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HAPS Educator. Vol 24 (2), pp. 58-63. Published August 2020.

https://doi.org/10.21692/haps.2020.019

Beck EJ and Roosa KA (2020). Designing High Structure Courses to Promote Student Engagement. *HAPS Educator* Vol 24 (2), pp. 58-63. https://doi.org/10.21692/haps.2020.019

Designing High Structure Courses to Promote Student Engagement

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Abstract
While there are many strategies for increasing the inclusiveness of anatomy and physiology courses, increasing course structure is a strategy that can not only close achievement gaps for first generation and underrepresented minority students, but also increase performance for all students. High structure courses are characterized by clear learning goals, regular in-class exercises that promote student participation, and frequent out-of-class assignments that promote practice and preparation. In this article we describe ways to increase the structure of your course design and the learning environment in both face-to-face and online courses. https://doi.org/10.21692/haps.2020.019

Key words: inclusive teaching, course structure

Introduction
Teaching inclusively means reaching students of diverse backgrounds and experiences with a focus on identifying and mitigating biases that create barriers or exclude students (Dewsbury and Brame 2019). By being mindful of the diversity of our students we can create environments where any student can find success. Inclusive teaching can help students feel welcome in our classrooms and institutions. Furthermore, it welcomes more diversity in our discipline. The makeup of our institutions continues to change. Fifty-six percent of US undergraduates are white, 19% report disabilities (U.S. Dept. of Education 2018) and at least 40% are first generation college students (U.S. Dept. of Education 2019). Therefore, we need to pay attention to creating environments and experiences that welcome all of our students to learn and achieve success.

While there are several ways to make your teaching more inclusive, we can reach more of our students, no matter their background, by developing high structure courses and learning spaces. The structure of a course is the set of activities and experiences you use to expose students to course material and encourage them to practice using it. An example of a low structure course would be one based on low-interaction lectures and few, high-stakes assessments. In a low-structure course we assume that students know how to use their time and efforts wisely to achieve success. However, large-scale studies on student use of concrete study skills indicate that 80% of students do not use strategies that were taught to them by past instructors, 86% never review material after a class, 60% consider highlighting readings to be studying, and 60% do not plan their studying ahead of time and instead focus on what is due next (Hartwig and Dunlosky 2012). These data suggest that many college students must learn how to learn at the same time they tackle course material.

In a high structure course, we remove the assumption that students know how to work with the material both in and outside of class time. Students are provided with regular opportunities to practice working with course material in the form of preparatory assignments prior to class, engaging in-class activities (active learning), and regular low-stakes review or practice assignments (Freeman et al. 2011; Haak et al. 2011). Eddy and Hogan (2014) have defined high structure courses as those with both preparatory and review assignments at least once per week where student participation constitutes at least 40% of the class time. Many assignments and activities in structured courses are low stakes and guide student reading and studying. Students are assessed more frequently than in a traditional low structure course. In a structured course we provide clear learning goals for our students, which specify the information they need to know and what they should be able to do with it. More structure in a course reduces guess work and trial and error as students learn how to work with course material. This allows more students to be deeply involved in learning, including those who may not have optimal social support systems, students with disabilities, and shy students.

In the biological sciences increased structure is associated with improved performance for all students (Eddy and Hogan 2014; Freeman et al. 2011; Haak et al. 2011). Students in moderate to high structure courses use their textbook more frequently, do less cramming, and use more of their textbook (Seaton et al. 2014). Improvements in performance are especially notable for first generation students and underrepresented minorities, where high structure eliminates the achievement gap (Eddy and Hogan 2014; Haak et al. 2011). Many of the studies on Open Educational Resources or free textbook materials that report closing achievement gaps may be actually seeing the benefits of increased course structure that come with

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course packages that include reading quizzes connected to texts (Fischer et al. 2015; Hilton et al. 2016). The evidence suggests that there is no harm to our well-prepared and high achieving students by boosting course structure, but it promotes significant gains for students traditionally affected by achievement gaps in the sciences.

