Scratch This!

The IF-AT as a Technique for Stimulating Group Discussion and Exposing Misconceptions

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This study (a) documents the use of the Immediate Feedback Assessment Technique (IF-AT) as a group-centered activity in a large-lecture environment; and (b) evaluates student perceptions of IF-AT utility. The IF-AT succeeds as a relatively simple, low-tech tool for providing immediate feedback, targeting student misconceptions, and generating group discussion.

Among the characteristics of so-called "millennial learners" or "Generation Y" students is the perceived need for immediate interaction (Pew Research Center 2007; Twenge 2006; Windham 2005), hence the popularity of instant messaging, speed dating, and flash mobs. When it comes to teaching strategies, is it pedagogical pandering or educational efficiency to tap into this desire? Can this need for speed be channeled for improved learning?

One would think that in the digital age, speed would be equated with Web 2.0 applications and integrated devices. However, these technologies can be burdensome in a large-lecture course setting, so we opted for an easy, low-tech approach: the old scratch-off technology that was popularized during the 50s and 60s at gas stations and supermarkets. The scratch-off technology applied to a standard multiple-choice answer sheet is called an *IF-AT*, or Instant Feedback Assessment Technique (Epstein and Brosvic 2002b).

IF-ATs consist of a typical four- or five-item answer sheet with each option concealed by a thin opaque film (Figure 1). Students commit to their answers by scratching off the film, exposing either a star, for a correct answer, or a blank space. Students may then continue scratching selec-

tions until they get a star; however whether or not they chose the correct answer initially is disclosed in perpetuity by the blank they originally and permanently uncovered. There is space on the IF-AT form to record full credit, partial credit (at the instructor's discretion), and a final tally. Unfortunately, the IF-AT form cannot be machine-graded, like a Scantron instrument, but of course a Scantron instrument does not provide instant feedback.

As its name implies, the IF-AT provides instantaneous feedback on student performance (Epstein et al. 2002), a critical component of educative assessment (Fink 2003). Wiggins notes that effective feedback is "always timely, continual, and user friendly" (1998, p. 47), while others have documented the great value students place in strong feedback loops (Kuh et al. 2005; Klionsky 2002; Angelo and Cross 1993). To make an assessment a learning experience and not simply an audit of student knowledge, it's critical not to delay corrective feedback. Fink (2003) describes the issue: "The problem with delayed feedback is that students cease to care about why their answer or activity was good or not. When the feedback comes a week or more after the learning activity, they just want to know, 'Wha'd I get?'" (p. 96).

Instant feedback can be generated through newer technologies, of course, such as personal response systems, or "clickers." Herreid reminds us, though, that it is the "feedback pedagogy" that's more critical than the tool used to deliver it (Herreid 2006). Although clickers may eventually become standardized and their software easier to use for faculty (Hatch, Jensen, and Moore 2005), the IF-AT is currently less expensive, the technology is nearly flawless, and there is no software to learn. Furthermore, if students lose or "break" their IF-AT, it's not a grave problem to surmount.

Since we wanted to try to introduce a slate of active-learning techniques in a large-lecture, introductory biology course, we thought the IF-AT might give students what they sought—frequent immediate feedback—while simultaneously reducing the anxiety they might feel around assessment and group learning. We wanted to increase student motivation to persist on difficult science problems even after their first efforts failed. To accomplish this, we felt students needed to be cognizant that the IF-AT helped them untangle their persistent misconceptions and that this low-stakes group assessment activity might lead to their own improved exam performance.

We designed the IF-AT interaction with both students and faculty in mind. If the IF-AT was effective but difficult to implement, faculty wouldn't adopt it. Thus our learning interaction had to be effective and efficient, involving little additional instructor guidance or an increase in their administrative burden. Most instructors may not share a "Generation Next" need for instantaneity, but many are willing to adopt new teaching techniques as long as they are sustainable and improve the learning environment (Hodges 2006; Rogers 1962).

