

Economies of Scale and Large Classes

by Martin Saiz

Making classes larger saves money—and public universities across the country have found it a useful strategy to balance their budgets after decades of state funding cuts and increases to infrastructure costs.

Where I teach, in the College of Social and Behavioral Sciences at California State University, Northridge (CSUN), student to faculty ratios have increased by 25 percent since 2008.¹ Across CSUN, those ratios have increased 11.5 percent since 2000, and beyond our campus, across all 23 universities of the CSU system, they increased by 9.5 percent between 2007 and 2011.²

While these larger classes have helped provide fiscal stability and flexibility to CSUN, the benefits have not been distributed equally among the stakeholders in the university. Administrators may capture the economies of increasing returns to scale, and this strategy may work for them and their budgets, but it also exposes where power lies within the university. Larger class sizes and higher student to faculty ratios provide large benefits to administrators; some benefits to faculty; but only few, if any, benefits to students.

This trend and its consequences for students are not specific to CSUN, nor the large public institutions of California, but are symptomatic of the changes occurring in higher education across the nation.

LEARNING FROM BUDWEISER: MAKING EFFICIENT CONTAINERS FOR EDUCATION

Considered in terms of production, higher education is not much different

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from other industries. Concentrating a lot of activity in a small area generates efficiencies. In a single day, in one facility, students attend classes in a variety of disciplines, collaborate with peers, eat, study, and exercise. Administrators, staff, and faculty do much the same. This concentration of activity generates more than convenience and sharing—it permits economies of scale. To serve each student costs less when more is done for many in close proximity. In just a few years, our students can amass a number of courses across multiple disciplines to claim a liberal college education—a wide range of understanding about the world, as well as in-depth knowledge about a specific field of study.

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In some cases universities can take advantage of increasing returns to scale (a special case of economies of scale). Here, education has much in common with brewing and bottling, industries where containers are a significant cost. By analogy, in higher education, the container is the classroom. Assuming the classroom is square, the output is roughly proportional to the square of the length of its sides. If a room has a capacity of 40 students, the maximum yearly output will be limited by the number of times the university can use that classroom annually. The inputs (drywall, plaster, steel, etc.) depend on the length of the classroom perimeter. More specifically, a 50 by 50 foot classroom with a capacity of 40 requires 200 linear feet of wall, while a 50 by 100 foot classroom with a capacity of 80 students requires only 300 linear feet of wall to give the same amount of space per student. Similarly, a 100 by 100 foot classroom will accommodate 160 students with only 400 linear feet of built wall. The ratio of students to walls for the three examples are five feet of wall per student for the 40 student classroom, 3.75 feet of wall for the 80 student classroom, and 2.5 feet of wall per student for the 160 student classroom. Each time we double the number of students we only need to increase the size of our container by two-thirds. Because over a semester's time the number of students served depends on the combined length of walls of the classrooms, larger classrooms generate increasing economies of scale and reduce per-student costs.

Before 2000, CSUN had only two rooms with capacities of more than 100. Since then, the university has built six additional large-capacity rooms; increasing the university's large classroom capacity by 1,293 seats. This represents a capacity of 30,360 students per semester in large lecture halls!³ In the meantime, in some other classrooms, separating walls have been torn down, turning small rooms into larger rooms, and increasing their capacities from 40 to 80.

Other economies of scale associated with larger class sizes are even more impressive. A double-sized “smart” classroom needs only one computer, projector, monitor, screen, and data port, instead of the two required for two single-sized classrooms. Most importantly, a double-size classroom has only one instructor. Because each room is used for multiple classes per day, an institution like CSUN can save more than \$100,000 per semester in faculty salaries across the life of each doubled classroom.⁴ If all of our classrooms were doubled, CSUN also could eliminate half the classroom computers, projectors, monitors, screens, data ports, and faculty and still produce the same outputs. Theoretically, a university could

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increase its returns to scale until classrooms reach the size of stadiums. Only issues of congestion and demand may limit the university’s ability to lower costs this way. Consequently, administrators tend to increase class sizes during times of fiscal stress.

SURVIVING LARGER CLASSES: WHAT FACULTY DO

You would think that professors would howl at the prospect of having more students in their classes. In fact, most faculty in my department have not complained until recently. Our department and others in our college embraced large classes, especially when they came with reductions in course loads. Our dean, being a clever administrator, offered a valuable incentive to any faculty member willing to teach large classes. Classes with enrollments larger than 120 students would count for two classes (or six teaching units). Those with enrollments larger than 180 would count for three (nine units) and any class above 220 would cover one faculty member’s entire required teaching load of four classes (12 units) per semester. The capacities of large classrooms vary across campus, but the effective ratio of students to teaching units was about 20:1, or about 60 students per three units. For comparison, the average class of 40 students comes with a teaching credit of three units or a ratio of students to teaching units of about 13:1. For faculty teaching in the large classrooms, our dean effectively increased the student to faculty workload ratios by about 65 percent.

Faculty in the Political Science department rationalized that by delivering introductory courses for non-majors in large classes we could lavish attention on our majors in smaller classes. In the first years faculty were offered student assistants in the large sections to help with administrative tasks like proctoring exams,

taking attendance, running exam forms, and recording grades. Unfortunately, the funding for student assistants lasted only two years and this year the number of units faculty receive for the very large classrooms was dropped from 12 to nine, raising the ratio of students to teaching units to about 26:1 or about 78 students per three units. Our dean has effectively increased faculty workload by 100 percent in the largest classrooms. Still, some faculty covet the opportunity to teach the large classes. Why?

Again, the reasons have to do with increasing returns to scale. To prepare a lecture for 100 or 200 students takes no longer than to prepare one for 10.

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Similarly, to write an exam or prepare a syllabus for a big class takes no longer than to do the same for a small one. Additional students may even help class dynamics if they ask good questions or offer helpful comments. Some adjustments need to be made; mostly in lecturing style. Teaching large classes requires more performance with exaggerated vocal inflections and gestures. Developing a series of media clips and learning a few jokes also helps. Of course, students can be disruptive and ask silly questions, and the more students there are in a class, the more likely it is that a few of them will be.

But not all things come with economies of scale; some tasks require individual attention. Most obviously, the time it takes to grade student performance increases proportionately with the number of students enrolled in each class. Some assessment tools like multiple choice exams take only minutes, if scored by machine, but essay questions need to be deciphered individually by hand (or eye and mind). Indeed, as the examples below show, writing assignments of almost any length are impossible in large classes.

Two classes I have taught recently illustrate the dramatic effect that assignments and grading have on workload. My class with 231 students had no writing assignments while the one with 43 students had a series of weekly essays for the students to write and for me to grade. Even with more than five times the number of students, the large class was actually less work. The large class involved developing and giving 27 lectures, and writing and grading 27 daily quizzes, two midterms, and a final exam. Other tasks included meeting individually with students and answering their emails. My smaller class, which was classified as an upper-division general education course, required that I assign writing amounting to a minimum of 2,500 words per student. Over the semester, this equals about 10 pages of writing per student (double-spaced with citations and references) or about 430 pages of grading for me, not including the required re-writes and re-grading

as per university standards. I believe that short assignments develop better writing skills so I spread the 2,500 words across 13 weekly assignments of 200 words each. Grading is tedious labor so I do not dwell on these essays. I spend about five minutes on each: reading, correcting grammar and spelling, checking documentation, assessing the substantive content, writing a few comments, and determining the grade. Even this cursory effort adds up to about four hours per week, again, not including re-writes and re-grading. Add in three hours per week of in-class teaching and about one hour for everything else (class preparation, writing and grading quizzes and exams, and answering emails), and the total reaches eight hours per

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week for this one small class. If I added this modest writing requirement to my large class, the workload would increase proportionately. I would have to grade about 575,000 words, or more than 2,300 pages during the semester.

To be clear, I do not consider the writing requirement unreasonable for small classes and the 43 students I have in the smaller class seems to be the limit for a single class. I also believe that it is critical that we develop the writing abilities of our students. Many faculty members find it impossible to teach meaningful classes without including writing assignments, and feel that not doing so would undermine the discipline and their sense of professionalism. Still, I also have colleagues who are assigned 80 student classes with the same 2,500-words-per-student writing requirements and are only given credit for teaching one class. This increases their workload by about 50 percent. Thus, I am grateful to be assigned a large class where teaching writing is considered impossible, or at least too onerous. This gives me license to take advantage of economies of scale and some time to devote to my research and service responsibilities. In sum, large classes are not a problem per se from the perspective of many instructors. Workload depends as much on how much attention is required for each student as well as the numbers in each class.

THE BENEFITS OF CLASS SIZES FOR STUDENTS: WHAT THE EVIDENCE TELLS US

Students, on the other hand, get few advantages from large classes. They may gain opportunities to learn from the few truly brilliant professors, and the presence of other students listening silently to a lecture doesn't detract from their learning in the same room. Of course, distractions caused by cellphones or from students multitasking on laptops increase with the size of the class. Over the past few years, more students seem to feel free to come to class late and leave early, and students

distract themselves by texting or surfing (on the Internet) during class; all these things are easier to get away with in large classes. And, while a professor can police students' distracting behavior, controlling disturbances is itself a distraction that increases with size. Other "benefits" to students are dubious from an educational standpoint: not having to speak up or write papers; the increased likelihood of having close friends in class; and the opportunity to remain anonymous and free ride on the efforts of others.

