

Structuring Courses for Equity

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Abstract

As instructors, we continually look for new ways to create equitable learning environments and support learning for all students in our courses. Recently, we have explored ways that we can increase structure to better support students. We have identified four evidence-based elements that we include in our course design and implementation: 1) structured assessments and feedback; 2) structured out-of-class learning; 3) structured class time using inclusive practices; and 4) structured assignments using transparent design. In this essay, we identify some relevant literature to address each of these levels of structure and describe our experiences with implementation at each level to support equitable classroom environments.

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INTRODUCTION

We view our primary responsibility as instructors to structure learning experiences to allow all students to be successful and included in the learning process. However, the persistent inequities in student success rates for underserved student groups suggest faculty should consider continuing to improve teaching practices to support more students (1,2). Fortunately, a growing base of evidence demonstrates that faculty can implement more structure into their teaching to increase success of traditionally underrepresented and underserved students (for review see (3)). In this essay, we present a framework based on four separate elements of course structure: 1) structured assessments and feedback; 2) structured out-of-class learning; 3) structured class time using inclusive practices; and 4) structured assignments using transparent design (Figure 1). This framework is grounded in literature of inclusive, evidence-based pedagogy. We have included the four levels in our own teaching practice. Fortunately, none of these structures are so prescriptive as to limit student freedom to explore individual learning strategies; instructors can personalize adoption of different levels of structure to align with their course goals and objectives. For each element of structure, we provide examples and reflection of ways we have implemented the structure in our lower division and upper division life science courses. Individually and collectively, these elements promote equitable student success.

Such elements of structure clarify for students what is expected in our courses and how to navigate the unwritten rules of college, while also directing faculty effort in

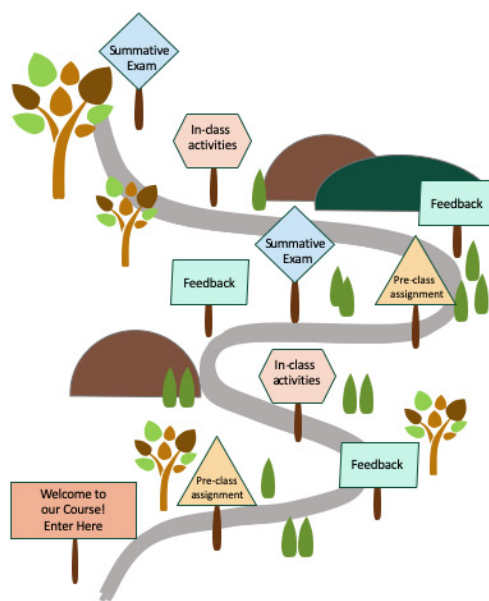


Figure 1. Structuring courses with evidence-based practices to promote equity. The image represents the map we provide students to the structured path through our courses. The map provides guide points for students in the form of transparently designed assignments, activities, regular feedback, and assessments.

productive directions. Just as student confusion about how to study can create roadblocks to learning, faculty member's lack of feedback on student learning can misdirect their planning. Often faculty do not know how students study or how to suggest more effective ways for students to learn course

material. Increased course structure makes the path through a course clearer for both students and faculty. Therefore, we visualize these structured elements as a road map based on what it takes to succeed in our courses. Instructors may think it is obvious what students need to do in their courses, but deliberately structuring each course assessment or activity with signposts and directions along the road helps more students find their way.

STRUCTURING ASSESSMENT AND FEEDBACK

The first element of structure includes summative (e.g., high stakes unit exams) and formative (e.g., low stake clicker questions or quizzes) assessments across a course that are: 1) frequent; 2) interleaved with topics and types of problem solving that are mixed and repeated throughout the term; and 3) provide students with immediate feedback about their learning. Collectively, these three components have among the most significant effects and best evidence for improving student learning (4,5). Frequent assessments that are spaced throughout the course promote the “testing effect” or test-enhanced learning to benefit student learning, retrieval, and retention of concepts (6) and improve course performance for traditionally underserved students (7,8). Interleaved problem solving, where students can return to the same content in a slightly new context throughout the term, creates desirable difficulties for students (9) because students have the opportunity to recall and repeatedly practice with information throughout the term. Even when students find it challenging to return to material for review, this interleaving allows multiple opportunities for students to learn and re-learn material. Together, structured assessment scheduled with frequent opportunities for feedback improve learning for all students, incentivize students to study more regularly over the term, and decrease exam performance inequality for underserved students (6,8). One advantage of purposefully designing structured formative and summative assessment learning experiences for students is that we must regularly confirm that assessments align directly with course goals and learning objectives. By adding in more frequent assessments, some faculty report to us that they uncover student misconceptions and spend more time on fewer topics. Simultaneously, students develop a deeper understanding of those topics than if the course emphasized covering all topics in a textbook.

