

Toward an Ungraded CS50

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ABSTRACT

In 2010, we proposed to eliminate letter grades in CS50 at Harvard University in favor of Satisfactory/Unsatisfactory (SAT/UNS), whereby students would instead receive at term's end a grade of SAT in lieu of A through C- or UNS in lieu of D+ through E. Albeit designed to empower students without prior background to explore an area beyond their comfort zone without fear of failure, that proposal initially failed. Not only were some concentrations on campus unwilling to grant credit for SAT, the university's program in general education (of which CS50 was part) required that all courses be taken for letter grades.

In 2013, we instead proposed, this time successfully, to allow students to take CS50 either for a letter grade or SAT/UNS. And in 2017, we made SAT/UNS the course's default, though students could still opt out. The percentage of students taking the course SAT/UNS jumped that year to 31%, up from 9% in the year prior, with as many as 86 of the course's 671 students (13%) reporting that they enrolled because of SAT/UNS. The percentage of women in the course also increased to 44%, a 29-year high. And 19% of students who took the course SAT/UNS subsequently reported that their concentration would be or might be CS. Despite concerns to the contrary, students taking the course SAT/UNS reported spending not less but more time on the course each week than letter-graded classmates. And, once we accounted for prior background, they performed nearly the same.

We present the challenges and results of this 10-year initiative. We argue ultimately in favor of SAT/UNS, provided students must still meet all expectations, including all work submitted, in order to be eligible for SAT.

CCS CONCEPTS

• **Social and professional topics** → **Student assessment; Computer science education; CS1; Information technology education.**

KEYWORDS

comfort, CS1, exploratory, grades, pass, fail, fear, satisfactory, unsatisfactory

ACM Reference Format:

David J. Malan. 2021. Toward an Ungraded CS50. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education (SIGCSE '21)*, March 13–20, 2021, Virtual Event, USA. ACM, New York, NY, USA, 6 pages. <https://doi.org/10.1145/3408877.3432461>

1 INTRODUCTION

At Harvard University, students have long been allowed to take courses Pass/Fail (PA/FL), whereby, instead of a letter grade at term's end, they receive a grade of PA in lieu of A through D- or a grade of FL in lieu of E (i.e., F). In fact, students can take as many as 11 out of 32 courses PA/FL. But there just isn't a culture of taking many, if any, at all.

For some students, their choice of concentration (i.e., major) requires that they take most of their courses for letter grades. Historically, the university's general-education courses have required letter grades as well. Some students simply prefer to receive letter grades for courses in which they expect to do well. And to take courses PA/FL, students must even obtain instructors' signatures.

But we hypothesized, back in 2010, that some students assume PA/FL implies an inability to perform at their classmates' level. And, because of that stigma, they might be disinclined to take courses PA/FL, even to explore new academic areas beyond their comfort zone. We suspected, too, that the process itself was uncomfortable: it often involved standing in front of a roomful of classmates, either before or after class, holding a pink form, awaiting a signature. With letter grades thus a de facto norm, we suspected that some students were shying away from some courses (and, in turn, some concentrations) altogether for fear of underperformance, our own introduction to computer science for concentrators and non-concentrators alike, CS50, among them. But no concentration should be beyond reach upon students' arrival on campus, we felt, simply for lack of prior background, particularly with Harvard's student body increasingly drawn from a broader demographic of high schools.

And so we proposed in 2010 to eliminate letter grades altogether in CS50 in favor of Satisfactory/Unsatisfactory (SAT/UNS), whereby students would receive a grade of SAT in lieu of A through C- or a grade of UNS in lieu of D+ through E. At the time, SAT/UNS was only offered by certain seminars and tutorials on campus. Albeit similar in spirit to PA/FL, SAT/UNS differed in policy. SAT/UNS would no longer require the signature of CS50's instructor. And SAT/UNS would raise the bar for success from D- to C-, the latter, we felt, a more reasonable threshold (for all students to meet) and a stronger signal of outcome.

While well received in some circles, the proposal met resistance in others. Multiple concentrations on campus were unwilling to accept SAT in lieu of a letter grade for credit, as was the university's program in general education. Even within computer science, the concentration, there was hesitation to accept SAT for credit.

