A Chat With the Survey Monkey: Case Studies and the Flipped Classroom

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Our lives are filled with polls and surveys. We are asked to participate in dozens every year. We all face the same onslaught. There are pollsters everywhere. It is part of modern life and the ubiquitous presence of phones and the crushing onslaught of the electronic juggernaut, leading us to be wary of anyone approaching with a clipboard in a neighborhood mall or a stranger at a table hailing with a hearty greeting in an airport—especially at election time, when everyone has their own polling agency and spins the results in their own inimitable style.

And we can't just be part of a poll; we have to be enlightened with the results. We are then bombarded with statistics on our computer, on our iPad, and from nattering nabobs on television. Nowhere are we safe from intrusion, be it in our bedroom or bath. And you are not safe in this essay either. For we are here to tell you the results of a survey that we posted for folks who regularly peruse the website of the National Center for Case Study Teaching in Science (NCCSTS). We asked faculty about their use of case studies and videos in their General Biology classrooms. We think the results are enlightening because General Biology is arguably the course most commonly taught to students in high schools and college. And the flipped classroom is the hottest ticket in town.

What prompted our interest in all of this is that we submitted a successful grant proposal to the National Science Foundation making the argument that case study teaching is now one of the favorite methods of science, technology, engineering, and mathematics (STEM) teachers because it engages students with real-world problems. It promises to help overcome the disenchantment found in 60% of the STEM students who choose to leave the disciplines. According to an editorial in *Science* by Gates and Mirkin (2012), three factors are responsible for the attrition: uninspiring introductory courses (86% of science faculty use lecture as their primary mode of teaching), difficulty with the required math, and an unwelcoming academic culture in STEM. One of the major innovations in the college STEM classroom developed to help correct this situation is case-based learning (Herreid, 1994), which teaches scientific content, concepts, and skills in a real-world, problem-solving context that provides the kind of active, student-centered learning called for in *Vision and Change* (American Association for the Advancement of Science, 2011). In fact, Gates and Mirkin recommended that the "federal government catalyze widespread adoption of active learning approaches using case studies, problem-based learning, peer instruction, and computer simulations" (p. 1545).

As much as we favor case study teaching (Herreid, 2007), there are some critics who have argued that it uses too much class time. Faculty who are concerned with the coverage issue say they can't afford to turn over a class to a case study because they won't be able to get through the material that they believe is essential or is mandated. Faculty making this assertion often ignore two important facts, of course: (a) many students who have suffered through the lecture method still receive Ds and Fs or withdraw—the method clearly doesn't work for them, and (b) you can still get coverage without the teacher having to say it all out loud; there are other ways to get coverage.

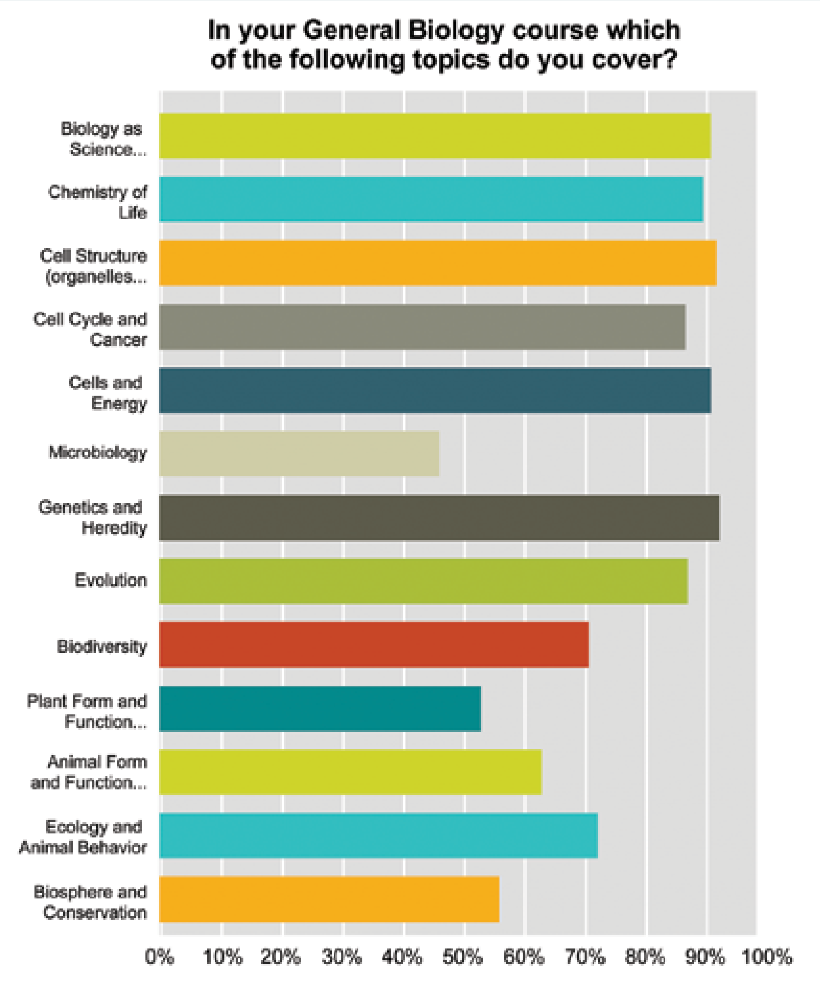
That's where the flipped classroom comes in. The classical flipped approach advocates that teachers give the students homework that covers the essential material habitually presented in lecture, then when class time rolls around, the teacher has time for practical exercises such as case studies, games, contests, problem solving, etc., which reinforce the key points of the material. Thus, the approach flips the normal classroom pedagogy on its head, reversing the usual procedure of lecture first, homework after.

Now let's be clear about this: There is little new about this approach. Ever since the invention of the printing press, countless teachers have implored their charges to read the chapter in the book ahead of time, often to no avail. Additionally, this approach is the centerpiece of team learning, developed by Larry Michaelsen, where students are given reading assignments before class, and then in class they encounter individual quizzes, group quizzes, and finally case studies (Michaelsen, 1992, 2002). Herreid (2002, 2004) has described the successful use of Michaelsen's method in STEM courses. Just-in-time teaching (JiTT) requires significant student preparation too. Students are required to accomplish web-based assignments that are due shortly before class. The instructor reads the student submissions and adjusts the classroom lesson to suit the students' needs. Class time is spent dealing with questions and introducing material on a need-to-know basis (Novak, Patterson, Gavrin, & Christian, 1999; Simkins, Maier, & Rhem, 2009). "Hybrid courses" and "blended courses" (Buzzetto-More & Sweat-Guy, 2006; Wu, 2010) have students learning their subject matter via a combination of traditional classroom interactions and some form of internet-based learning. These and related methodologies, cooperative learning (Slavin, 1990), collaborative learning (Dillenbourg, 1999), and process-oriented guided inquiry learning (Farrell, Moog, & Spencer, 1999; Hanson & Wolfskill, 2000) share some of the same advantages and challenges. Like the flipped classroom, all of these methods allow instructors to cover principles, facts, and terms as part of out-of-class student preparation and use classroom time to engage in active learning exercises in which they apply what they have learned.

But what's new about the flipped method is this: We now have the internet, YouTube, and a host of other websites like the Kahn Academy and Bozeman Science that provide high-quality short videos that cover key concepts in STEM education. In less than 10 minutes one can see an animation video of the differences in mitosis or meiosis, an explanation of DNA replication, or how the planets move. A student can look at these repeatedly. When made well, these videos appeal to a crop of students who are immersed daily in a visual culture with high entertainment value. There are two clear problems however. The first is how to get the students to watch and learn from these sources. This problem is often solved by giving short exams either online or in the classroom before the classroom exercises begin. The second problem is that not enough

FIGURE 1

Topics covered in General Biology classes by case study teachers.



high quality video material or case studies exist. This challenge is now partially being met with videos that are produced by groups such as the Khan Academy (www.khanacademy.org) and Bozemanscience (bozemanscience.com/science-videos/) or by faculty who are creating their own using software programs like Camtasia, PaperShow, and ShowMe or apps on the iPad like Educreations and Explain Everything, which they then post to YouTube, iTunes U, and Podcasts (Vodcasting) or on course management systems such as Blackboard or Moodle. Still, we are a far cry from having high-quality free videos that cover the fundamental topics in general biology. It is the latter problem that our current National Science Foundation grant is trying to address over the next 3 years. As a preliminary step to that work, we invited members of the NCCSTS's listserv to take a survey designed to find out how many of them are currently using cases and the flipped classroom approach.

This survey was only intended for faculty teaching General Biology at the college level. Over 1,300 people answered the Survey Monkey's call, 46% of them high school teachers of Advanced Placement (AP) biology courses. Virtually all respondents were teaching face-to-face classes, although a handful was also teaching via distance learning. The typical class size was 11–25 students (47%) or 26–50 students (34%). These sizes are quite favorable to various forms of case study and flipped classroom exercises. Not all of us have such luxury. Some of the key findings are not too surprising to those of us immersed in the day-to-day operations of General Biology, but they are nonetheless relevant to those of us interested in seeing that the flipped classroom gets a fair shake. First, let's look at the topics covered by the teachers who responded to our survey. A typical General Biology textbook gives us a sense of the material, but what is the emphasis we find among case study teachers? Figure 1 provides the answer.

What is striking from Figure 1 is that the topics that many of us took as young biology students are still being taught today, but the emphasis is quite different. The course called "biology" didn't exist at all until the 1960s. Students took separate courses in zoology and botany, a year of each. And those courses were totally focused on taxonomy, diversity, life cycles, anatomy, and physiology, with a bit of Mendel, ecology, and evolution thrown into the mix. One

FIGURE 2

Subjects in General Biology where teachers use case studies.

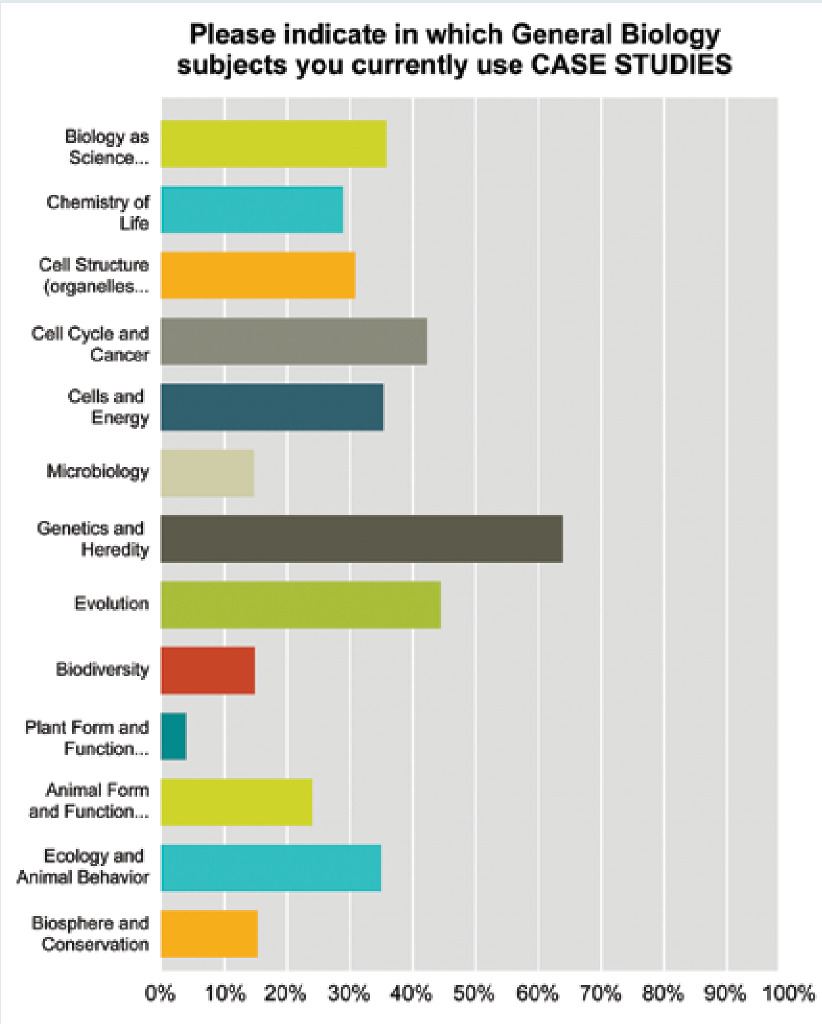


FIGURE 3

Top cases on the National Center for Case Study Teaching in Science website chosen by General Biology teachers (college, university, and AP biology) at the time of the Survey Monkey (January, 2014).