Examples from our courses

At our large public research institution in the Pacific Northwest, instead of waiting until the middle of the term to give our first exam, we provide early and frequent formative assessment opportunities for students. We create these opportunities if we have 20 or 300 students enrolled in the course. For example, students complete multiple formative assessments each week with varying types of clicker questions and peer discussion (10,11) and out-of-class quizzes with interleaved content all of which provide students with immediate feedback (Table 1). In some courses, we implement two-part, cumulative summative assessments (12-14) where students engage in peer feedback with exams as intentionally designed learning experiences. Students first complete an exam independently (80% of their exam grade) and then collaborate with peers either in the class or after class to complete the same exam (20% of their exam grade). In this format, students constantly add to their body of

content knowledge, receive immediate feedback, uncover and address their misconceptions, and grapple more with difficult concepts. Some of the best content discussions we have heard among students in our courses have occurred during the group exams when students are deeply invested in improving their understanding of content after the individual portion of the exam.

STRUCTURING OUT-OF-CLASS LEARNING

Evidence suggests increased out-of-class course structure improves: 1) student weekly engagement with study time (rather than cramming before an exam) which in turn increases student learning; 2) classroom culture where students build on their pre-class learning with collaborative activities; and 3) students’ value of class time (8). At our institution, undergraduate students are expected to spend two hours outside of class for every hour of class time; however, many students are not experts in how to most effectively use this time for learning. While a significant portion of teaching preparation may be used for planning class time, the time students spend learning out-of-class is equally important and their activities should be equally well-planned. In our courses, we identify suitable content that can be shifted to out-of-class learning experiences and deliberately structure pre-class assignments for deeper exploration of topics during class (15). Simply assigning reading is not enough to engage the majority of students, but the addition of structured assignments or quizzes can greatly improve student engagement with course materials (16). Structured out-of-class activities may include graded pre-class reading assignments or structured problem sets to guide students’ engagement with the material. When students know how to spend time out-of-class, they are prepared to spend more time in class to deepen their knowledge.

Examples from our courses

Before class, in some of our courses, students write responses to daily reading questions based on the daily learning objectives (Table 1). Students receive credit on the learning management system if they complete written answers to each of the questions. Responses are graded as 10% of the final grade; daily clicker questions build on the pre-class knowledge students explored in questions. In other courses, we have developed daily, graded, out-of-class assignments where students explore and learn material on their own with guided prompts (an assignment called an “external brain”). Students bring these pre-class assignments to class each day, engage with the content during class time through activities and application questions, and receive feedback from peers and instructors as they use the pre-class materials to aid their in-class learning. Students take a photo of their assignments to upload to the learning management system for grading that is based on completion and adequate formatting. The in-class formative assessment is led by students. Assignments are meaningful because students may use class notes for exam review and open-book case-study portions of exams. Students in one of our courses also complete regular Scientist Spotlight activities where they read, watch, and write about scientists engaged in cutting edge research, who are also from groups underrepresented in scientific disciplines (17). Rather than asking students to have the intrinsic motivation to learn about these scientists, we make it a regularly graded activity.

STRUCTURING CLASS USING INCLUSIVE PRACTICES

Our own professional development, as well as many of our faculty colleagues, began with learning how to structure in-class time with active learning and formative assessments (18). Many resources discuss weaving formative assessments (such as clicker questions, small group discussion, or worksheets) throughout a class to create an inclusive learning environment (11,19,20). Active learning provides an opportunity in which every student can engage with material and receive feedback about their learning in every class session to improve inclusivity. Additionally, structuring student interactions with discussions and small-group activities can increase students' sense of belonging and community (8,19), which may improve performance and retention as well as combat feelings of isolation among students from groups underrepresented in science (21,22). Some of the ways that we structure interactions include learning and using students' names and using name tents (23), varying group size and make-up, varying the roles that students have in groups (23), and providing opportunities to learn from clicker questions (10,11). Structured class sessions involving collaborative learning also reinforce the utility of pre-class engagement. Together, these engaging environments allow voices of all students to be heard and provide feedback to all students in every class.