Interestingly, despite gaps in STEM degree persistence (Chang et al. 2014) and course achievement (Haak et al. 2011), the self-reported study habits of undergraduate students do not differ between ethnic groups (Lopez et al. 2013; Rodriguez et al. 2018). Perhaps the social aspects of a structured course design and learning space are integral to closing the achievement gap. In a highly structured course all students have frequent opportunities to participate in the dialogue of the discipline. All students are invited to participate in class activities. If more students feel comfortable and included in the class, perhaps they will seek help when they need it, which first generation and non-white students may do less frequently (Jenkins et al. 2009). Structure may also foster a greater sense of community among the students. Students also work more effectively outside of the classroom, perhaps more often with their peers.

There seem to be two major themes in promoting the success of diverse students in higher education: changing the students and changing the system. Increasing the structure of our courses is a way that instructors can work to change the system. In this article we describe the elements of a high structure course and offer recommendations for increasing the inclusiveness of the learning environment in both traditional face-to-face classrooms and in asynchronous online teaching.

Designing a Structured Course

Structured courses can be characterized by those with clear and accessible learning goals and expectations, inclusive, in-class opportunities to work with course material (Eddy and Hogan 2014), and frequent activities to practice working with material outside of class (Eddy and Hogan 2014).

1. Clear learning outcomes

Learning outcomes provide a course framework for both you and your students. They lay out what you expect of your students and how they will be assessed (e.g. do they need to know a fact or be able to do something with a fact?). The learning outcomes are your guide to how you will deliver the course and the tools you give to students to promote their success. General learning outcomes for the course are provided in the course syllabus, but offering more specific guidance to students in the form of more detailed learning outcomes on a daily or weekly basis increases structure as it provides more specific expectations for students.

It is beneficial to spend time throughout the term training students in how to best use learning outcomes to guide their learning and preparation. In an sample of undergraduate biology students nearly 1/3 reported not using learning outcomes to prepare for an exam. Fewer than 5% used the learning outcomes to self-assess their learning (Osueke et al. 2018). Few students may know how to locate or recognize learning outcomes, and student perception of the objectives of the course can be quite different from what the instructor intends (Austin et al. 2019). Students may give up on using learning outcomes if they have an incorrect understanding of their utility in learning and self-assessment (Austin et al. 2019). However, there is alignment between the ways students are *encouraged* to use learning outcomes (by current and former instructors) and how they *actually use* them (Osueke et al. 2018). Therefore, it is important to model and encourage appropriate use of the learning outcomes, as it could have lasting effects on self-regulated learning. In a high-structure course, there is the opportunity to create activities that serve the dual purpose of practicing course material and training in the use of learning outcomes. For example, learning outcomes could serve as questions for a ticket out the door exercise, or for clicker questions, or students could be asked to generate potential exam questions based on their understanding of the learning outcomes.

2. Course activities

The activities you use in your structured course must be closely aligned with your learning outcomes. In backward course design we begin by identifying what we want students to accomplish, then choose suitable teaching methods to meet those goals. When developing a structured course, the teaching methods will not always be a traditional lecture. It may be helpful to think of it this way: for each learning outcome, what is the best preparation students could do in their own time in order to achieve it? Would they read the text and make notes, make tables and diagrams to summarize their reading, complete practice questions, etc.? Your task is to find ways to get students to do these things. These tasks will become your in-class and out of class activities.

As you plan your activities, you'll want to be cognizant of the following: Who might be left out of the conversation or learning opportunities when I do X in my class? Identifying moments when you might lose students is the first step to remedying them. For example, you decide to do practice problems in class and then go over them as a group. Will all students have the opportunity to participate in the dialogue if you do this? Who may be left out? How can you structure the class discussion about the practice problems so that everyone has the chance to participate?

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A. In class activities

In anatomy and physiology, in-class activities could fall into these three general categories: practice questions, organizing course material, and discovery activities.

Practice questions

Here, students complete questions for practice and to check their understanding. These also provide you as the instructor with timely feedback on student learning. A lecture can be broken up by brief periods of practice that are designed to allow all students to work with the lecture material. These can be placed at logical stopping points in the lecture (e.g. when you need to wrap up a concept and check understanding before moving on and adding to it). Strategies here may include think-pair-share, clicker questions, or a half-sheet problem set.