Previous studies have emphasized the value of immediate feedback in identifying misconceptions (Fink 2003). In addition, a body of literature supports group activities to foster cooperative learning (Lodish, Rodriguez, and Klionsky 2004; Bransford, Brown, and Cocking 1999; NRC 2003). A few studies have demonstrated that student perceptions of the IF-AT are largely positive (Epstein and Brosvic 2002b; DiBattista, Mitterer, and Gosse 2004), and Epstein et al. (2002) have evidence of increased

FIGURE 1

Biology students enjoying an IF-AT exercise (left); (b) The Immediate Feedback Assessment Technique instrument (right).

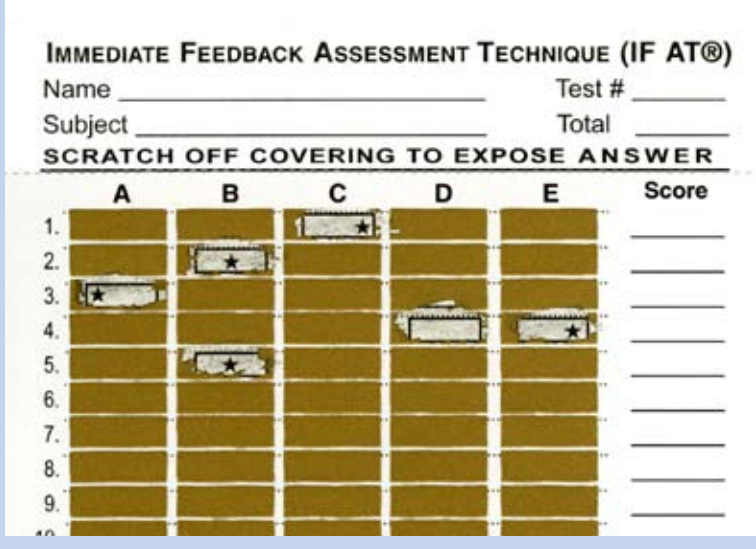
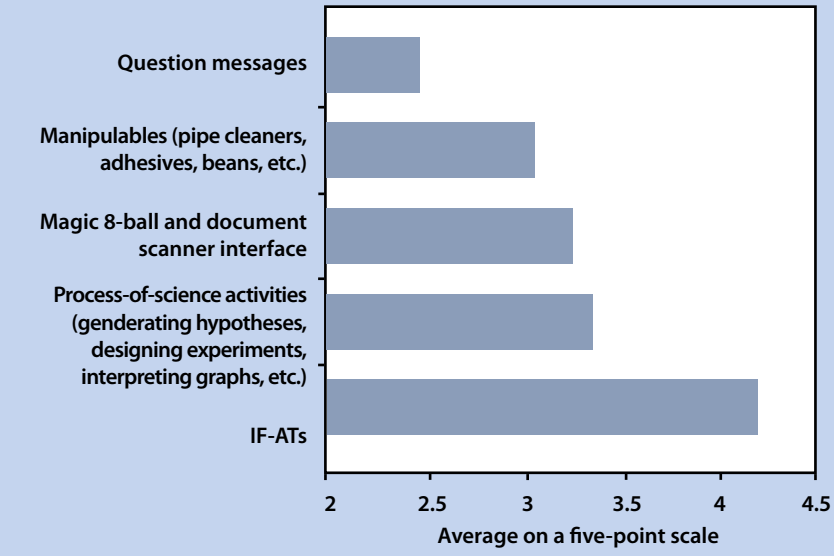


FIGURE 2

Student perceptions of in-class activities. Numbers correlate to the following scale: 1. Don't remember/didn't attend; 2. Useless; 3. Somewhat useful; 4. Highly useful; 5. Extremely useful ("Don't remember/didn't attend" selections were excluded from analysis).



retention of material after an initial test with an IF-AT (compared with a Scantron instrument that delays feedback). This study (a) documents the use of IF-ATs as a group-centered activity in a large-lecture environment, as part of a larger project supported by the Archibald Bush Foundation; and (b) evaluates student perceptions of IF-AT utility. In our assessment, we were particularly curious if the IF-AT's reception would vary by gender and ethnic group.