1. The Mystery of Seven Deaths (17.6%)—Cell respiration
2. Osmosis is Serious Business! (8.7%)—Chemistry of life
3. My Dog is Broken (6.8%)—Cell signaling
4. A Can of Bull? (6.3%)—Animal structure and function; cell metabolism
5. Little Mito (6.1%)—Cell division
6. The Case of the Dividing Cell (5.4%)—Cell division
7. Those Old Kentucky Blues (5.4%)—Genetics
8. Chemical Eric (5.2%)—Animal structure and function
9. I'm Looking Over a White-Striped Clover (5.2%)—Evolution
10. Classic Experiments in Molecular Biology (4.7%)—Molecular biology; chemistry of life
11. Newsflash! Transport Proteins on Strike! (4.7%)—Chemistry of life
12. Diabetes and Insulin Signaling (4.7%)—Cell signaling
13. But, I'm Too Young! (4.2%)—Cell cancer
14. Identical Twins, Identical Fates? (4%)—Genetics
15. The Case of the Druid Dracula (4%)—DNA structure
16. Darwin's Finches and Natural Selection (3.8%)—Evolution
17. Mystery in Alaska 16 (3.8%)—Conservation
18. Water Can Kill? (3.8%)—Animal structure and function
19. Bad Fish (3.8%)—Animal structure and function; cell function
20. The Return of *Canis lupis*? (3.5%)—Animal structure and function
21. Why is Patrick Paralyzed? (3.5%)—Cell metabolism

lecture (repeat: one lecture) in each of zoology and botany on the cell was standard; we didn't know much about it in the old days. Today, the curriculum is turned on its head. Our standard course in biology focuses heavily on the cell and molecular biology, with genetics and heredity leading the way. Biodiversity, if it is taught at all, is relegated to a few survey classes. And life cycles? Forget it. Anatomy and physiology topics don't fare much better, especially if we are talking about plants. Evolution actually is much better represented today than in the previous generation, unless you are in a creationist stronghold.

Figure 2 shows how teachers use case studies to teach these subjects. You might expect it to be pretty much the same as in Figure 1, but there are differences because the pattern also reflects the availability of cases. For example, there are very few cases available in plant structure and function. The same is true in biodiversity, so these topics receive even less emphasis then we might expect. Contrariwise, there are a large number of cases in genetics and heredity, evolution, and ecology, as these fields are easier to find suitable topics for cases. They receive more attention than expected.

When we asked teachers where they got their cases, overwhelmingly, it was from the NCCSTS website. This is to be expected, given that the survey emanated from this site, but further, the site is arguably the largest and best known peer-reviewed case repository of STEM cases, with over 500 cases published. Other sources are less well used. A handful of instructors (6%) said that they used their own cases or had picked them up from the news media; (3%) said they got them from textbooks or journals (Waterman & Stanley; Campbell & Reese; McGraw Hill texts; *The American Biology Teacher*; Sadava et al.; *Journal of Heredity*; *The American Biology Teacher*); and 1% came from other case study websites (Environmental Protection Agency; Howard Hughes Medical Institute; Evergreen State College's Native American Case Collection; TED talks).

What kinds of cases studies do the General Biology faculty actually find most useful in their classrooms? Surprisingly to us, there was abundant diversity: 275 different cases were chosen out of a total of 500 cases available (55%), but 80 of these cases were only chosen one time (i.e., these cases were specific to the tastes and needs of only one teacher). On the other hand, 195 cases were identified by more than one person. The Mystery of the Seven Deaths (the top choice), which teaches students about cellular respiration and the electron transport chain though a story based loosely on the real-life 1982 Chicago Tylenol murders, was chosen by 75 different faculty (17.6% of total taking the survey), but because 46 faculty said they used cases but didn't identify the particular cases used, the percentage is probably higher. This is especially likely since most of these folks said they used cases exclusively from the NCCSTS website.

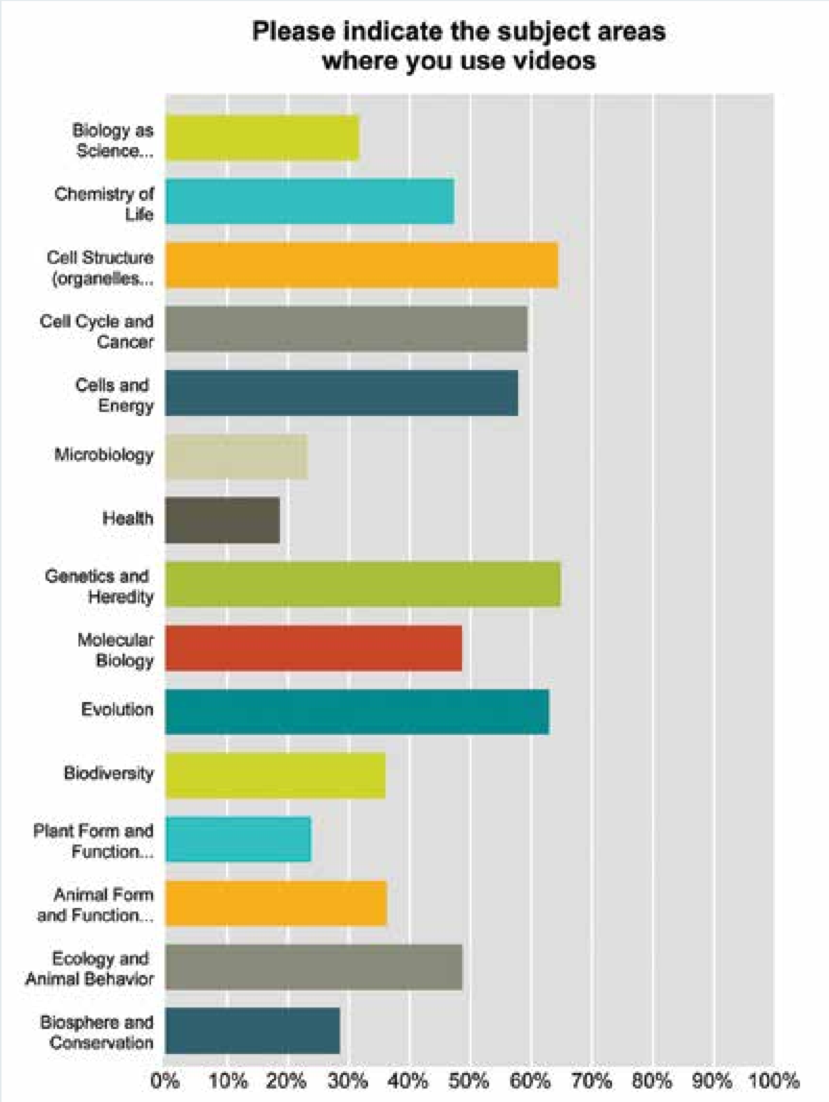
Figure 3 shows the distribution of the choices and the overwhelming number of faculty who favor cell and molecular biology. With this as background, let's turn to how these case study teachers are responding to the flipped classroom movement. Our survey shows that only 20% have seriously integrated the method into their classrooms, with over 40% rarely or never using it, and 35% using it occassionally. So far it seems that the method hasn't been widely adopted. Figure 4 shows the subject areas where videos are used; recognize that this reflects on both the teachers' choices and the limited avialabiltiy of videos in certain subject areas.

Most faculty who use videos don't make them themselves. Only 20% of the faculty who responded to our survey do so. And the ones that have been submitted to the NCCSTS as examples are mostly slide show presentations with the teacher's disembodied voiceover explaining all. A few showed an inset with a headshot of the instructor as well. Interestingly, in a survey of 200 faculty who said they were crafting instructional videos, 47 different software programs were identified. The most common ones were Camtasia (44%), iMovie (24%), Windows Movie Maker (9%), and Tegrity (8%). In spite of the different programs used, creative videos were rare (e.g., there were none like the animations showcased by The Virtual Cell Animation Collection at the Molecular and Cellular Biology Learning Center (http://vcell.ndsu.edu/animations/). But because no one seems to have studied the impact of these different styles of presentation, it is hard to be critical except on aesthetic grounds; indeed, the videos showing a student teacher giving a minilecture might be the most compelling and enlightening after all.

If the teachers are not making them, where do they find them? Few of our survey group reported that they used the case studies commissioned by textbook companies. Regardless of their quality, these cases are under proprietary protection and are hardly free of charge. Instead faculty depend

FIGURE 4

Subject areas in which faculty use videos in teaching General Biology.



on open-access sites. And in spite of its great publicity, few biology teachers use those of the Khan Academy; the latter are basically chalkboard descriptions with a voiceover. Students are not enchanted with such presentations in our experience. In contrast, the Bozemanscience series has a wide audience (see http://www.bozemanscience.com/about/). This site is maintained by Paul Andersen, a high school science teacher in Bozeman, Montana, who has produced hundreds of videos published on YouTube in all fields of science. His videos are brief, with large numbers of pictures and always with a headshot of him talking. He is young, energetic, and articulate. Take a look at him giving a TED talk and you will get the idea (http://www.bozemanscience.com/speaking-workshops/).

Returning to the theme of this essay, case studies in science have a great potential; thousands of instructors are using them. But their use would be much more common if we solved the major problem of coverage. It is a given that teachers need to feel that that they are treating their subject matter in sufficient depth in their classes. The flipped classroom approach—with its reliance on excellent videos—is one solution to this dilemma. But the bottom line is that we need more excellent cases supported by videos that are targeted, readily obtained/accessible (e.g., via YouTube), and need we say it again . . . free. ■

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