade book, such that any blank cells correspond to a student absence. Students learn that the instructor may request index cards from them at the beginning, middle, or end of class. This means students must attend the entirety of each class period if they do not want to miss out on index card and attendance credit. Except in special circumstances, instructors generally do not allow absent students to make up index cards, as they miss the opportunity to teach and learn from their peers in class.

Size of index cards

Having all students use the same size of cards greatly facilitates the storage, sorting, and distribution of cards. One of the handy aspects of 3×5 cards is their limited amount of writing space. This provides a physical limitation to the amount of words students can use to respond to a prompt. As a result, students must think more carefully about which salient points relevant to the question they wish to communicate, and they must use more clear and direct language to express those ideas (see also

the similar “microthemes” of Leahy 1994; Collins 2004). The physical limit on response length also helps to keep the review of index cards manageable in an instructor’s teaching and prep schedule.

Assessment types most appropriate for Cards

Some index card assessments are more time-consuming than others to sort after class. When first implementing the strategy, some instructors report taking almost two hours to sort cards for a 70-student class, but the process becomes much faster—requiring under an hour—as instructors gain fluency with the technique (see also *Reflections by Instructors* section). Assessments requesting labeled diagrams are generally much easier to sort than assessments that require only writing. Extremely broad or complex assessments lend themselves better to exams than to index cards, where responses must be sorted quickly into only three categories. Therefore, assessments requesting diagrams, or those whose optimal

answer can be expressed in a few sentences, provide the richest data in an efficient amount of time.

Assessing Cards

To understand the impacts of *Cards* on both students and instructors, I assessed *Cards* in four ways: (1) analysis of midterm feedback responses in three different community college biology courses, (2) surveys regarding rates of resubmission of index cards, (3) analysis of customized end-of-class feedback forms, and (4) review of reflection papers from other instructors implementing *Cards*. The assessments took place over three terms in classes including a general education biology course for non-majors (“Non-Majors”), an introductory organismal biology course for majors (“Majors”), and an anatomy and physiology (“A&P”) course for allied health students. All of these courses served more women than men (60% women overall), and the majority of students (65%) spoke a language other than English as their first language.

TABLE 3

Sample student responses to “What aspects of this course have most supported your learning of biology so far?”

Cards goal illustrated (Table 1)	Student type	Student response
2	Non-Major	The process that you use of having us think about a question, talk to a person next to us, and then to discuss it as a class. This allows us to always be engaged—we hear it, talk about it, see it, and write it, which makes it a lot easier to learn and remember.
2, 3, 4	A&P	I believe that writing the index cards during lecture helped to ensure that we understood a topic and get the clarifications if needed.... I feel that working and answering questions together in lecture helped to further understanding. I enjoyed the real-life applications because connections could be made that allowed me to remember topics better.
4	Major	I really like the index card assignments.... This is where I can reflect on what I think I know, and know what ideas or misconceptions I need to fix. Having to think, write, draw, and explain on index cards really helped me understand better.
4	Non-Major	Another [supportive] aspect [of the class] for me would definitely be the index card process that I used to my full advantage to study from/refresh my thoughts.... There never seem to be any “wrong” answers, rather answers that just need more elaboration.
5	Major	I like the index cards, because they make me write concisely and use lots of evidence.
6	A&P	The index cards are like a review quiz and a study guide. They show me what I do and do not know and get me back on track to the main ideas.

Note: A&P = Anatomy & Physiology.

Student midterm feedback

At the end of the first midterm exam, I asked students to answer the following question: What aspects of this course have most supported your learning of biology so far? Although nothing in the question specifically instructed students to discuss in-class teaching methodology, 51% (30/59) of Non-Majors, 48% (32/67) of Majors, and 41% (27/66) of A&P students specifically discussed the index card strategy as most supportive of their learning. These students described how *Cards* benefited them, including specific reference to many of the goals outlined for *Cards* (see Table 3).

Index card resubmission rates

In my Non-Majors class, I noticed that only 30% of index cards eligible for resubmission actually were revised and resubmitted by students. Although the previously described data implied students valued the strategy, I wondered why more students did not take advantage of the ability to revise their ideas for more credit. In order

to probe this question and attempt to raise resubmission rates, in my Major and A&P classes, I asked students to anonymously respond to a brief survey at midcourse. On a spare index card, students (1) indicated whether they felt *Cards* represented a helpful strategy to them, and (2) wrote either “I have resubmitted all my eligible index cards so far,” or “I have *not* yet resubmitted all my eligible index cards because . . .”

