

ARTICLE

Building an Inclusive Classroom

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Over the past two decades, a growing body of work has focused attention on the need for change in science, technology, math, and engineering (STEM) undergraduate education in order to broaden the participation and retention of a more diverse population of students. Increasing course structure and the use of active learning strategies are two of the ways that educators have successfully created more inclusive classrooms. This growing body of work makes it possible to adopt pedagogies based on the evidence that

these strategies are effective for all of our students, and that they can help us close the achievement gap for underrepresented populations of students. This paper provides a brief summary of some of the strategies instructors may consider adopting in their own classes to provide an inclusive, structured environment.

Key words: inclusive pedagogy; active-learning; retrieval practice; equitable teaching

Students come to our classrooms with a variety of skills and life experiences that have a significant impact on their success. Thinking back to your own undergraduate experience, do you remember your first undergraduate science class? I do. As a minority, first-generation student, I felt completely out of my depth in science classes, and I committed to taking only the science classes I needed to graduate. Would it have been different had I been coming to campus with a different set of skills or life experience? It's hard to know, but what the data say is that feelings of exclusion and alienation are reported by students of diverse backgrounds in undergraduate science classes (Tobias, 1990; Seymour and Hewitt, 1997; Johnson, 2007). I was ultimately successful in my pursuit of a science education because of a research project at my institution investigating the success and persistence of women in science, but this kind of lucky intervention isn't something that happens for everyone. Students leave the sciences for a variety of reasons, and while we might assume that they leave because of a lack of talent or competence, the research on this subject suggests otherwise (Tobias, 1990; Seymour and Hewitt, 1997). The drop-out rates among introductory students, and achievement gaps for underprepared and underrepresented student groups, have conspired to leave STEM fields suffering from a lack of diversity (Seymour and Hewitt, 1997). However, significant efforts have been made to transform undergraduate STEM education in recent years, and a shift in pedagogical strategies aimed at providing inclusive learning experiences for *all* undergraduate students (National Research Council, 2011; PCAST STEM Undergraduate Working Group, 2012).

As a STEM educator, my focus over the past several years has evolved from being solely concerned about *what* students must know to be successful in my classes, to *how* I will get them to know it. This is especially true for my Introduction to Neuroscience class, which is a required gateway class students must complete to minor or major in Neuroscience. Introductory STEM classes are significant in the lives of many students, who often talk about them as "weed out" courses whose sole intention is to explicitly

prevent some students from moving forward. This perception isn't necessarily wrong: Introductory STEM classes often have high failure rates (e.g., Burrowes, 2003; Wischusen and Wischusen, 2007; Reardon et al., 2010; National Science Board, 2016). There is now a growing body of work suggesting that it's not that students can't do the work, but that some instructors are slow to change their pedagogy to ensure that students with a range of skills and life experiences can (Freeman et al., 2011, 2014; Haak et al., 2011; Eddy and Hogan, 2014; Killpack and Melon, 2016). What ultimately convinced me to change my methods was the data, and here's the data point that stuck with me: students in traditional lecture classes are 1.5 times more likely to fail than students in active learning classes (Freeman et al., 2014). I was struck by this statistic and confronted with the idea that continuing to offer traditional lecture classes might be considered educational malpractice. I immediately committed to making some changes, and in the process of doing so, shifted my focus from a "student deficit model" to a "dynamic model" of thinking. This entailed moving away from the idea that some students (e.g., low performing students) are somehow intellectually lacking or incapable of doing the work and getting comfortable with the idea that a lack of structure in my course design and classroom environment was the real problem (Ford and Grantham, 2003; Tanner, 2013).

Transforming my pedagogy is a work in progress, but I have seen some preliminary learning gains as I get comfortable with the changes I made. Lucky for me, I have found myself surrounded by talented colleagues who have been eager to share their ideas and resources with me (this work was featured in an article in the Chronicle of Higher Education found here: <https://www.chronicle.com/article/Traditional-Teaching-May/243339>). What I've come to know is that to really have a shot at teaching every single student in my class, I need to provide structure. As many before me have pointed out, an inclusive class is a structured class: both course design and the classroom environment can (and should) be structured to promote an inclusive learning experience that can be accessed by all