Students benefit more from smaller classes. Large classes have less class time per student—more students means more questions and answering more questions

The most important research question of all asks if lower grades or less learning is associated with larger classes — and often, the answer has been yes.

takes time away from presentations. Students may also be reluctant to ask questions in big settings and less time is available per student for discussions. Because the professor's voice is the only one amplified in a large class, students may not be able to hear the questions asked by other students and often do not fully understand the answer given in class. Instructors also have less time per student during office hours.

These observations are reinforced by copious amounts of empirical evidence that suggests that large classes are characterized by:

- increased reliance on lectures as a method of instruction;⁵
- less instructor-student interaction;⁶
- less student involvement in classes;⁷
- less feedback from faculty;⁸
- reduced breadth and depth in course assignments,⁹ assessments,¹⁰ and writing assignments;¹¹
- reduced student satisfaction with larger classes¹²
- lower attendance;¹³
- less civility;¹⁴
- more cheating;¹⁵
- declining student evaluations of professors;¹⁶
- significant negative correlations between class size and grades;¹⁷
- higher drop-out rates; and¹⁸
- decreased student learning.¹⁹

The most important research question asks if lower grades or less learning is associated with larger classes—and, in many studies, the answer has been yes. From 1989, when Hopkins and Hahn found that students enrolled in smaller sec-

tions had higher GPAs, to 2001, when Keil and Partell found that the probability of a freshman receiving an A in a small class at Binghamton University was 2.4 times higher than their peer enrolled in a much larger lecture class, the evidence is clear.²⁰ In 2012, my colleague at CSUN, Bettina Huber, found that GPAs decrease as class sizes increase.²¹ In particular, sections with more than 50 students “appear to be particularly deleterious for students enrolled in lower-division classes.”

This point about lower-division classes is particularly important, as we know that more than half of all students who withdraw from college do so in their first year,²² when they are most likely to be enrolled in classes of 100 or more stu-

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dents.²³ At CSUN, the numbers confirm that first- and second-year students are being herded into large classes. In the College of Social and Behavioral Science, the increases in lower division classes have been dramatic—from an already high 50.4 students per class, on average, in 2008, to 69.9 students in 2012. Meanwhile, over the same period, CSUN’s College of Business and Economics increased their lower division classes from 44.9 to 56 students.²⁴ Campuswide, average student-to-faculty ratios in lower division classes are almost twice as large as those for upper division classes, and about 4.5 times bigger than graduate courses.²⁵ This is particularly unfortunate because an increasing number of students entering CSUN lack sufficient skills in reading, writing, and mathematics, and need individualized attention to diagnose and overcome these deficits.²⁶

But perhaps the most convincing evidence around the power of small class sizes comes from a large five-year study in a leading university in the United Kingdom following several years of budget cuts and corresponding increases in class sizes.²⁷ Academic achievement was measured by observing student performance on year-end exams. The sample covered 10,873 students enrolled full-time between 1999 and 2004 in 626 different courses in 23 academic departments offering 125 degree programs. The large sample allowed researchers to compare the same student’s performance across large and small classes for a total of 40,851 observations. They were also able to control for a wide range of student and faculty effects. Class size did not vary with measures of student wealth or other demographic characteristics. They observed the same faculty member teaching different class sizes and found no evidence that departments assigned faculty of differing quality to different class sizes. In the end they found that, all else being equal, effect of class size on student performance was negative; students do worse in bigger classes.

CONCLUSION: MORE EDUCATIONAL BOTTLING?

After decades of effort around college access, the U.S. does see more students going to college, but now the attention of policymakers is shifting to other metrics of progress, like retention and graduation rates. The research reviewed above shows that these are adversely affected by larger class sizes. More troubling is a recent study that concluded that most college graduates are learning little during their years in college. This study assessed the education, using a standard measure of learning, over a four-year period for several thousand students in more than two dozen institutions.²⁸ The researchers found that after two years in college almost 50 percent of students could not demonstrate any gain in critical thinking, complex reasoning and writing, and more than one third could not show any improvement after four years. They also found that many college courses lacked rigor: specifically, during a given semester, one third of students did not have a course requiring them to read more than 40 pages per week and half had no course that required more than 20 pages of writing. Time spent studying has dropped by 50 percent since 1960.

I find this study distressing, but I must admit its findings don't surprise me. My workload, as measured by the number of students I teach, has increased incrementally for 22 years. The fall semester of 2012, when I was assigned 267 students in three classes, was the high point (or low point, depending on one's perspective). Every increase in the number of students in my classes requires that I must cut back the number, length, and rigor of assignments—otherwise, I couldn't possibly keep up with the grading. My supervisors understand this and allow me to make such adjustments based on the size of my classes. When our department expressed concern over the rising class sizes coexisting with intensive writing requirements, our associate dean told us that we were spending too much time correcting our students' writing. No wonder students show little improvement in higher-level skills such as critical thinking, complex reasoning, and writing.