Organizing course material

Academics tend to be good at organizing their knowledge, and sometimes we assume that students show up to our courses with the same abilities. In anatomy and physiology, becoming overwhelmed with details can hinder student success. Taking the time to make your in-class activities also serve as opportunities to organize and summarize knowledge should help students in your course and perhaps in other courses. Students can be tasked with making a table to organize information they gained from lecture or readings. Summing up information with a simple graph or as a mathematical equation are also appropriate forms of this type of practice in anatomy and physiology. In this way students learn to and practice categorizing, summarizing, and simplifying course material in ways that make it less overwhelming to work with on their own. Examples of activities include making a table comparing the anatomy and physiology of smooth and skeletal muscle or drawing a graph that summarizes the relationship between venous return and cardiac output.

Discovery activities

In physiology, there are several general models that can serve as the basis for understanding many physiological systems (Modell 2000). For example, an understanding of the concept of mass flow provides the basis for students to understand pressure-flow relationships in the vascular system or capillary exchange. Therefore, in physiology there are many opportunities for students to draw on their prior knowledge to generate knowledge about a new concept. Several published activities have been particularly useful in teaching undergraduate physiology such as an exercise that allows students to derive the Frank-Starling Law of the heart based on predictions they make about stretch and recoil of a rubber band (Groh 2017). Applying the concept of mass flow to the vascular system is an important component of Malmquist's set of activities on Flux, Gradient and Resistance (Malmquist 2017). When appropriately tailored to your course activities such as these can nearly eliminate traditional lecture on particular topics. These activities also promote the practice of the skill of transfer, applying prior knowledge to a new situation or context, which can be difficult for students in physiology (Goodman et al. 2018).

B. Out of class activities

Out of class work can be categorized into two broad categories: (1) formative and preparatory assessments or (2) summative and review assessments. Preparation assignments get students ready for what is to be discussed in class. These can include guided reading questions, quizzes to be completed before class, or graphic organizers to organize information from readings. A trend in higher education has been the use of automatically graded or adaptive learning online homework systems. Carnegie Mellon's *Open Learning Initiative* specializes in creating homework and quiz questions embedded in readings that give instant feedback to students. They estimate the learning benefit of their learn-by-doing activities to be six times the benefit of watching videos or reading alone (Koedinger et al. 2016).

Summative or review assessments may include a variety of methods, such as authentic assignments that mimic professional tasks (e.g. medical case studies), cumulative quizzes that draw from a larger pool of knowledge, or assignments that ask students to summarize or explain key topics. By asking our students to apply particular knowledge and skills in different ways and different contexts, we can reinforce the importance of the learning outcomes and promote transfer of knowledge (Wiggins 1998). Both formative and summative assessments provide practice and feedback with course material rather than simply an assessment of student learning. With frequent (e.g. weekly), lower stakes assignments and corresponding feedback both the instructor and student have more opportunities to better understand when learning is going well and when students are struggling. By continuing to emphasize learning outcomes throughout the course, we encourage students to be more analytical about why they are asked to do things, and make connections between the outcomes, readings, small performance tasks, and authentic skills application.

Box 1 outlines a sample course unit on membrane and action potentials. This could be a weekly structure in which students complete the pre-unit activities prior to class on Monday and the post-unit activities at the end of the week.

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Example course unit on membrane and action potentials
Pre-unit activities: • Students review learning outcomes and complete required reading. • Students complete a self-grading online quiz on the reading. To keep this low stakes, students are offered multiple opportunities to retry the quiz and the best score is kept. Class meetings: • The instructor reviews new and most challenging material with particular focus on the areas where students struggled on the homework quiz. • Students complete a discovery activities (Based on Groh 2015) that allow students to 1) determine how ion concentrations and permeability result in a membrane potential of – 70 mV, 2) determine how cells can become depolarized or hyperpolarized, and 3) discover how the function of voltage-gated ion channels leads to a typical action potential. • The discovery activity is completed in small groups in multiple parts, with discussion and mini lectures between parts so that all pertinent new material is introduced. Post-unit activities: • Students are asked to explain one of the key learning outcomes to a classmate in 30 seconds using one diagram and one real world application. • Material covered by the lower stakes reading quizzes will be seen again on cumulative exams.

Box 1. *Sample activities in a high structure course unit.*

Structured and Inclusive Learning Environments

Students are necessarily asked to participate in class activities more often in a structured course as compared to a traditional didactic format. In developing structured undergraduate physiology courses, it has become clear that explaining your reasoning for your course format and activities goes a long way in student participation and success. For example, homework assignments do not assess learning as much as they provide practice and feedback on learning. Explain that your methods are backed by research and learning theory. For example, activities that require students to practice simpler component skills will help them achieve more complex learning outcomes (Ambrose et al. 2010). You may also simply emphasize that they will learn more by doing than watching or reading (Koedinger et al. 2016). Simple reminders that you want all of your students to succeed can also be powerful, as students may not hear that enough.

Providing students with adequate quiet time to think and write ideas during in-class activities has a powerful effect on encouraging student participation, particularly for students who usually keep quiet in class. In a study of college classrooms 81% of questions posed in class required higher-order thinking, but the average wait time between the questions and accepting a student response was only 2.25 seconds (Duell et al. 1992). Rowe (1974) found that increasing wait time to 3-5 seconds was associated with increases in the length of student responses, number of unsolicited responses, number of speculative responses, and a decrease in the number of students who fail to respond. Without adequate wait time it is likely that the questions you pose in class will only benefit the quickest, most experienced students.

During in-class activities one can monitor participation so that a few students do not dominate the conversation. In large classes it may be helpful to have a system to regulate participation in discussions, such as using index cards for responses or calling on group reporters (Penner 2018). In smaller classes a mental list of who has and has not contributed to the discussion should suffice. It is also important to monitor participation in the work that goes on in class. In small classes, visiting each group during an activity can stimulate participation or clear up questions that were barriers to progress. You may reach more students by varying the types of active learning activities you use in your course (Tanner 2013). There are many ways to represent and summarize information in anatomy and physiology. Activities can be based on diagrams, graphs, or mathematical equations, and varying which mode you use throughout the course can ensure that no student becomes frustrated because they are out of their comfort zone all the time.

Beyond the design of the course, the structure and organization of an online learning environment is important for including all of our students. In general, all course materials should be clearly organized in the learning management system so that students can locate course expectations, access all their course learning materials and tools, and know

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how they will be assessed. Students should have links and directions on how to access multiple support structures including technical supports and academic tutoring supports. An orientation to the course and to the technology used should be included to make sure that the rigor of the course is the course material, not the technology or organization of the course.

It is good practice to divide course materials by unit, module, or other divisions. Each section should have clear learning outcomes, a task list, and criteria for success. Our most at risk learners may be the ones that depend on this clear structure the most. When adding additional formative assessments and assignments, it is good practice to set these up in a routine so that students can become accustomed to a pattern of typical assignments and due dates. By making sure that all directions are explicitly clear and including the criteria by which students will be assessed, good course design takes away the guesswork for students by setting clear targets connected to frequent assessment. A typical module should have learning objectives, task lists, readings, activities, and assessments all organized linearly so that students can work their way through the materials.

Conclusions

Designing structured courses provides a starting point for making higher education, particularly in the sciences, a more inclusive environment. It is not the same type of work as creating and delivering traditional didactic courses, but the payoffs include closing achievement gaps and welcoming more diversity to our disciplines. Furthermore, structured courses are a way of demonstrating care for students and sending the message that we want all to succeed.

Acknowledgements

We thank two anonymous reviewers for their comments and suggestions on an earlier draft of this article.

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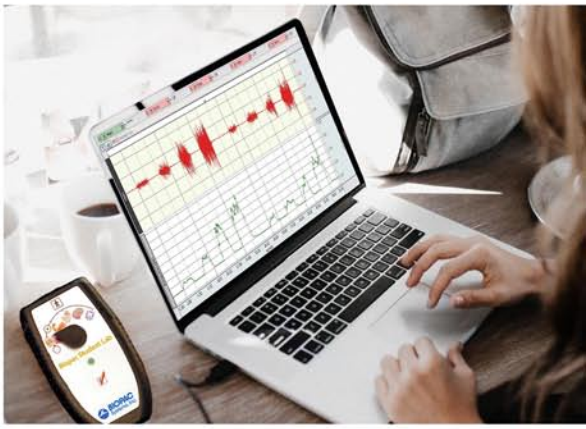

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