students in the class, regardless of prior learning history, demographic/social identities, or belief in their ability to succeed (e.g., Freeman et al., 2011; Haak et al. 2011; Tanner, 2013; Eddy and Hogan, 2014; Killpack and Melon, 2016). Putting the effort into creating structure for your students is a significant act of “academic care” that is very likely to extend beyond the walls of your classroom. What follows is by no means a comprehensive “how to,” nor is it an exhaustive review of the literature. My hope is that it may lead to some reflection about your own pedagogy, and maybe you will find a thing or two to try in your own classes. For a more exhaustive overview of inclusive teaching strategies, I direct you to a superb summary by Kimberly Tanner (2013). Her extensive and ongoing research on this subject is an invaluable resource when you’re ready to get started or need some fresh ideas. I access her work at The Science Education Partnership and Assessment Laboratory at San Francisco State University when I am looking for new evidence-based ideas (<http://www.sfsusepal.org/>).

STRUCTURE COURSE DESIGN

A structured course design provides an environment that sets our students up for success (Freeman et al., 2011; Haak et al., 2011; Eddy and Hogan, 2014). Building a structured course for our students should involve some key elements, including a syllabus that communicates clear expectations, the learning goals and intended outcomes for each lesson and class session, frequent opportunities for retrieval practice, and frequent and low stakes assessments.

It took me some time to really appreciate how frequently student expectations were different from my own. Students expected that if they read (and then maybe re-read) their textbooks and notes and were physically present in class, they’d master the course material and do well on exams (Karpicke et al., 2009). While this approach may lead to knowledge acquisition and comprehension, it doesn’t typically produce the kind of learning most instructors are expecting (Callender and McDaniel, 2009). Certainly, I did expect students to achieve knowledge and comprehension, but I also expected them to be able to apply, evaluate, and synthesize what they were learning. Students were usually at a loss as to how to meet these expectations, and there was frustration expressed on both sides. When I sought out help from my Institution’s Center for Faculty Excellence and Office of Instructional Innovation, I was directed to some excellent resources, including work by Drs. Kelly Hogan, Sarah Eddy, and Kimberly Tanner, and I set to work putting their ideas into practice. I am always working to improve, and so I consider all of my classes works in progress, but here you will find some strategies for communicating clear expectations, as well as some ideas for building structure into your course design to help students meet those expectations.

I begin by making my expectations clear in my course syllabus (see Supplemental Material). I introduce students to Bloom’s taxonomy (Bloom et al., 1956), and clearly describe where I want them to get to in order to demonstrate mastery of the course content. Our goal, as a class, is to move from remembering to applying, evaluating, and

synthesizing information. In class, I provide examples of the difference between a “remember” test question, and an “apply” test question, and use this discussion as an opportunity to talk with students about the rationale for my course structure, a strategy that has worked well for many of my colleagues when they transformed their classes to structured active-learning classes. I take these steps because I need my students to believe that I am interested in their success, and I think that letting them know I have their learning success in mind when I design a class helps to communicate that idea. This “instructor talk” may also be crucial for getting the buy in that you need from your students and may also quell resistance to implementing a structured course design (Seidel and Tanner, 2013; Cooper et al., 2017).

Students also need us to be clear about what we want them to know. I am not talking here about simply “what’s going to be on the exam,” but rather what we want them to be able to *do* with the information they have acquired. Providing learning goals and outcomes for each topic and class session explicitly lays out what you want students to know and be able to do. Use specific and deliberate outcome verbs (e.g., “predict,” “compare and contrast,” “diagram”). Creating clear learning goals and outcomes also facilitates the use of backward design techniques to create effective activities, assignments, and assessments that align with the learning goals and outcomes you have provided. In class, students should be reminded of the objectives, and your class time should be structured to meet the learning outcomes. A fantastic resource to help you create course structure using evidence-based backwards design methods is Scientific Teaching by Handelsman et al. (2007). I also highly recommend attending a Summer Institute on Scientific Teaching (<https://www.summerinstitutes.org/>) to practice backward design.