For students, larger classes seem to offer little. But if administrators are rewarded for employing economies of scale, we are likely to see more of the same. Indeed, instituting massive online courses becomes even more tempting because they do not require sizable capital expenditures and class sizes can be almost limitless. Of course, access to the institution has little meaning if the quality of education is poor. 

ENDNOTES

1. B. Huber, "CSUN by the Numbers."
2. California Faculty Association, "Summary of Changes in CSU Student to Faculty Ratios: 2007 to 2011."
3. Large lecture hall capacity is assumed at full capacity, eight times per day for Monday through Thursday schedules, four times per day Fridays and Saturdays.
4. Calculation based on part-time faculty cost of \$5,000 per three-unit class (2012 dollars). Classroom use is assumed at eight times per day for Monday through Thursday schedules, four

- times per day Fridays and Saturdays.
5. W. McKeachie, "Class Size, Large Classes, and Multiple Sections," pp. 24-27.
 6. J. L. Ratcliff, "What They Took and What They Learned: Learning From Assessment and Transcript Analysis"; and G. Kuh, J. Schuh and Whitt & Associates, *Involving*.
 7. E. Stones, "Students' Attitudes Toward the Size of Teaching Groups"; D. Karp and W. Yoels, "The College Classroom: Some Observations on the Meanings of Student Participation"; D. H. Wulff, J. D. Nyquist, and R. D. Abbott, "Students' Perceptions of Large Classes"; and P. A. Fassinger, "Professors' and Students' Perception of Why Students Participate in Class."
 8. E. Carbone and J. Greenberg, "Teaching Large Classes: Unpacking the Problem and Responding Creatively," pp. 311-96.
 9. D. P. Hoyt and S. Perera "Teaching Approach, Instructional Objectives, and Learning."
 10. J. L. Ratcliff, "What They Took and What They Learned."
 11. K. Scouller, "The Influence of Assessment Method on Students' Learning Approaches: Multiple Choice Question Examination Versus Assignment Essay," pp. 453-72.
 12. W. McKeachie, "Class Size, Large Classes, and Multiple Sections"; and E. Carbone and J. Greenberg, "Teaching Large Classes."
 13. J. L. Cooper and P. Robinson, "The Argument for Making Large Classes Seem Small," pp. 5-16.
 14. E. Carbone, "Students Behaving Badly in Large Classes," pp. 35-43.
 15. M. D. Sorcinelli, "Dealing With Troublesome Behaviors in the Classroom," in *Handbook of College Teaching: Theory and Application*; M. D. Sorcinelli, "Promoting Civility in Large Classes"; and M. J. Weimer, *Teaching Large Classes Well: New Directions for Teaching and Learning*, no. 32.
 16. Schnell in B. O. Barefoot, *Exploring the Evidence: Reporting Outcomes of Freshman Seminars*, Monograph no. 11.
 17. J. L. Franklin and M. Theall, "Grade Inflation and Student Ratings: A Closer Look."
 18. H. Ashar and R. Skenes, "Can Tinto's Student Departure Model Be Applied to Nontraditional Students?" pp. 90-100.
 19. W. E. Becker and J. R. Powers, "Student Performance, Attrition, and Class Size Given Missing Student Data"; and O. Bandiera, V. Larcinese, and I. Rasul, "Heterogeneous Class Size Effects: New Evidence from a Panel of University Students."
 20. Hopkins and Hahn, cited in P. P. Fidler and M. S. Hunter, "How Seminars Enhance Student Success," in *The Freshman Year Experience*; J. Keil, and P. J. Partell, "The Effect of Class Size on Student Performance and Retention at Binghampton University." See also R. J. Light, *Making The Most of College: Students Speak Their Minds*.
 21. B. Huber, "Do the Average Grades Awarded in the Undergraduate Class Sections Offered at Cal State Northridge Vary by Section Size?" p. 2.
 22. Consortium for Student Retention Data Exchange "Executive Summary" in *1998-1999 CSRDE Report: The Retention and Graduation Rates in 269 Colleges and Universities*; and C. A. Twigg, "Improving Quality and Reducing Cost: Designs for Effective Learning," pp. 23-29.
 23. M. J. Dooris, "Working with your IR officer," cited in J. Cuseo, pp. 5-21.
 24. B. Huber, "CSUN by the Numbers."
 25. Ibid.
 26. B. Huber, "FTF-Proficiency-CSUN-1998-to-2009."
 27. O. Bandiera, V. Larcinese, and I. Rasul, "Heterogeneous Class Size Effects: New Evidence from a Panel of University Students," pp. 1365-98.
 28. R. Arum and J. Roksa, *Academically Adrift: Limited Learning on College Campuses*.

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