

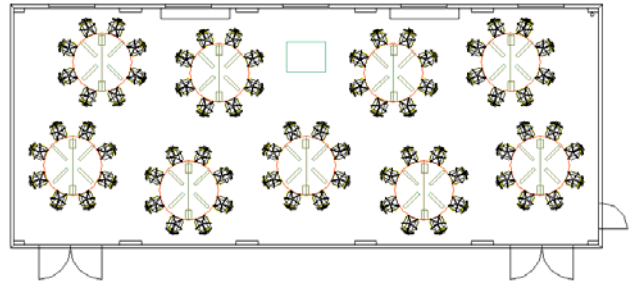
Case Study 2: SCALE-UP in the General Engineering Program

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Many collegiate disciplines have a set of common first year requirements, typically involving large enrollment courses. The goal of this portion of the curriculum is for students to learn basic skills essential to their upper-class discipline. Instructors at the freshman level must cover a broad array of topics, deal with a multitude of learning styles and college adjustment issues, and address vastly different academic backgrounds often requiring remedial instruction.

To meet these criteria, the General Engineering program at Clemson utilizes the unique teaching method of SCALE-UP (Student-Centered Activities for Large-Enrollment Undergraduate Programs) to provide instruction to 850 students a year during their first year engineering courses. The philosophy behind this first year program is to help students move from a mode of learning where everything they needed to learn was presented for them in a neat package of lecture and handouts, to a mode of learning where self-exploration and questioning each answer become the standard procedure. SCALE-UP has allowed us to help the students move beyond the “plug-and-chug” problem-solving methods they have been taught to a level where they ask themselves and each other if their approaches and answers make sense in the physical world.

We provide academic instruction to groups of up to 72 students, with one instructor and two undergraduate assistants (referred to in our program as Undergraduate Teaching Assistants, or UTAs) in each lab. The students are seated eight to a table, providing two teams of four students each. The instructor is located at the center of the room, no longer at the front of the classroom; in fact, our classroom has no real “front” at all. Movable seating allows students to adjust the layout of their workspace and each student group is accessible to the instructor. Two projection screens at the left and right ends are visible from any seat in the room. Each group of four students in the room has a collaborative workspace in the form of whiteboards surrounding the perimeter of the room. In addition, the instructor has access to a Symposium tablet to use in place of the traditional chalkboard.



While SCALE-UP can be used in standard 50-minute classes, we teach extended period classes (typically 2 hours). A typical class period consists of a short lecture to review the expected reading materials and expand upon the topic giving alternate examples and explanations not found in the written text. Depending upon the topic and progression of the semester, these lectures can range from as long as 30 minutes during the first few weeks of the semester to as little as 10 minutes to simply introduce the topic, activities and goals for the day.

After lecture, the students work on learning activities for the remainder of the period. These in-class activities require students to complete a graded assignment before they leave for the day. This reinforces classroom attendance, which is important at the freshman level, and provides students with goals to achieve in each class. The instructor and UTAs circulate to provide

guidance throughout the activities. Students usually start out a learning activity by grappling with it individually, then moving towards peer interactions to work through the problem. Pairs or groups come to a consensus on the approach and correct answers. Formative assessment takes place through observations by the instructor and UTAs of student interactions, approaches to problem solving, and questions. When student questions reveal that many students are struggling with the same point, the instructor will sometimes choose to briefly return to lecture mode.

The collaborative activities used in this classroom change throughout the semester, ranging from written questions to the use of computer tools such as Excel and Matlab. Clemson has a mandatory laptop policy, and having students work on their own laptop ensures that each student is engaged in the learning process, while the collaborative environment ensures that students are never stuck for long without help. Students are encouraged to use collaboration to learn from each other, but are ultimately responsible for their own work. Each student is expected to finish the assignment and be individually evaluated by the instructor or UTAs. Students who grasp the material are allowed to leave class early, and those who require more assistance are required to stay until they finish and are given more individualized help. This provides each student with a sense of mastery over the material before they are asked to expand upon the concepts during homework. Homework assignments are designed to reinforce and expand on the learning activities. By forcing the students to complete the in-class activities as an individual before leaving class, students are able to work on homework with the confidence that they understand the material. Similarly, students must pass a series of three mastery tests in order to pass the class. Students have up to three chances to pass each test, which are given during regular class hours. In addition to in-class activities and homework, many online resources are available for students to prepare for these mastery tests, and they are given ultimate responsibility for mastering these skills that are considered essential for any engineering discipline.

In addition to serving as in-class resources, UTAs also provide open evening drop-in sessions five nights per week. Students typically come to complete the in-class learning activities or to get help with homework assignments. This has been an invaluable resource for the students who may need more than two hours to grasp a concept, and still allows those students to demonstrate their mastery of the material. Typically 10 – 20% of the students each week will not finish an activity in class and require outside help from the UTAs.

Grades for the course rely mainly on student-centered activities (homework, learning activities and quizzes), which reflect a student's efforts towards achieving mastery, and on exams, through which a student actually demonstrates mastery. A portion of students' grades are also attributed to aspects of professional and personal development, such as team projects, tours of engineering departments, and career planning. A typical grade distribution follows:

