

Feature

Approaches to Biology Teaching and Learning

“What if students revolt?”—Considering Student Resistance: Origins, Options, and Opportunities for Investigation

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“What if the students revolt?” “What if I ask them to talk to a neighbor, and they simply refuse?” “What if they do not see active learning as teaching?” “What if they just want me to lecture?” “What if my teaching evaluation scores plummet?” “Even if I am excited about innovative teaching and learning, what if I encounter student resistance?”

These are genuine concerns of committed and thoughtful instructors who aspire to respond to the repeated national calls to fundamentally change the way biology is taught in colleges and universities across the United States. No doubt most individuals involved in promoting innovative teaching in undergraduate biology education have heard these or variations on these fears and concerns. While some biology instructors may be at a point where they are still skeptical of innovative teaching from more theoretical perspectives (“Is it really any better than lecturing?”), the concerns expressed by the individuals above come from a deeply committed and practical place. These are instructors who have already passed the point where they have become dissatisfied with traditional teaching methods. They have already internally decided to try new approaches and have perhaps been learning new teaching techniques themselves. They are on the precipice of actually implementing formerly theoretical ideas in the real, messy space that is a classroom, with dozens, if not hundreds, of students watching them. Potential rejection by students as they are practicing these new pedagogical skills represents a real and significant roadblock. A change may be even more

difficult for those earning high marks from their students for their lectures. If we were to think about a learning progression for faculty moving toward requiring more active class participation on the part of students, the voices above are from those individuals who are progressing along this continuum and who could easily become stuck or turn back in the face of student resistance.

Unfortunately, it appears that little systematic attention or research effort has been focused on understanding the origins of student resistance in biology classrooms or the options for preventing and addressing such resistance. As always, this Feature aims to gather research evidence from a variety of fields to support innovations in undergraduate biology education. Below, we attempt to provide an overview of the types of *student resistance* one might encounter in a classroom, as well as share hypotheses from other disciplines about the potential origins of student resistance. In addition, we offer examples of classroom strategies that have been proposed as potentially useful for either preventing student resistance from happening altogether or addressing student resistance after it occurs, some of which align well with findings from research on the origins of student resistance. Finally, we explore how ready the field of student resistance may be for research study, particularly in undergraduate biology education.

WHAT IS STUDENT RESISTANCE, AND WHAT MIGHT IT LOOK LIKE IN A CLASSROOM?

In undergraduate biology education, we typically hear negative student reactions in a classroom—often in conjunction with the use of new teaching approaches—referred to as *student resistance*. However, in other fields, similar student responses may be referred to using different language, such as *instructional dissent* or *student misbehavior* or *student demotivation* (Kearney *et al.*, 1988; Gorham and Millette, 1997; Goodboy, 2011). These terms typically refer to behaviors and actions students take in a classroom situation when they become frustrated, upset, or disengaged from what is

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happening there. However, in the field of communication studies, student resistance in a classroom may be defined as either *constructive or destructive student behavior that is in opposition to the instructor* (Richmond and McCroskey, 1992). While constructive student resistance may seem oxymoronic to some, it is described as including such student behaviors as asking challenging questions, offering suggested corrections, helping other students without request, and submitting constructive feedback for instructor improvement on evaluations. As such, constructive student resistance is a positive outcome in the context of most innovative biology teaching approaches currently being promoted. Whether in the context of inquiry-based learning, active learning, or other student-centered approaches, a common goal is to develop student skills in thinking independently, critically, and skeptically. Constructive resistance, therefore, would be expected to result if an instructor were successful in cultivating these skills, since why should students apply these habits of mind only to the biological concepts at hand and not also the pedagogical situation?

The more common concern of most instructors is student resistance that is destructive in nature, behaviors that limit the learning of the students themselves and potentially other students around them. While we may each have examples of destructive student resistance that we have experienced in our teaching, what research has been done to describe the landscape of student resistance behaviors more broadly? In the field of communication studies, investigations of the dynamics of power, language, and behavior have been studied extensively in K–12 classrooms and to a lesser extent in college settings. In the book *Power in the Classroom: Communication, Control, and Concern*, authors Kearney and Plax describe a variety of behaviors reported by college-level students themselves as to how they might exhibit resistance in college classrooms (Burroughs *et al.*, 1989; Richmond and McCroskey, 1992). These researchers directly queried almost 600 students who generated ~3000 open-ended responses describing classroom resistance behaviors. From these responses, 19 categories of student resistance techniques in college classrooms emerged (Burroughs *et al.*, 1989; Richmond and McCroskey, 1992). Some of these reported student behaviors were passive forms of resistance, such as “avoidance,” defined as not attending class or sitting in the back of the room, or “ignoring the teacher,” wherein a student attends class but ignores requests for participation or other instructions given by the instructor. Other student resistance behaviors reported were more active, such as “disruption,” wherein a student may purposefully interrupt class, “student rebuttal,” wherein a student asserts that they know what will work for best them, and the dreaded Appeal to Powerful Others, which would involve threats to take student complaints about a course to an authority figure, such as a chair or a dean. Perhaps the most helpful of the student behaviors that emerged in the study was “direct communication,” in which a student would approach the instructor directly outside of class time to voice his or her concerns. Interestingly, these authors went further to investigate which of these resistance strategies college students might be most likely to employ. Results suggested that college students would be least likely to employ active resistance techniques, with the exception of direct communication, and more likely to employ a host of passive resistance techniques (Kearney *et al.*, 1991a).

