innovations & implementations
Exemplary Practices in Teaching and Learning

SCALE-UP: Student-Centered Activities for Large Enrollment Undergraduate Programs

North Carolina State University

What is it?

The SCALE-UP Project provides an effective and affordable model for introducing hands-on, team-based learning into large-enrollment undergraduate courses. SCALE-UP's approach to undergraduate education was first applied to introductory physics and chemistry courses at North Carolina State University in 1997. Since then, the model has been replicated at more than two dozen other institutions, including the University of Central Florida and the Massachusetts Institute of Technology (MIT).

Developed by Robert J. Beichner, professor of physics at North Carolina State University, SCALE-UP adopts a "studio-style" curriculum. The studio/workshop class replaces the lecture/laboratory format with 4–6 hours of activity-based instruction per week, typically in 2-hour blocks, during which students work in teams observing and studying phenomena. The studio approach to introductory physics was first introduced in the late 1990s at several private institutions, where class sizes were relatively small (Dickinson College, Rensselaer Polytechnic Institute). In studio courses, students' conceptual understanding of complex material was significantly improved when they were able to interact with faculty, collaborate with peers on interesting tasks, and become actively involved with instructional materials.

Begun in 1997, the goal of the SCALE-UP Project was to demonstrate that a studio-style curriculum could be "scaled up" to accommodate the needs of research institutions, where introductory physics classes enrolled up to 100 students. In controlled tests conducted between 1997 and 2002, SCALE-UP students were shown to have outperformed their peers in traditional classes.[1]

What problem does it solve?

By improving the quality of the overall learning experience for students in introductory physics courses, the SCALE-UP Project tackles the problems associated with the large lecture course:

- Low attendance rates
- Low student retention
- Poor conceptual understanding
- Poor problem-solving skills

The traditional introductory physics course, with its lecture/laboratory format and minimal student-faculty interaction, often discourages all but the very talented or the very determined from pursuing a career in science or engineering. As a consequence, undergraduate programs in the STEM (science, technology, engineering, mathematics) disciplines find it difficult to retain students, attract a more diverse group of majors, and fill their upper-division courses.

When the studio approach to instruction is substituted for the traditional lecture/laboratory format, student attendance, retention, and performance rates show substantial increases. Significantly, SCALE-UP students outperform their counterparts in tradition classes because the studio-style classroom places greater demands on them. In a traditionally taught large-enrollment course, students can "hide" from the instructor as she walks up and down the aisles of the lecture hall simply by sitting in the middle of a row. With the SCALE-UP seating arrangements, the instructor is free to interact with any student at any time. SCALE-UP students are prepared for pointed questions from the instructor, and they take their responsibilities toward their classmates seriously. Students offer one another valuable resources, alternative approaches, feedback, and support.

The studio-style introductory class, with its emphasis on social interaction and risk taking, was shown to improve the quality of the learning experience for all students—most commonly for students in the top third of the class (probably the ones who do most of the peer teaching in their groups), and most dramatically for the bottom third of the class (those whose math SAT scores were below 500). Nearly three times as many students are likely to pass a SCALE-UP section of an introductory physics course than an equivalent, traditionally taught section. As a result, a larger fraction of students move beyond the "filter" course and progress toward a degree in science or engineering.

How did they do it?

The SCALE-UP Project was funded by the U.S. Department of Education's Fund for the Improvement of Post-Secondary Education (FIPSE) and the National Science Foundation's Division of Undergraduate Education. It involved substantial curricular and environmental redesign.

Curricular Redesign

Students are divided into groups of nine at round tables; teams of three students share one laptop. Students work together to perform hands-on measurements or observations (tangibles), paper and pencil activities (ponderables), longer hands-on activities

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(labs), and collaborative experiments (group problem-solving). All this teamwork takes place under the watchful eye of the instructor, who continually circulates among the groups, monitoring the whiteboards (public spaces) where group members record their thoughts and engaging students in Socratic dialogue.

Learning-Space Redesign

To promote collaboration and support team-based learning activities, the classroom environment must also be redesigned. In place of the amphitheatre seating customary for large lecture courses, the SCALE-UP approach utilizes a learning space that resembles a banquet hall layout:

- Round tables (seven feet being the ideal diameter), with comfortable seating for three teams of students (nine students in total).
- Three networked laptops per table. To encourage cross-table discussions and maximize desktop space, laptops (rather than stationary workstations) are advised.
- Whiteboards (either portable group boards or large ones mounted on the walls), providing "public spaces" where student groups can mull over problems in full view of the instructor and teaching assistants.
- Table numbers (making it easier to assign specific tasks to particular tables).
- Name tags (so that no one remains anonymous).

What does it take?

Transitioning to a studio-style large-enrollment course requires resource commitments. An institution must be able to reallocate a physical space large enough to accommodate 99 students in a banquet hall layout and to equip the remodeled classroom with 33 laptops and whiteboards (either wall-mounted or portable). A single faculty member, graduate student, and, if possible, an undergraduate are sufficient to monitor the work of 99 students. However, the ability to monitor student activities is not enough. The instructor and teaching assistant will also need to resist the urge to show what they know, which would stifle discussion. Accepting the role of "guide on the side" rather than "sage on the stage" takes practice on the instructor's part and training for teaching assistants. Finally, there are the consequences of success, which could have considerable impact on upper-division instruction and resource allocation. Assessment data document that SCALE-UP students (particularly African Americans and female students) pass introductory filter courses at substantially higher rates than their counterparts in traditional courses. With the SCALE-UP model in place, students who might otherwise have given up on their ambitions will pass through barrier courses like introductory physics to swell the ranks of physics and engineering majors.

Why is it noteworthy?

- **Student success.** Quantitative studies show that SCALE-UP's active learning approach, when compared with traditional teaching practices, leads to higher attendance and passing rates, along with higher performance levels on traditional exams and in subsequent higher-level courses.
- **Improved course coherence.** Instructors frustrated by the limitations of the lecture/laboratory format point to inconsistencies in the overall learning experience that arise when students go off to separate classrooms for their hands-on activities. One lab section may be weeks ahead of or behind another in its coverage of the material, making it difficult for the instructor to sequence learning activities so that they build on one another effectively. The studio format, by concentrating all student activity in the same classroom environment and freeing the instructor to circulate among student work groups, allows instructors to monitor student progress, to intercede when necessary, and to ensure that the quality of the learning experience is consistent, regardless of class size.
- **Replicability.** To date, North Carolina State University's SCALE-UP program has been replicated at two dozen universities; the model has proven to be replicable and sustainable.

To learn more

Visit the SCALE-UP Web site at
http://www.ncsu.edu/per/scaleup.html.

To share your innovation

If your institution has a practice that you believe would be of interest to the EDUCAUSE Learning Initiative, please share it with us. To submit your innovation for review, please use the ELI Innovations Contribution Form on our Community Exchange page <http://www.educause.edu/ELICommunityExchange/6797>. A panel will review your submission and make a recommendation to the ELI staff.

About the EDUCAUSE Learning Initiative

The EDUCAUSE Learning Initiative (ELI) is a community of higher education institutions and organizations committed to advancing learning through IT innovation. To achieve this mission, ELI focuses on learners, learning principles and practices, and learning technologies. We believe that using IT to improve learning requires a solid understanding of learners and how they learn. It also requires effective practices enabled by learning technologies. We encourage institutions to use this report to broaden awareness and improve effective teaching and learning practice.

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[1] R. J. Beichner and J. M. Saul, "Introduction to the SCALE-UP (Student-Centered Activities for Large Enrollment Undergraduate Programs) Project," in *Invention and Impact: Building Excellence in Undergraduate Science, Technology, Engineering and Mathematics (STEM) Education*, proceedings of an April 2004 conference, AAAS/NSF, 2004.

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