Background

A large-enrollment, mixed-majors, introductory biology lecture section was redesigned to evaluate the effectiveness of various active-learning strategies. The active course elements included structured group activities (including the IF-AT activities discussed below), extremely shortened mini-lectures, unannounced quizzes, a few graded homework assignments, two multiple-choice midterms, and a final.

Students in the active section were assigned to 60 groups on the first day of class. Each group was randomly assigned and permanent, and had a numbered folder to collect at the beginning of every class. The folder included the materials needed for that day's activities; materials might be printed media or manipulables (e.g., ad hoc puzzle pieces, beans, pipe cleaners) in envelopes or zippered plastic bags. In general, the group activities emphasized (a) generating testable hypotheses to explain observable phenomena, (b) designing experiments, and (c) analyzing authentic data from current scientific literature.

IF-AT interactions

The IF-AT activities took place 10 times during the semester, often as a way of introducing a set of learning units or covering a theme. Typically, each student worked independently on three to eight challenging multiple-choice questions. Groups then convened to commit answers to the IF-AT form. Students would discuss the merits of different answers, and in the best cases, dissenters would be asked to articulate the superiority of their choices. Groups were instructed to assign point values to each question as follows: If correct on the first try, four points; on the second try, two points; on the third try or beyond, zero points.

Class discussion following the small-group activity took various forms. Initially, we used the IF-AT experience as a tool for illustrating the value of collective wisdom and compelling students to make their thinking transparent. We also queried students to ascertain if they changed their answers after group discussion, and if the change led to higher scores. In other words, did they benefit appreciably from the group interaction? After that, we selected distracters from the quiz to model a studying technique whereby questions could be "massaged," distracter by distracter, to make wrong answers correct. The idea was to peel away layers of nuanced misconceptions, one at a time.

We also used our class discussion to encourage groups to guess which was the most commonly selected wrong answer for each question, and then to articulate the reason for their choice. We felt this approach would encourage students to identify misconceptions without putting them on the defensive. In addition, we understand that instructors are not always aware of the naïve conceptions at work in every area of the knowledge base (Duit and Treagust 2003; Tanner and Allen 2005). Through polling students on the outcomes of their IF-ATs, we were able to narrow our discussions to their most entrenched misconceptions and eliminate lecture on commonly understood material that was well represented in the textbook. It was also an easy way for the class to see how well they understood the material in relation to their peers. IF-AT sheets stayed in the group folders for the duration of the course. We did not record group scores, nor did we suggest to students that their scores would be recorded.

Student perceptions of IF-AT utility

Our understanding of the utility of IF-AT-based group work is constructed from student opinion surveys. Students in the active section were asked specifics about the range of in-class activities, such as the value of the following:

- process-of-science activities (generating hypotheses, designing experiments, interpreting graphs, etc.);
- IF-ATs;
- question massages;
- working with manipulables (pipe cleaners, adhesives, beans, etc.);
- reporting data to the class with our "magic 8-ball" group randomizer and document scanner interface.

Student responses are summarized in Figure 2. Among the 213 responses, the IF-AT emerged as the obvious favorite use of group time ("highly useful").

We also asked students to rate the following IF-AT-specific statements on a 5-point Likert scale:

- I enjoy the group interaction encouraged by the IF-AT.
- Knowing whether or not I/we got the right answer immediately on the IF-AT helped me learn.
- With the IF-AT, knowing right away when I was wrong helped me correct my misconceptions on a problem.
- I get a real feeling of satisfaction whenever I get the correct answer on my first try.
- I get a real feeling of disappointment whenever I get the wrong answer on my first try.
- I feel that I may have done better on midterm exams because of what I learned with the IF-AT activities.

Student responses are summarized in Table 1. Among-group comparisons of IF-AT attitudes offer some insight into how different populations perceive the utility of IF-ATs. Overall, females appear to value the IF-AT more than males. For the value of IF-ATs in general, females were significantly more positive (t-stat 3.74; 211 df; $p < 0.001$), with more males (13 out of 114) than females (2 out of 98) finding IF-ATs "useless."

Females were also significantly more likely to feel that immediate feedback aided with learning material (t-stat 2.84; 210 df; $p < 0.05$) and specifically helped correct misconceptions (t-stat 2.81; 204 df; $p < 0.05$). Chi-square tests comparing student characteristics to IF-AT perceptions revealed no statistically significant differences among groups based on grade-point averages, academic standing, academic program or ethnic group.

Discussion

Several authors have documented instructor reluctance to incorporate active-learning, student- or group-centered techniques into their classes (Herreid 1998; van Dijk, van den Berg, and van Keulen 1999; Goodwin, Miller, and Cheetham 1991; DeHaan 2005). The reasons include concerns about not covering content deemed essential, worries about the amount of time involved in designing and assessing interactive elements, and qualms about student resistance and problematic group dynamics. The IF-AT offers a nonthreatening, low-tech solution to some of these concerns.

Student enthusiasm across gender for IF-ATs

First and foremost, students and instructors value the IF-AT. Or, more specifically, students perceive their utility (as reflected on formal surveys) and instructors appreciate their efficiency (as reflected in colleagues' comments, along with the authors' positive experiences). Even where disparities arise between male and female students, the perceptions are still positive. DiBattista, Mitterer, and Gosse (2004) question whether students value the corrective aspect of immediate feedback, and these data—particularly in response to the items "Knowing whether or not I/we got the right answer immediately on the IF-AT helped me learn" and "With the IF-AT, knowing right away when I was wrong helped me correct my misconceptions on a problem"—suggest that students in fact do value corrective feedback. In general, students are more likely to express satisfaction with a correct answer than disappointment with a wrong answer, a combination that may bolster the nonthreatening aspect of the IF-AT. It may be that their novelty is part of the attraction, a possibility that will be tested with semesters of repeated use and increased encounter rates. And it is also possible that students' satisfaction with the IF-AT is a general expression of their desire for more practice with test questions.

Seymour and Hewitt discuss "the difficulty of establishing effective collaborative learning arrangements in learning cultures focused on individual

TABLE 1

Student input on the IF-AT activities. Numbers correlate to the following scale: 1. Don't remember/didn't attend; 2. Disagree strongly; 3. Disagree; 4. Agree; 5. Agree strongly. (The last two questions have fewer respondents due to survey error.)

Questions on in-class activities	Average out of 5	*n*
I enjoy the group interaction encouraged by the IF-AT.	3.97	213
Knowing whether or not I/we got the right answer immediately on the IF-AT helped me learn.	4.16	213
With the IF-AT, knowing right away when I was wrong helped me correct my misconceptions on a problem.	4.08	213
I get a real feeling of satisfaction whenever I get the correct answer on my first try.	4.05	213
I get a real feeling of disappointment whenever I get the wrong answer on my first try.	3.33	74
I feel that I may have done better on midterm exams because of what I learned with the IF-AT activities.	3.71	74

competition" and note that "group study may be more effective where faculty take an active role in setting up the system and offer guidance about the choice of study partners and the most effective ways to conduct study sessions" (1997, p. 176). Given the aforementioned concerns faculty may have about group dynamics, and this call to orchestrate group work more effectively, the IF-AT may offer a mitigation strategy. And, at a time when the retention of women in the sciences is critical and problematic (Seymour and Hewitt 1997), the IF-AT may offer a vehicle for student engagement that serves both genders.