These findings might at first seem reassuring, as no instructors welcome disruption of their classrooms or difficult conversations with their administrators. However, these results may also suggest that student resistance may go undetected by instructors if college students are preferentially using passive methods. Anecdotally, some biology instructors report experiencing little student resistance when introducing innovative teaching and learning strategies, while other instructors report a great deal of resistance. One wonders whether these different instructor perceptions of student resistance may actually reflect similar levels of resistance but in passive versus active forms. More broadly, it is unknown whether investigations of student resistance in college science classrooms, in particular undergraduate biology classrooms, might yield a different landscape of student resistance behaviors than those that were reported in the studies described above, which examined resistance broadly.

WHAT IS KNOWN ABOUT THE ORIGINS OF STUDENT RESISTANCE?

While being able to recognize student resistance behaviors may be helpful to instructors (see Table 1), understanding the origins of these behaviors would seem essential to efforts to either prevent or address them. The use of the phrase “student resistance to active learning” itself belies a common tacit assumption that the culprits fostering these resistance behaviors are somehow the innovative teaching techniques themselves. However, little evidence from the research literature appears to support this assumption. Below, we consider three potential origins of student resistance in college classrooms, highlighting research literature where possible.

Interactions with Peers: The Phenomenon of Social Loafing as a Potential Origin of Student Resistance

Rather than demonstrating an opposition to innovative teaching approaches per se, student resistance may emerge from poor interactions between individual students and their classroom peers as a result of the increased classroom collaboration demanded by many of these pedagogical approaches. In almost all traditional teaching approaches, students sit quietly and individually, receiving information via lecture from the instructor. In contrast, a variety of active-learning strategies, ranging from simple pair discussions to more complex cooperative learning groups and class projects, require students to interact with peers in classrooms.

With increased student–student interaction comes the possibility of poor interactions that could cultivate student resistance, not because of the pedagogy itself, but due to the accompanying interactions that result from these teaching approaches. One example of poor student–student interaction in a classroom that has been studied in a variety of fields, including marketing education, is *social loafing*, a term used to describe what happens when individuals working in a group do not participate equitably. Those students who are contributing less are considered social loafers. Social loafing, and the perceived unfairness of workload distribution within a group that it implies, can have a strong negative impact on student attitudes toward teamwork (Pfaff and Huddleston, 2003). Aggarwal and colleagues investigated what factors correlated with student

Table 1. Examples of what student resistance can look like^a

How students exhibit resistance	Sample student behaviors and/or language ...
Teacher advice	"I would offer the teacher advice by saying something like: 'Be more expressive.' or 'If you open up, we'll be more willing to do what you want.'"
Teacher blame	"I would resist by claiming that 'the teacher is boring,' or 'I don't get anything out of it.' or 'You don't seem prepared yourself.'"
Avoidance	Students drop the class; do not attend; do not participate.
Reluctant compliance	Students comply, but unwillingly.
Active resistance	Students attend class, but come purposefully unprepared.
Deception	"I'll act like I'm prepared for class even though I may not be." "I'll make up some lie about why I'm not performing well in class."
Direct communication	"I would talk to the teacher and explain how I feel and how others perceive him/her in class."
Disruption	"I would be noisy in class." "I would be a wise-guy in class."
Excuses	"I don't understand the topic." "The class is so easy I don't need to stay caught up."
Ignoring the teacher	"I would simply ignore the teacher." "I probably wouldn't say anything; just do what I was doing before."
Priorities	"This class is not as important as my others."
Challenging the teacher's power	"Do you really take this class seriously?"
Rallying student support	"I would talk to others to see if they feel the same." "I might get others to go along with me in not doing what the teacher wants."
Appealing to powerful others	"I would threaten to go to the dean."
Modeling teacher behavior	"If you're not going to make the effort to teach well, I won't make an effort to listen."
Modeling teacher affect	"You don't seem to care about this class. Why should I?"
Hostile-defensive	"Right or wrong that's the way I am."
Student rebuttal	"I know what works for me; I don't need your advice."
Revenge	"I'll get even by expressing my dissatisfaction on evaluations at the end of the term." "I won't recommend the teacher/class to others."

^aAdapted from Burroughs *et al.* (1989) and Richmond and McCroskey (1992).

reports of social loafing in collaborations with other students, and their findings suggested that social loafing was associated with larger student group sizes, projects that were larger in scope, and projects with fewer opportunities for peer evaluations (Aggarwal and O'Brien, 2008). In a different study of student dissent behaviors in college classrooms, the only instance of dissent by students in a college classroom that was not directed specifically toward the instructor was an example of social loafing (Goodboy, 2011). As such, student resistance in college biology courses may stem from perceptions of unfairness or unequal workloads among students that can occur when teaching approaches that increase the frequency of group work are used.

The Role of Instructor (Mis)behavior in Fostering Student Resistance

Whenever I've explored this issue with instructors distressed by it, I have invariably found that the teaching method they were trying was not the real problem. It was either that they were making one or more mistakes in implementing the method, or something else was troubling the students and the method was a convenient scapegoat. (Felder, 2011, p. 131)

It is convenient to assume that the origins of student resistance lie in classroom active-learning strategies themselves (Prince and Felder, 2007); however, many have suggested that we ought to look instead to instructor behavior, particularly the implementation process, as a more important consideration (Kearney *et al.*, 1991b; Gorham and Millette, 1997; Chory-Assad and Paulsel, 2004; Silverthorn, 2006; Goodboy, 2011). While it may be unpleasant to consider, student resistance may be well founded and reflect a negative reaction to teacher behaviors—termed *teacher misbehaviors* in the literature—that many of us might deem worthy of student resistance. Once again, the field of communications research provides evidence that may be helpful in understanding how instructor behaviors may be a potential origin of student resistance.

Kearney and colleagues have investigated what teacher behaviors may provoke student resistance in college classroom settings (Kearney *et al.*, 1991b). They asked more than 250 college students to identify teacher misbehaviors—"specific instances where teachers had said or done something that had irritated, demotivated, or substantially distracted them in an aversive way during a course" (p. 313)—from all of their classroom experiences during their college career. From the almost 1800 student descriptions that were collected, 28

Table 2. Instructor misbehaviors that may elicit student resistance^a

Top 20 instructor misbehaviors	Sample instructor behaviors and/or language as reported by students. . .
Sarcasm and put-downs	"Is sarcastic and rude, makes fun of and humiliates students, picks on students, and/or insults and embarrasses students."
Absent	"Does not show up for class, cancels class without notification, and/or offers poor excuses for being absent."
Strays from subject	"Uses class as a forum for his/her personal opinions, goes off on tangents, talks about family and personal life and/or generally wastes class time."
Unfair testing	"Asks trick questions on tests, exams do not relate to the lectures, tests are too difficult, questions are too ambiguous, and/or does not review for exams."
Boring lectures	"Is not an enthusiastic lecturer, speaks in a monotone and rambles, is boring, too much repetition, and/or uses no variety in lectures."
Tardy	"Is late for class or tardy."
Keeps students overtime	"Keeps class overtime, talks too long and/or starts class early before all the students are there."
Unresponsive to students' questions	"Does not encourage students to ask questions, does not answer questions or recognize raised hands, and/or seems 'put out' to have to explain or repeat him/herself."
Confusing/unclear lectures	"Unclear about what is expected, lectures are confusing, contradicts him/herself, jumps from one subject to another and/or lectures are inconsistent with assigned readings."
Apathetic to students	"Doesn't seem to care about the course or show concern for students, does not know the students' names, rejects students' opinions and/or does not allow for class discussion."
Verbally abusive	"Uses profanity, is angry and mean, yells and screams, interrupts and/or intimidates students."
Unprepared/disorganized	"Is not prepared for class, unorganized, forgets test dates, and/or makes assignments but does not collect them."
Unfair grading	"Grades unfairly, changes grading policy during the semester, does not believe in giving A's, makes mistakes when grading and/or does not have a predetermined grading scale."
Does not know subject matter	"Doesn't know the material, unable to answer questions, provides incorrect information, and/or isn't current."
Negative personality	"Teacher is impatient, self-centered, complains, acts superior and/or is moody."
Shows favoritism or prejudice	"Plays favorites with students or acts prejudiced against others, is narrow-minded or close-minded, and/or makes prejudicial remarks."
Inaccessible to students outside of class	"Does not show up for appointments or scheduled office hours, is hard to contact, will not meet with students outside of office time and/or doesn't make time for students when they need help."
Information overload	"Talks too fast and rushes through the material, talks over the students' heads, uses obscure terms and/or assigns excessive work."
Information underload	"The class is too easy, students feel they have not learned anything, and/or tests are too easy."
Deviates from syllabus	"Changes due dates for assignments, behind schedule, does not follow the syllabus, changes assignments, and/or assigns books but does not use them."

^aAdapted from Kearney *et al.* (1991b).

categories of teacher misbehaviors emerged, the top 20 of which are shown in Table 2. Importantly, these data were collected in a general education communications course, in which no particular innovative pedagogical approaches were being used and which is no doubt culturally distinct from undergraduate biology courses. Some of the reported instructor misbehaviors seemed to reflect an unwillingness or inability of the instructor to engage with students: "apathetic to students," "inaccessible to students outside of class," and "unresponsive to students' questions." Other behaviors suggested that the instructors did not treat students collegially and respectfully: "verbally abusive," "sarcasm and putdowns," and "negative personality." Questions about the instructors' level of commitment to the course were evident from behaviors such as: "absent," "tardy," "unprepared/unorganized," "keeps students overtime," and "deviates from syllabus." Issues of a perceived lack of instructor fairness were present:

"unfair testing," "unfair grading," and "shows favoritism or prejudice." Finally, several categories of instructor misbehavior reflected struggles with how many and which concepts to include in a course: "information overload," "information underload," and "does not know subject matter." Interestingly, innovative teaching approaches being encouraged in undergraduate biology might successfully address the final three reported student frustrations: "boring lectures," "confusing/unclear lectures," and "strays from subject."

While we doubt that any instructor reading this will see himself or herself as egregiously or extensively engaged in any of these behaviors, we are all no doubt occasionally guilty of many of these instructor behaviors (authors included). A busy instructor may miss office hours on a given day or fail to respond to a student email before it scrolls off the screen. It is easy to feel impatient with a student or complain in class when things simply are not going as planned. The pressure of

preparing new materials/activities can result in a late arrival to class. It can be tempting to go ahead and teach scheduled material, even though it may seem that most of your students are still struggling and could use more exploration of previous ideas. In fact, taken one by one, few of these instructor behaviors may seem all that surprising. However, accrual of multiple of these behaviors could promote student resistance, suggesting that consistent diligent attention to avoiding these behaviors could facilitate introduction of innovative approaches into the college biology classroom.

Student Resistance and Faculty Barriers to Innovative Teaching: Common Origins?

Finally, a third potential origin of student resistance that bears exploring is students' prior experiences in and resulting expectations about college classrooms. Just like faculty, students enter classrooms with extensive personal experiences that lead them to have preconceived expectations about what teaching and learning should entail. In Brownell and Tanner (2012), we explored four barriers that may impede faculty members from implementing innovative pedagogies in their biology courses: lack of training, lack of time, lack of incentives, and the more rarely discussed tensions with integrating teaching into our professional identities as research-focused scientists. These hypothesized barriers to faculty embracing innovative teaching may also be paralleled and play some role in student resistance to innovative teaching.

Concerning training, students may be experiencing active classroom learning strategies with little to no training or practical experience in how to participate as a student in this environment. Required behaviors, such as negotiating a biological discussion with an unfamiliar neighbor or collaborating with a team of students to produce a product, may be something that students have no training for or experience in. In terms of lack of time, busy undergraduate students may not be used to teaching approaches that require them to do homework that goes beyond textbook reading, such as viewing a lecture and/or writing responses to assessment probes before coming to class. These students may see active-learning approaches, just as some faculty do, as requiring more time than traditional classroom environments have previously demanded of them. Concerning incentives, students may not easily or immediately perceive the learning advantage of active classroom learning strategies. While we would like to think that students view learning as the primary incentive in their course work, the reality may be that some students view high grades, minimal effort, and ease of completion as motivating incentives in their college course work. As such, students may not immediately see the external incentives and rewards they will accrue by participating in active-teaching and active-learning approaches. Finally, even if we were able to provide students with the training to be successful in an active-learning classroom, convince them that their time is being well-used, and make clear to them the benefits of active approaches to learning, might they still struggle with their preconceived identity of what it means to be a student in a college classroom: namely, a student whose role is to sit, listen, and take notes?