Examples from our courses

We design the structure of class time to incorporate multiple opportunities for students to actively engage with material in different ways every day, but some elements are consistent. In all of our courses, each class begins with explicitly sharing learning objectives and then our exploration of course content (through clicker questions, videos, discussions, worksheets, hands-on demos, gallery walks, etc.) builds on the material students were asked to learn and practice before class. We ask students to make name tents (and write large enough for a big lecture hall), so we can use students' names and pronouns during class discussions.

We also set a consistent expectation of active learning and collaboration in the classroom starting on the first day of the term. We do this first by making content from pre-class assignments necessary for in-class activities, and then by structuring in-class activities to encourage students to talk to their classmates and practice sharing their reasoning and problem-solving process. When students work in groups we assign them roles (e.g. reporter, recorder, time keeper) and vary these roles within groups (24). Some days, students work in groups with the people they are sitting near, other days we have students sit in lab groups, and sometimes we use different mechanisms (e.g., colored cards) to mix up and randomly select groups. In the large class or group settings, we ask students to keep their name tents out and use each other's names. Group size and structure varies throughout the term to best match the daily and activity learning objectives.

STRUCTURING ASSIGNMENTS USING TRANSPARENT DESIGN

Not all students come to college with the knowledge of how to successfully navigate courses and assignments. Communicating the design, purpose, and outcome of student

assignments creates an equitable learning environment because it allows instructors to assess students' work and not students' ability to find their route through college (25). Transparently designed assignments have a clearly communicated purpose, well-described task, and include criteria for evaluation and success. Students in courses with transparent assignments reported more academic confidence, more employer-valued skills, and a greater sense of belonging (26). Transparent design also increases retention, especially for students from underserved populations (26).

Examples from our courses

For assignments, we use the transparent assignment template (27) to describe the purpose of assignments in relation to the overall course or to students' lives. We include the learning objectives and their alignment with course goals that more transparently communicate the skills students practice through completing the assignment and the knowledge students will gain. For each assignment, we describe the individual steps required for completion including a timeline. Finally, we always share criteria for evaluation with detailed grading rubrics and frequently reiterate and model how students can utilize rubrics to self-assess their own progress.

CONCLUDING THOUGHTS

In our teaching, we start with the assumption that all students can be successful, and therefore, our job is to structure courses to reduce barriers to students' success. To create learning environments that support students, we purposely use four elements of structures to create courses where more of our students can engage, learn, and be successful. Visualizing these elements of structure as a road map allows us to think about how we create a course experience where all components from homework, to class activities, to assessments are structured and aligned to guide student learning along the course path.

We emphasize that many of these structured elements can be added without major overhaul of a course. For example, establishing active learning routines like small group discussions on challenging clicker questions, name tents, or transparent assignment design can be added into existing course structures with minimal effort. Additionally, some structures facilitate other improvements. For example, in our experiences, structured pre-class assignments help more students know how to prepare for class, and therefore, engage with in-class activities, which consequently makes active learning more successful. On the other hand, changing formative and summative assessments so they are more frequent and interleaved requires considerable work; however, these loftier changes have the potential to have big impacts on student learning.

We have had the best luck adding in new structural elements, when we have not tried to do too many new things all at once but have picked an area of focus for one term (e.g., daily clicker questions or weekly quizzes). Then, the next time we teach a course we weave in additional structural elements. The choices that each instructor makes to increase structure are dependent on many variables including department learning objectives, course sequencing, or instructor comfort with different tools. Incremental change coupled with assessment of student learning allows us to make iterative, informed

change so we know what is working to best support students learning of our course objectives.

We have found that some students dislike additional structures. Some students perceive that the structure increases their workload because, for example, they must really spend two hours outside of class preparing for every hour in class. At the beginning of the term, we share education research literature and set up course expectations to provide students with a context for our course design decisions (28), and we continue to address student concerns following midterm course feedback. However, student discomfort is outweighed by increased student achievement overall and students who recognize the ways increased structure were beneficial to their learning.