One hundred twenty-one of the 125 student respondents in those courses indicated they valued *Cards*. The most common excuses for *not* having turned in all index cards included distractions/assignments in other classes and the need for further personal content review. Those students indicated that they still liked the process and hoped to resubmit their cards shortly. This indicated to me that, although some students fail to resubmit cards, even those students value the strategy and feel *Cards* assists their learning. The midcourse reminder about card resubmission also appeared to spur more students to take advantage of that opportunity; 82% of index cards

eligible for resubmission in my Majors class were revised and resubmitted and 65% of eligible cards in my A&P class were resubmitted. Because the resubmission process represents an excellent opportunity for learning, I therefore recommend having students somehow briefly reflect on the status of their index cards midway through the course.

Student end-of-class feedback

Following my Non-Majors course, I wanted to better understand how every student perceived *Cards* to impact their learning—not just those students electing to discuss the technique in midterm feedback. On the final day of class, my Majors and A&P students completed anonymous written surveys. I asked students to circle *disagree*, *somewhat disagree*, *neither agree/disagree*, *somewhat agree*, or *agree* to the following statements: (1) “Being in Mr. Schinske’s class included answering questions on index cards,” and (2) “If I found out that I could take another class that used index card questioning like Mr. Schinske did,

TABLE 4

Instructors respond to the question, “Why do you use index cards in your classes?”

[Using <i>Cards</i>] spread[s] out grading time so that it isn’t just clustered around exams.
Sitting down with a stack of papers seems more daunting than sitting down with a stack of cards. The first semester I used index cards, I think I was grading/marking them in a very inefficient manner. Now, I’ve gotten a sorting technique down, and it takes almost no time to sort.
Another aspect of [<i>Cards</i>] that I appreciate is that once material has been covered on an index card, it has been formally assessed so I don’t need to cover that material on an exam.
I like the immediacy with which students get feedback about their class standing. They don’t need to wait for an exam to find out whether they understand the material. . . . Even if they weren’t able to answer the index card question, they have the opportunity to go back and re-write their answer. [This means] they don’t need to keep a low score. As long as they attend class, they can [potentially] have at least an 80% on their index cards. . . . They have the opportunity to go back and learn material that they did not understand the first time.
I really like index cards for the class attendance/participation aspect. Students are always bummed if they missed a card, and I feel this motivates them to be at every class so that they aren’t missing out on the opportunity for points.
I like using the index cards as a way for students to discuss and explain their understanding. Too often students sit passively in class, and don’t contemplate information. . . . I feel that [<i>Cards</i>] questions . . . help to spur [students] into active behavior.
[I like how] students who get the [lower] marks are motivated to revise their responses to show an understanding of the concept.
[Using <i>Cards</i>] makes me trick myself . . . into thinking grading is kind of fun!

I would make an effort to enroll in that class.” The first probe served as a control as to whether students understood the Likert scale (all students should have agreed to some extent). Responses of students not agreeing with this control ($n = 2$) were eliminated from analysis. Figure 3 shows the distribution of responses to the second question above. Both Majors and A&P students overwhelmingly agreed that they would make an effort to enroll in classes using *Cards*. Only eight students (6% of analyzed respondents) in the two classes disagreed ($n = 5$) or somewhat disagreed ($n = 3$) that they would seek out future classes using *Cards*.

Reflections by instructors using *Cards*

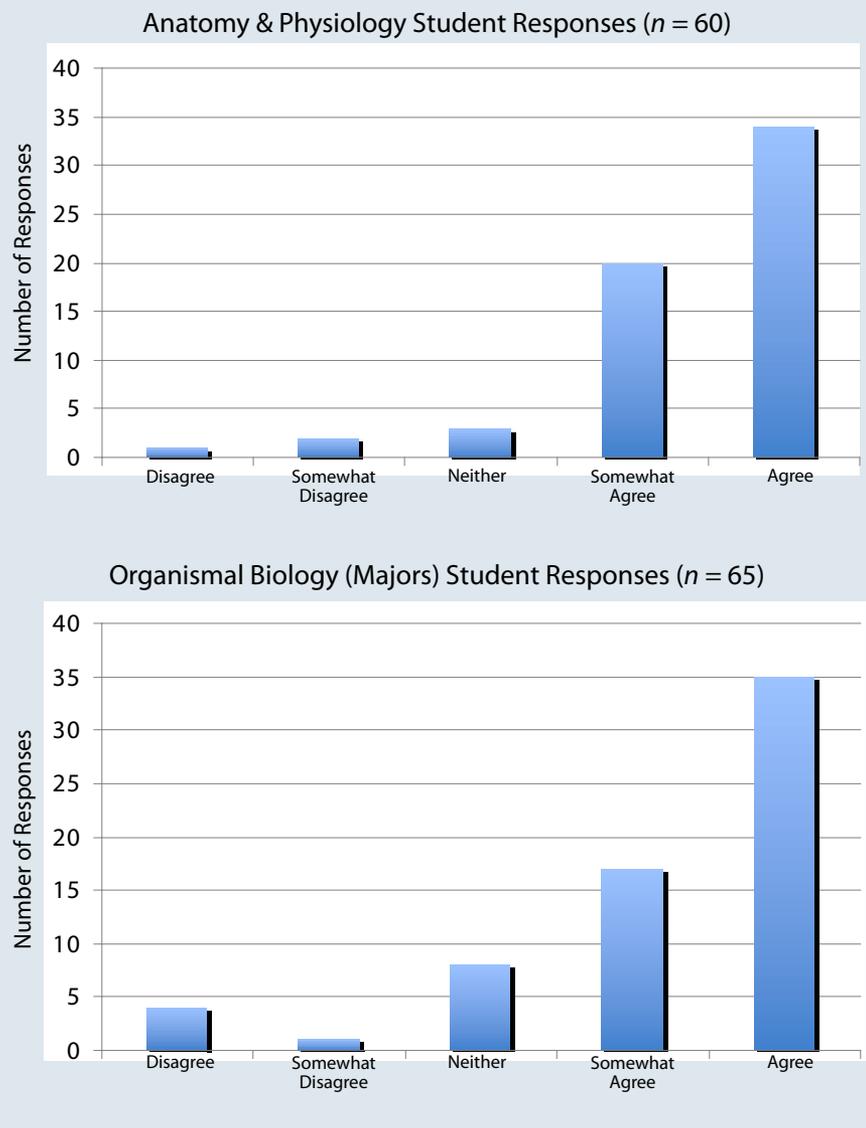
Three other community college biology faculty piloted—and subsequently continued to use—*Cards* in their classes. All these faculty expressed interest in expanding the role of open-ended assessments in their classes. Before using *Cards*, the composition of their assessments (tests/quizzes) included between 10% and 75% close-ended/multiple-choice assessments depending on instructor. This indicates the faculty had a varied background in implementing open-ended assessments as formal testing tools and had not necessarily already moved to open-ended assessment as the primary assessment tool in their courses. After implementing *Cards* in their classrooms, I asked each instructor to spend 10–15 minutes writing to the questions: “(1) How do you use index cards in your classes? and (2) Why do you use index cards in your classes?” All instructors described using *Cards* in their classes in the general manner outlined in Figure 1. Table 4 shows quotes from those instructors’ reflections on the utility of *Cards* for them.

Taming the testing cycle with *Cards*

Although *Cards* yields great benefits to students in the ways outlined

FIGURE 3

Student responses to the statement, “If I found out that I could take another class that used index card questioning like Mr. Schinske did, I would make an effort to enroll in that class.”



previously and in Table 1, the initial motivation for developing *Cards* involved making open-ended assessment logistically easier to use as the centerpiece for larger courses. In my own experience and communications with other faculty, the most prevalent reported barrier to using open-ended assessments is the large amount of time associated with grading open-ended exams. An instructor might typically have two midterms and one final in a course, with each exam consisting of approximately

15 open-ended assessments. Each of those exams requires a substantial—and for many instructors an unmanageable—amount of time to grade for classes of greater than 30 students. Because *Cards* involves assessing students more frequently and more intensively than in exams, it allows instructors to reduce the midterm (now only one) and final exam to only three to six questions. As a result, index card questions may comprise approximately as much of the course grade as do exams. The short-

ened, single midterm and cumulative final exam remain part of the course in order to assess retention of, and accountability for, key class content in more formal settings. Instructors find the reduced-length exams much more manageable to grade in large classes. Further, the relatively short grading time associated with *Cards* is spread out over the entire course, mitigating the impact of grading those open-ended assessments. Indeed, instructors find the grading time in *Cards* enjoyable and helpful to their teaching (see Table 4).

When performed with frequency, *Cards* also gives back class time to instructors that otherwise would have been needed for exams. That saved class time helps to offset time needed to perform *Cards* in class. Instructors might alternately choose to use *Cards* more sparingly than recommended previously in order to experiment with the use of open-ended questioning in their classes. Although this could be an excellent means of trying out a new assessment strategy, instructors have the best chance of achieving the full range of benefits if they use *Cards* in most or all lecture meetings.

Conclusions

Cards appears to accomplish the goal of creating a more manageable overall workload for instructors using open-ended assessment, while concurrently taking advantage of the benefits of writing to learn science (Moore 1994). It additionally creates a construct for collaborative learning between students, a quality particularly important for non-traditional students, language learners, and students of color (Tobias 1990; Seymour and Hewitt 1997; Tanner 2009). Finally, *Cards* provides students with timely feedback on their progress and allows instructors to collect data on class progress (Tanner and Allen 2004; Handelsman, Miller, and Pfund 2006). Students greatly value *Cards* as a learning tool and as a means for communication with peers and their instructor. *Cards* therefore represents an effective

technique for using open-ended assessments and collaborative learning, even in larger lecture environments. ■

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