As neuroscientists, it should come as no surprise to us that distributed practice is best for learning. First described by Ebbinghaus (1885), this “spacing effect” refers to the observation that repetitions spaced over time produces stronger memories than repetitions massed closer together in time. A large body of research has shown the spacing effect for a wide variety of skills and subjects (see Smith and Scarf, 2017), and we tell our students all the time that they need to avoid massed studying, or “cramming” for their exams if they hope to retain the information beyond any single exam. Even if you’ve handed out this tidbit of advice, if you ask your students about their study habits, you will probably find that many still engage in massed studying right before an exam (McIntyre and Munson, 2008). After poor performance on an exam, some students might try to solve the problem by attempting to study longer, because intuitively, more studying should be better. We know, however, that an increase in study volume does not always correlate with performance (e.g., Schuman et al., 1985; Plant et al., 2005), so even with these adjustments, students might not be able to improve performance. In addition, many students self-report that they are using relatively ineffective study techniques such as reading and re-reading their textbook and notes (Karpicke et al., 2009; Dunlosky et al., 2013), rather than focusing on retrieval practice (Plant et al.,

2005; Karpicke and Roediger, 2008). In this unstructured learning environment, many students may begin to view their poor performance as an indication of their ability (or inability) to learn, rather than an issue with study methods and the course structure. Our task for helping our students in this situation is straightforward: require frequent and distributed retrieval practice as part of our course structure.

A number of educators have transformed their STEM classes to structured formats that include frequent and required retrieval practice (Freeman et al., 2011; Haak et al., 2011; Eddy and Hogan, 2014). In one example, Eddy and Hogan (2014) demonstrated that pacing students through the semester with small homework assignments and low stakes assessments helps students distribute their study efforts and significantly improves performance on higher stakes assessments. Requiring practice is key: Eddy and Hogan (2014) also found that without accountability, students don't do the retrieval practice they need to succeed. Ideally, we should aim to require retrieval practice before, during, and after class, and we shouldn't assume that students have a good grasp of how to do this on their own (e.g., Karpicke and Rodiger, 2008; Karpicke et al., 2009). Providing opportunities for structured *required* retrieval practice sets *all* of our students up for success, and this appears to be especially true for underserved students (Freeman et al., 2011; Haak et al., 2011; Eddy and Hogan, 2014). These opportunities for practice should be made up of low stakes assessment opportunities, in order to minimize the achievement gap in our classes. Certain student groups (e.g., women) may be at a disadvantage when high-stakes assessments are used, but the achievement gap can be minimized when mixed assessment methods are used (Cotner and Ballen, 2017).

STRUCTURE CLASS ENVIRONMENT

Providing a structured classroom environment is absolutely crucial for promoting feelings of inclusion and belonging for our students (Trujillo and Tanner, 2014; Tanner, 2013). This may be particularly important for first generation college students, students of color, and women, as a sense of belonging and the creation of a sense of community within a class may prevent attrition from STEM class (Trujillo and Tanner, 2014; Killpack and Melon, 2016). Eddy and Hogan (2014) that by providing structure in an Introduction to Biology class students were twice as likely to view their class learning environment as a community.

I begin setting up expectations for what our classroom environment will be like in my syllabus. I did not come up with this idea on my own; there are some really amazing student groups on my campus who have advocated for faculty to include things like diversity statements on course syllabi, and I am happy to oblige. My students have access to the syllabus well ahead of the first day of class, and I use a syllabus quiz (low stakes assessment!) to get students to think about what will happen in our classroom before they arrive on the first day (e.g., classroom norms and expectations). Being explicit about promoting access and equity for all of your students is fundamental to creating a sense of community among students (Tanner, 2013). My syllabus explicitly states that my class is an active learning

class, and what that entails. It also includes an explicit statement to my students that they belong in my class and that they deserve to be there. Increasing feelings of belonging in our classes can help to significantly reduce the "stereotype threat" that many students face (Rydell and Boucher, 2010).

On the first day of class, students work in small groups to generate additional classroom norms that they'd like to see. I ask students to think about how we can ensure that everyone in the class is successful. In asking, I am hoping to bring my students on as a partner in the learning process. I am always delighted to observe that students have similar ideas to my own, and align with the data out there (Tanner, 2013). Here are some things I practice regularly to create a structured and inclusive class environment:

1. I promise not to cold call unless students have had an opportunity to think and discuss ideas with a partner or small group. In that case, I will call on reporters from the groups to share with the class. To ensure that everyone theoretically has a chance of being the reporter for their group, I assign reporters in each group using characteristics of my students that helps them get to know each other. Thus, I might ask that the "person with the most pets" to be the reporter for that class.
2. As Tanner (2013) has pointed out, one of the simplest things you can do to make students feel comfortable in class is to give them time to think. A wait time of just 3-5 seconds gives students time to process what you've said, and classic work by Rowe (1974) demonstrated that students are more willing to participate when given this time. Another strategy for giving students time to think is to have them respond to a prompt in writing. I am a huge fan of using index cards to do this. Make sure that your prompt and instructions are clear; include how long they have to think, how many ideas you'd like them to generate, and how their responses will be shared out in class. Many students need these structured instructions to feel confident that they are using their think time wisely. To make participation anonymous, the cards can be shuffled or passed multiple times before a few are selected for sharing out to the class. This method gives students an opportunity to hear what others are thinking, and you will get a sense of where your students are. This method can also support a think-pair-share activity. Providing adequate think time, structured instructions, and a clear idea of how ideas with the class are key. If I am using this method a couple of times in a single class session, I mentally divide the room and let students know that I will be asking students in some part of the room to share out, and then I will switch to another location to ensure I am hearing from everyone.
3. I monitor who I have heard from, and who I haven't. In large classes, I monitor areas of the room, and in small classes I can keep track of who has contributed. I insist on hearing many voices in each class period and will sometimes simply ask for a contribution from someone I haven't heard from on that day. I tell students this before I send them off to work in groups or pairs, and then monitor the class. I will then quietly ask someone if they

will share out so they have lots of time to think and discuss ideas with their group or partner before I call on them.

- Learning your students' names, or at least accessing them in large classes when that's impossible, is something students ask for and appreciate when I collect anonymous feedback from them. If you are not able to learn everyone's name, simply asking a student to tell you who they are before they report out or share something gives you an opportunity to use their name in that class period.

Connect the concepts you are teaching to culturally relevant and diverse examples. Cultural diversity is sometimes hard to tie into particular topics, and when that happens, I do not shy away from acknowledging that in the history of Neuroscience, diversity has been lacking and still is lacking. You might also address issues of relevancy by using supplemental readings and discussions to contextualize what students are learning. For example, when we are learning about pain pathways, students do supplemental reading on the history of discrimination in treating pain (e.g., <https://www.theatlantic.com/health/archive/2017/02/chronic-pain-stigma/517689/>).

STRUCTURED CLASSES EXPRESS ACADEMIC CARE TO OUR STUDENTS

Building structure in our course design and classroom environments creates an inclusive educational experience for our students. This structure allows students with diverse backgrounds, skill levels, and life experiences to succeed. The message we can send to our students through our pedagogical choices is "you belong here and you deserve to be here." This message is critically important to build a sense of belonging on campus, which can have a significant impact on academic success (Trujillo and Tanner, 2014).

Inclusive teaching is more than a set of specific practices, it is a change in the way we view our students and care for them in our classes. As educators, we can practice academic care in our teaching by being mindful of the pedagogical choices and classroom environments we

create for our students. This kind of deliberate, reflective instruction moves us away from a prescription or check list; instead we should aim to assess the evidence on the particular teaching practices we use or are interested in using, try new things incrementally, and most importantly, listen to our students.

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Before class	During class	After class
<ul style="list-style-type: none"> Complete assigned readings, watch videos Answer guided reading questions Identify 'muddiest point' in the assigned readings, videos, etc. Reflect on what has been learned 	<ul style="list-style-type: none"> Identify and address "muddiest point" Work on problem sets, respond to open ended prompts with peers to facilitate reciprocal learning (e.g., think-pair-share) Take practice exam 	<ul style="list-style-type: none"> Create Peerwise questions Answer Peerwise questions and provide constructive feedback to other students about their questions
<p>Assessment: low stakes quiz, complete guided reading questions</p>	<p>Assessment: PollEverywhere questions, practice exam</p>	<p>Assessment: Completion of homework assignments (e.g., problem sets, Peerwise)</p>
<p>Resource: Novak et al. (1999) Just-In-Time Teaching: Blending Active Learning with Web Technology Heiner et al. (2014) Preparing student for class: How to get 80%of students reading the textbook before class</p>	<p>Resource: Barkley et al. (2014) Collaborative Learning Techniques: A Handbook for College Faculty, 2nd Ed. Tanner (2013) Structure matters: twenty-one teaching strategies to promote student engagement and cultivate classroom equity.</p>	<p>Resource: McQueen et al. (2014). PeerWise provides significant academic benefits to biological science students across diverse learning tasks, but with minimal instructor intervention.</p>

Table 1. Ideas and resources to design activities for students to complete before, during, and after class.

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Received July 26, 2018; revised August 13, 2018; accepted August 15, 2018.

This work was supported by UNC's Center for Faculty Excellence. Thank you to Drs. Kelly Hogan and Viji Sathy for generously sharing teaching materials, ideas, and mentorship.

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