This study describes several low-stakes classroom-management techniques centered on the IF-AT. Notably absent is any formal accountability, either for effort in general or IF-AT scoring in particular. While students habitually scored their group IF-AT sheet (all IF-AT forms were completed, 100% of the time), at no point were scores incorporated into their course grades. Yet IF-AT enthusiasm was steady throughout the semester, and the student perceptions we report were measured during the penultimate week of the term when one might expect student motivation to flag. This behavior signifies to instructors that concerns over grading logistics need not prevent attempting this technique in class. Rather, IF-AT use may please those students who value frequent quizzes (Grover, Becker, and Davis 1989) while eliminating the associated grading burden on the instructor.

Targeting student misconceptions

The IF-AT offers a tool for dynamically identifying problem areas during class and subsequently streamlining lectures or in-class discussions. We often used the IF-AT as a starting point for identifying misconceptions or confusing topics. We would ask students to tell us which question was the most difficult, and we'd encourage them to articulate the source of confusion. This gave us an ideal entry point for topical coverage. For example, following a cell division IF-AT, we were able, with some confidence, to eliminate discussion of mitosis entirely, and focus on areas where students demonstrated misunderstanding, such as on tetrad formation, reductive division, and sources of genetic variation. During a discussion of HIV evolution, we cut right through viral structure and reproductive cycles and focused on HIV/AIDS treatment as an example of natural selection in action. Not only were we able to avoid repeating material that was well understood, we put students in control of determining the direction of class discussion.

In what may be the most persuasive argument in their favor, the IF-AT working groups afforded us an entry for discussing the value of collective wisdom. Several studies have demonstrated that students prefer traditional lectures to a more active classroom format (e.g., Herreid 1998; Lake 2001), and the highest achievers may feel that group work offers them nothing. However, given time and IF-AT iterations, even the best students are likely to, at some point, change their answers for the better as a result of group discussion. This offers an excellent opportunity for "selling" the group model, and may leave students and instructors more open to additional group-centered activities.

Conclusion and recommendations

Rather than suggesting the IF-AT instrument as the ultimate panacea to large-lecture problems, it is our goal to share insights and recommendations from this experience:

- Introduce the IF-AT as an activity that will give students quiz practice and allow them to see where they stand in the class. DiBattista and Gosse (2006) believe that students may perceive testing as more of a game when done with IF-ATs.
- Begin with students working independently and graduate to small-group IF-ATs and, if desired, whole-class discussion. This technique may encourage full participation and more productive group discussion.
- Let students know that random groups will be asked to explain their answers. We used a randomized number generator in the form of a computerized "magic 8-ball" that was projected on a screen. The number that appeared determined which group would report their answers or problems. This randomized accountability generally serves to keep students on task and adds another element of gaming and excitement.
- Don't necessarily associate points with the quiz if you are concerned about the administrative burden. In place of points, remind students (1) that they may be called on to report their findings, (2) they'll be polled, and (3) they're getting quiz practice that may be repeated on the exam.
- Use the IF-AT to help students understand what their own misconceptions are so they can ask more targeted questions of each other and the instructor.
- Although we didn't do this, we think it might be useful to remind students that they learn better with instant feedback.

Our data show that students in overwhelming numbers enjoy the IF-AT group activities. They believe that this method helps them (1) reveal misconceptions and (2) perform better on exams. In particular, women highly value the IF-AT. On the pedagogical side, as instructors we, the authors, find the IF-AT to be a low-administrative strategy for directing class discussion to particularly persistent areas of student misunderstanding. In other words, it helps instructors choose the most important content to cover during class.

Frequent and immediate feedback is critical for learning and retaining content as well as developing effective learning teams (Michaelson, Knight, and Fink 2004). The IF-AT provides a single and efficient way for learners to self-assess their progress in a course and to structure significant small-group discussion. We regard the IF-AT as a tool with broad applicability in the college science classroom. Used within

the proper context, IF-ATs can coax students to collaborate on a cooperative quiz and to persist beyond their first and sometimes errant attempts. ■

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