In these ways, *student resistance* in the presence of active classroom teaching may be similar to *faculty barriers* to imple-

menting these innovative teaching approaches. This intriguing potential parallel offers one additional key insight. The differential language of student resistance and faculty barriers reflects assumptions about the origins of each of these phenomena. The term "student resistance" implies an internal source of resistance from within students themselves, which is inconsistent with the research literature described above, in which students detail external, often instructor-driven, origins of resistance. In contrast, the term "faculty barriers" seems to imply that external sources are causative and somehow preventing faculty members from acting in ways that they would choose to act otherwise. Perhaps just a small shift in how we view student resistance—recasting the phenomenon as *student barriers* to engaging in active-learning approaches—may be helpful in how we choose to understand and address these issues in our classrooms. If we can empathize with the challenges students face in our classrooms, sometimes challenges of our own making, then perhaps we can engage our students as colleagues and partners in the teaching and learning process, subsequently preventing or reducing resistance behaviors.

POTENTIAL STRATEGIES FOR PREVENTING STUDENT RESISTANCE BEFORE IT BEGINS

When teachers try something different in the classroom and students resist, the teacher may back down. Often, this is due to fear of what will happen to their student evaluations and contract renewals. I have been told by many instructors that they once tried active learning but the students hated it, so they went back to what was tried and true. (Silverthorn, 2006, p. 139)

There is little doubt that the potential for student resistance in response to attempting a new teaching strategy is a widespread fear of many instructors. Even the rumor that another instructor who tried innovative approaches may have experienced student resistance could be enough to deter instructors from ever trying these teaching methods themselves. While addressing student resistance in a classroom when it arises is no doubt a key concern for many instructors, preventing student resistance altogether would seem to be the ultimate goal. Few research studies appear to have directly investigated the efficacy of different teaching strategies in avoiding student resistance. However, numerous potential approaches are commonly suggested by experienced instructors and faculty professional development specialists that appear to address the classroom concerns raised by students as reported in the literature (Silverthorn, 2006; Prince and Felder, 2007; Smith, 2008; Science Education Initiative, 2013). Below are several such teaching strategies, connected where possible to the research literatures presented above.

Practice Instructor Immediacy—Decrease Social Distance between Yourself and Your Students

While teacher (mis)behavior may play a role in student resistance, teacher behaviors are also central to significantly and positively influencing student motivation and learning. Researchers in social psychology have characterized a phenomenon dubbed *instructor immediacy*, the presence of

behaviors by an instructor that effectively decreases the social distance between themselves and their students (Mehrabian, 1971; Science Education Research Center [SERC], 2013). Such behaviors encompass a variety of both verbal and non-verbal behaviors that are observed by students and influence their perceptions of their relationship with their instructor. Does the instructor smile? Does the instructor know students' names? Does the instructor seem comfortable with students? Does the instructor make eye contact? Does the instructor move around the classroom, physically reducing the distance between himself or herself and students? Importantly, research evidence suggests that high levels of instructor immediacy may be inversely related to student resistance in a classroom, as well as being positively correlated with student learning (Kearney *et al.*, 1988; Kelley and Gorham, 1988). One study of the relationship between student resistance and instructor immediacy found that students were significantly more likely to comply with instructor requests from a moderate or highly immediate instructor than requests from a low-immediacy instructor (Burroughs, 2007). In addition, high instructor immediacy has been shown to correlate with student motivation to learn, as well as affective and cognitive learning (Titsworth, 2001; Witt and Wheelless, 2001; Allen *et al.*, 2006). While instructor immediacy is likely not a term that many undergraduate biology instructors are familiar with, many no doubt either consciously or unconsciously engage in such behaviors. Actively maximizing these behaviors—smiling, learning students' names, moving around the classroom space, and making eye contact—are simple behaviors that could prevent or reduce student resistance in college biology classrooms, perhaps through countering the impact of instructor misbehaviors that may also occur.

Be Explicit with Students about the Reasoning behind Your Pedagogical Choices

Currently, there is little systematic investigation about the extent to which biology instructors attempting innovative teaching explicitly share with students the reasoning behind the pedagogical choices they are making in their classroom. However, many experienced practitioners and faculty development experts often encourage instructors to tell students why the teaching methods being used have been chosen as a method of blunting potential student resistance. Some have referred to this explicit discussion of pedagogical choices with students as *framing*, the use of language and class time to highlight the nature of the classroom environment rather than the conceptual ideas being taught there (Science Education Initiative, 2013). Sample strategies and language from a variety of instructors who have used framing in their classrooms include sharing with students findings from studies about research on the efficacy of active learning, engaging students in reflecting on how they learn, and establishing expected student behaviors during class (Science Education Initiative, 2013). Alternatively, Richard Felder provides what he calls “mini-sermons” to help explain to students why he uses the teaching strategies he does, including responses he has used to address student complaints about working in groups, writing assignments, and his choice of interactive teaching methods over lecture (Felder, 2007).

Being explicit with students about your pedagogical choices may be useful on the first day of a course, as well

as throughout the duration of the course term. Regardless of when they are used, these strategies from different sources all encourage instructors to metaphorically “pull back the curtain” on teaching and reveal for students the reasons behind the teaching choices being made. Not only might this practice provide students with a rationale for why their classroom experience in a course is the way it is, it may also effectively increase instructor immediacy through cultivating a partnership with students in the teaching and learning process. By explaining pedagogical choices to students, we treat them as colleagues, discussing with them—the same way you might with another instructor in your department—how you plan to teach and why you think this method will help them learn.

Structure Student–Student Interactions to Promote Fairness

As described above, one potential source of student resistance is poor interactions with peers that may result from the increase in student–student interactions often associated with the implementation of active-learning strategies. The social loafing research literature offers three specific, research-based suggestions for maximizing positive student interactions in highly collaborative classrooms and decreasing incidents of social loafing: decrease group size, decrease project scope, and provide mechanisms for peer evaluation (Aggarwal and O'Brien, 2008). First, when implementing new teaching approaches, keep the group size small. Not only is it more difficult to be excluded or not participate in a pair, communication is likely less complex, and there will likely be fewer ideas to entertain and negotiate. If students are expected to collaborate outside class, the choice of smaller group sizes simplifies the scheduling of meetings and division of labor on a project. Second, decreasing project scope is another method for promoting fairness in student collaborations, reducing social loafing, and preventing student resistance. Rather than assigning a long-term project to the same student group, instructors could break the assignment into multiple smaller experiences that can be tackled in student groups that change in composition throughout the course. Not only might this strategy allow students to work with different partners and experience divergent perspectives, it could also minimize the likelihood that students would be stuck in an unpleasant collaboration for very long. If social loafers were present in the course, they would at least not become the burden of any one subset of students over long periods of time in this scenario. Third, if students are going to work regularly or extensively in groups, instructors can provide multiple mechanisms for students to share with them an evaluation of the quantity and quality of their peers' contributions (Brooks and Ammons, 2003). Attention to these three strategies in structuring student interactions in the classroom, as well as host of other strategies for generally maximizing fairness in classrooms, may be promising strategies for preventing student resistance from arising (Tanner, 2013).

Use and Make Grading Rubrics Public for Students to Avoid Perceptions of Grading Unfairness

One cluster of teacher behaviors that students reported in the literature as a potential source of resistance included “unfair

testing," "unfair grading," and "shows favoritism or prejudice." While there may be much more complex and deeper issues at play when questions of prejudice are raised, issues of unfair testing and unfair grading can be addressed. In particular, research has been conducted on students' perceptions of *procedural justice* in a classroom—how grades are assigned and how course policies are enacted (Tyler and Caine, 1981; Chory-Assad, 2002). Results from these studies suggested a positive correlation between students' perceptions of classroom fairness and decreases in student resistance and aggression, as well as increases in student motivation (Chory-Assad, 2002). Additionally, it appears that perceptions of fairness in grading procedures were more influential in student evaluations of an instructor than the actual grade an individual student received (Tyler and Caine, 1981). As such, the regular use of scoring rubrics—explicit criteria about how an instructor will be evaluating student work—may be a simple strategy for reducing students' perceptions of unfair grading (Allen and Tanner, 2006). Often, rubrics are thought of as a private tool for instructors, used when assigning grades, but never seen by students, discussed in class, or shared publicly. However, rubrics can indeed be made public throughout the teaching and learning process. Providing a rubric to students before assigning a task, before they even begin their work, has the potential to make the learning goals, expectations, and criteria for evaluation clear when it is most needed by students. In the case of quizzes and exams, making specific grading rubrics public after the fact can help all students to understand the scores they have earned, reduce the number of arguments over individual points earned, and give instructors the opportunity to emphasize that students do indeed earn their scores, with instructors merely applying rubrics to fairly calculate scores earned by all members of the classroom community. In these ways, increased use of public scoring rubrics for evaluating student work may be a useful strategy in preventing some types of student resistance related to perceived unfairness in classrooms.