The levels of course structure we describe here are founded on inclusive pedagogy and evidence-based teaching practices that enhance student achievement. Much of the evidence supporting increased structure comes from introductory courses which have some of the largest achievement disparities for underserved student populations. The evidence-based practices disproportionately improve outcomes for traditionally underserved students, and therefore, are a significant component of inclusive and equitable teaching (29). However, it is critical to recognize that improving course structure is only one of many steps in making STEM disciplines more equitable and inclusive. Particularly, strategies to build classroom climate, develop student sense of belonging, and develop student science identity (30) are other important steps that instructors can take to make courses more inclusive. Additionally, recent evidence suggests instructors' growth mindset, the belief that student's ability is not a fixed trait, and students' trust of their instructors are correlated with improved student experience and achievement for underserved students (31,32). Therefore, we also make deliberate efforts to create an inclusive and welcoming classroom climate environment and communicate that we think all students can be successful by following the road map through the course.

To begin to assess our efforts at increasing structure, we have engaged in more systematic tracking of student success in our courses and departments. We survey students about their course experiences and what teaching practices they perceive as inclusive. Students often provide insightful comments and primarily describe the inclusivity of a course based on affective characteristics of the instructor (i.e., Does the instructor think I can be successful? Do they know my name? Do they care about me or what I think?). Student perceptions are a critical component of how we as instructors should think about creating inclusive learning environments for our students.

We continue to work with colleagues to expand out-of-class programs such as improved wrap-around support, early research experiences, and better cross-campus coordination. Many of these big picture campus elements require buy-in from many stakeholders and are longer-term commitments. However, we can control how we design, structure, and teach our courses focusing on creating equitable learning environments. Structuring our course design helps us deliberately create learning experiences that decreases some barriers for students and are an important step in decreasing inequity in our science courses.

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Table 1. Example structured elements used in courses taught by the authors. BI = introductory non-science majors general education biology course with 100 students. HPHY = upper division majors human physiology with 350 students.

Course	Example Structured Element	Citation	Notes
Structured Assessments and Feedback			
BI, HPHY	Daily clicker questions.	10, 11	Clicker questions are designed as formative assessments to measure students' understanding of both factual and conceptual content.
BI, HPHY	Weekly (HPHY) or every other week (BI) out-of-class quizzes.	8	Quizzes are designed as formative assessments so students and instructors can get regular feedback about students' progress in learning material.
HPHY	Two-part exams.	12, 13, 14	Exams are designed for students to take the entire exam individually (80% grade) and then with a group (20% grade). The exam also includes closed book (multiple choice knowledge and comprehension questions) and open book case study components. Students are encouraged to use the group time to deeply understand their own misconceptions of content.
HPHY	All exams are cumulative.	8	To reduce students cramming before exams and then forgetting material, all exams build on and include material from earlier in the course.
Structured Out-of-Class Learning			
BI	Daily online questions based on learning outcomes.	34	Before each class, students respond to written 2-3 questions from the assigned reading that are based on the daily learning objectives. Responses are automatically graded for completeness on the course management system.
HYHY	External Brain.	35	Before each class session, students complete a daily assignment designed to prepare them for the next class session. Students are encouraged to bring their completed "external brain" to class each day and continue to add to their knowledge. Students submit photos of their completed assignments to the course management system for completion points. Students may use the external brain as a reference on the open book.
BI	Scientist Spotlights.	17	Students completed a biweekly writing assignment to learn about five scientists doing research related to the course content.
Structured Class Time to Engage All Students			
BI	Daily learning outcomes and aligned activities.	18, 36	The course as a whole has 3 overarching goals, eight overarching learning objectives, and then 2-3 daily learning objectives. All class activities were designed to support student learning of the related content.
BI, HPHY	Name tents.	23	Name tents are used to learn students names, and encourage students to call each other by names.
BI	Vary group sizes and roles.	19, 33	By varying group size and structure, students have an opportunity to work with different students and hear diverse viewpoints. Roles allow students to practice different skills (how to record notes or how to prepare to speak in a group) in a supportive classroom environment.
BI, HPHY	Clicker questions.	10, 11	Clicker questions are designed as formative assessments to measure students' understanding of both factual and conceptual content.
BI, HPHY	First day of class set expectations.	33	Starting on the first day of class we set expectations for students by modeling the types of group, discussion, and manipulative activities students will complete throughout the term. We also discuss the setup and mechanisms of our teaching.
Structured Assignments with Transparent Design			
BI	Transparently designed template for assignments.	25, 26, 27	Templates are used to communicate to students the purpose of each assignment, the skills and knowledge students will practice, the step-by-step instructions, and criteria for evaluation including a grading rubric.