Vary the Teaching Methods Used

Finally, another approach that may be useful in preventing student resistance is simply to regularly vary the teaching methods used during a course. Individual instructors may find particular teaching approaches attractive and comfortable and may therefore employ these particular techniques extensively in their courses. However, different teaching approaches and activities are likely to resonate in different ways with different students. More introverted students may be more in their comfort zone during clicker questions or during moments of in-class reflective writing, while more extroverted students may be more in their comfort zone during extensive group work or pair discussions. One might hypothesize that students who are consistently out of their comfort zone in a classroom might be more likely to develop resistance to the teaching approaches used there. As such, simply varying the teaching approaches used throughout a course term may be one way to provide points of access to positive classroom experiences for diverse populations, perhaps quelling resistance that could arise from employing more singular teaching approaches that may consistently alienate a subset of students.

POTENTIAL STRATEGIES FOR ADDRESSING STUDENT RESISTANCE WHEN IT ARISES

While we all hope to avoid student resistance in our classrooms, it is not always possible. Sometimes the best resolution is to provide a forum for students to express what is effectively supporting their learning, as well as what is not. Providing a forum for each student to reflect on and share his or her ideas about how the course is going—in the second week, midsemester, and multiple times before formal student evaluations are given at the end of a term—may help an instructor identify, understand, and address student concerns about the teaching and learning in a course long before those concerns can grow into full-scale student resistance. In addition, systematic collection of student opinions allows instructors to be quantitative about what proportion of their students may be exhibiting resistance behaviors. So, what are some ways to make this happen?

Give Students Mechanisms to Voice Concerns before They Become Resistant

Student resistance may appear differently in different classrooms (see Table 1). Collecting systematic classroom evidence about student perspectives on the learning environment and student experiences within it is a simple way to gauge potential resistance and its sources. In fact, student resistance may be stemming from issues other than what the instructor might predict or expect to be the cause. Collecting classroom evidence of this sort has the dual benefit of providing instructors with information about what their students are thinking, as well as giving students a formal mechanism through which their ideas, concerns, and potential frustrations can be heard.

If you decide to collect opinions from students about the classroom learning environment, there are a few additional considerations. First, what do you specifically want to know? Would you like students to offer their general impressions of the learning environment or rather their perspectives on the effectiveness of a particular assignment on their learning? Table 3 offers several potential assessment modes and sample questions that may be used to increase communication between students and the instructor, as well as uncover potential triggers of student resistance. Second, should the evidence collected be named or anonymous? In many cases, anonymous feedback may allow students to convey their concerns more freely to the instructor without fear of retribution. However, the requirement of names on such an assessment could allow the instructor to maximize the number of students responding by giving (extra) credit to students for their responses, and perhaps increase the professionalism and constructiveness of the feedback offered. Importantly, these approaches require minimal instructor preparation or class time. The simple act of an instructor providing an avenue by which students can share their perspectives about the classroom may in and of itself be a key strategy for reducing student resistance.

Quantify Student Perspectives and the Level of Resistance in the Classroom

So, how many of the students are actually resistant to a particular teaching strategy or particular assignment?

Table 3. Methods for collecting evidence about students' concerns

Assessment mode	Sample queries	Potential benefits
In-class clicker question	Has this activity/assignment been . . . A. Very useful for your learning B. Sort of useful for your learning C. Not so useful for your learning D. I did not do the assignment.	<ul style="list-style-type: none"> • Is anonymous • Requires little in-class time • Generates quantitative data • Provides immediate results that <i>can</i> be shown to students
Minute paper/index card	To what extent do you agree with the statement: "I feel that the teaching approaches used in this course are improving my understanding of biology." Circle agree/disagree and explain your choice below.	<ul style="list-style-type: none"> • Provides option for anonymous or named feedback • Allows students to take a stand (agree/disagree) and then explain their reasoning. • Produces open-ended responses
Online assignment/reflective journal	Write ≥ 300 words evaluating what about this activity/assignment most supported your learning and/or least supported your learning.	<ul style="list-style-type: none"> • Requires no in-class time • Gives students extended time to reflect and be metacognitive about their learning • Produces open-ended responses
KQS: Keep, Quit, Start cards (Center for Teaching Development, 2013)	To support your learning in this class, please propose one thing you would suggest that I (the instructor) <i>Keep</i> doing, one thing to <i>Quit</i> doing, and one thing to <i>Start</i> doing.	<ul style="list-style-type: none"> • Creates an opportunity for both positive and negative constructive feedback about the classroom environment from every student in the class • Produces open-ended responses

Systematic collection of the kinds of assessment evidence described above from *all* students in a course, not just a few, is key. Only then can an instructor accurately gauge whether concerns they might have heard during office hours or from individual students are really the concerns of a larger number. Quantification of student responses through systematic assessment methods may reveal a concern of the majority of students that needs to be addressed. However, another possibility is that what an instructor may perceive as large-scale student resistance is really only an issue for a vocal few. If the feedback identifies a small group of unhappy students, the instructor may want to reach out to this group to further discuss their concerns.

Sharing the Concerns You Have Heard and Your Approaches to Addressing Them with Students

How can data about student resistance in the classroom be utilized effectively? Whatever data are obtained, sharing the results in some way directly with the students may be another strategy for addressing student resistance. Sharing the results—at least some aspects and not necessarily all—confirms for students that you indeed were thoughtful in reading and considering their ideas. Additionally, sharing the data may help students understand that their opinions as a class are not uniform, reiterating for them that it is not trivial to teach so many unique individuals in a single course and that the pedagogical decisions you make are meant to provide all students with access to learning. Finally, sharing results about evidence you have gathered may serve to build community in the classroom, because everyone is provided access to the information and your thoughts about how to go forward.

OPPORTUNITIES FOR INVESTIGATING STUDENT RESISTANCE AND EVALUATING INTERVENTION STRATEGIES

Existing research on student resistance that we have included here has come primarily from communication studies efforts, investigating college classrooms and college students generally without investigation of the unique qualities of student resistance that may exist among different disciplines. In our search of the research literature, we found no published studies that focused primarily on characterizing and quantifying student resistance to active-learning strategies used in undergraduate biology classrooms. In discipline-based science education research more generally, analysis of student resistance to innovative teaching has been minimally treated, if at all, within studies focused on other questions (e.g., Crouch and Mazur, 2001). Thus, there appears to be enormous opportunity for undergraduate biology education research, as well as discipline-based science education research more generally, focused on understanding student resistance and teaching interventions to address it. Below are examples of questions that apparently are not addressed in the current literature.

How might we go about characterizing, measuring, and quantifying the presence of student resistance in college biology classrooms? How might student resistance behaviors in college science courses, biology courses in particular, differ from behaviors previously reported for college students more generally (Burroughs *et al.*, 1989)? How might levels and kinds of student resistance vary between courses taken in a student's major area of study compared with general education courses?

How does an instructor's perception of student resistance align with an independent measure of student resistance? In other words, to what extent do a small number of students exhibiting resistance behaviors in classrooms influence faculty teaching choices, even when the majority of students

may not be resistant? To what extent do students in biology classrooms exhibit passive versus active forms of resistance?

To what extent can we predict the types of students who are likely to show resistance to active-learning strategies? To what extent does student resistance vary with the type of institution in which the students are enrolled? To what extent are student resistance behaviors related to the prior achievement of the student in traditional classroom environments? For example, might students who have been successful in traditional learning environments (e.g., students with a history of high grades or who are attending highly competitive universities), be more resistant to changes in biology teaching approaches compared with students who have had less success in traditional learning environments (e.g., students with a history of lower grades or who attend less competitive universities)?

In contrast to the instructor misbehavior studies described above (Kearney *et al.*, 1991b), what instructor behaviors and/or language do students report as best engaging them in new teaching approaches? To what extent are these positive instructor behaviors inversely related to the presence of student resistance in a college biology classroom? To what extent do strategies like those described in the section above minimize or address student resistance in classrooms?

Little evidence from the existing research literature would appear to support the assumption that innovative teaching techniques themselves are the primary origin of student resistance in a college classroom. Evidence-based insights into the questions above, and many more not listed, could help the undergraduate biology education community as a whole to gain insight into the prevalence and origins of that student resistance which causes such concern for instructors aspiring to introduce new approaches into their teaching.

To return to where we began, evidence about the origins of, and solutions to, student resistance may be critical in supporting continued pedagogical innovation by those committed and thoughtful instructors who are attempting to fundamentally change the way they teach biology, instructors who need time and space to try, practice, fail, iterate, and try again. Evidence about student resistance could help these instructors partner with their students in implementing new teaching approaches, rather than returning to old teaching practices in the face of student resistance, large or small.

POSTSCRIPT: OPTIMISTICALLY, WE ARE IN A PERIOD OF TRANSITION . . .

It seems we are in a time of transition, in which estimates are that less than half of all college faculty members are using student-centered teaching approaches (Hurtado *et al.*, 2012). As such, if you introduce an innovative teaching strategy into your classroom, it is likely that there are students in your course who have not previously experienced anything like this before. Even if they have, their experiences may not have been positive. However, in three, five, ten, or some unknown number of years, we may enjoy a different scenario in which so many undergraduate biology instructors are using active-learning strategies in the classroom that students will come to class expecting to participate actively and will be resistant to a lecture format that does not provide this engagement.

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