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SIGCSE '21, March 13–20, 2021, Virtual Event, USA
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ACM ISBN 978-1-4503-8062-1/21/03...\$15.00
<https://doi.org/10.1145/3408877.3432461>

And so we put the vision on hold, leaving letter grades and PA/FL students' only options for CS50 in 2010. Ironically, the percentage of students taking CS50 PA/FL that year jumped from 2% to 10%, the result, we suspect, of the failed SAT/UNS proposal having drawn so much attention on campus, coupled with our own evangelism therefor.

But in 2013, we proposed SAT/UNS for CS50 again, this time successfully, albeit with compromise: students could take the course either for a letter grade or SAT/UNS (instead of PA/FL). By way of Harvard's student-information system, selection of either would be self-service during registration online, entirely sans signatures. We promised to make clear to students taking the course for concentration or general-education credit, though, that they must select letter grades. And we qualified in the course's syllabus that "All students, whether taking the course SAT/UNS or for a letter grade, must ordinarily submit all nine problem sets, take both quizzes, and submit a final project in order to be eligible for a satisfactory grade unless granted an exception in writing by the course's heads."

For several years, the percentage of students taking CS50 SAT/UNS hovered between 9% and 12%, not far from recent years' PA/FL numbers. It seemed signatures were not the barrier we thought. But we suspected that the stigma of having to opt in, a la PA/FL, remained, and so, in 2017, we made SAT/UNS the course's default. Students would no longer choose between a letter grade and SAT/UNS a priori at term's start during registration. Rather, all students would register for the course SAT/UNS initially but could opt into a letter grade some time later, by the term's fifth Monday, the university's deadline for changes. Our intent was that students make a more-informed decision, a posteriori, with a few weeks' experience under their belt.

The percentage of students taking the course SAT/UNS (through term's end) immediately jumped that year to 31% (from 9% in 2016), with many of those students reporting that they enrolled because of SAT/UNS. The percentage of women in the course also rose to 44%, a 29-year high. And 19% of students taking the course SAT/UNS reported at term's end that their concentration subsequently would be or might be CS.

We elaborate in Section 2 on our motivation for this SAT/UNS vision alongside related work. In Section 3, we discuss the challenges thereto. In Section 4, we share our decade's results. We conclude with recommendations in Section 5.

2 MOTIVATION, RELATED WORK

Although CS50 has long strived to reach out to those "less comfortable" with computing on campus, the course was still considered one to beware in 2010, not only for its workload but also for its unfamiliarity. Particularly among students who didn't think of themselves as "computer persons," a fear factor remained. Even though more than two thirds of the course's own students had never taken a CS course before, some students still assumed otherwise. We worried the effect was discouraging, with some students disinclined to explore a field beyond their own comfort zone.

Yet ours is a liberal arts institution, and students are here for a liberal arts education. And what better way to attain it than to venture beyond their own comfort zone. SAT/UNS, we felt, would empower students to do just that, without fear of failure (be failure

an E or, in some students' minds, a B or a C). We drew inspiration, in fact, from Harvard's own first-year seminar program, which is also graded SAT/UNS. Taught by faculty across campus, those seminars empower first years to encounter faculty and explore fields that they might not otherwise consider accessible to them.

We also drew inspiration from innovations off campus, including MIT's "Sophomore Exploratory Option," which effectively allows students to take any one course per semester with non-letter-graded status, including departmental requirements [11]. Introduced at MIT in 2003, initially as a five-year experiment, the institute found by 2008 that the "option was well-used and valued by students," per its Committee on the Undergraduate Program [12]:

Between 25 and 30 percent of the sophomores designated a subject as Exploratory each term between Fall 2003 and Spring 2007, and this number was closer to 35 percent in Fall 2008. The data—both quantitative and qualitative—show that students use and benefit from the opportunity to explore inside and outside their majors, and they do so in ways that were both anticipated and unexpected. Students value the Exploratory option as a sort of grade insurance that allows them to try challenging subjects within their newly declared majors as well as for the opportunity it provides to explore subjects in other academic areas at a reduced risk.... 33 percent of students reported that their designation of a subject or subjects as Exploratory was related to their interest in doing a minor or second s.b. program, and 11 percent reported that it led to their decision to switch majors between their sophomore and junior years. It is clear from the data that students value this flexible grading option highly.

MIT also allows first-year students in their first semester to take courses Pass or No Record, though faculty do still submit "hidden grades" for advising purposes [10].

Though MIT is not alone in its innovations. While implementation details differ, other universities offer students similar options as well. Princeton, for instance, allows students to take one course Pass/D/Fail each term [15]. Inspired by Cuba et al. [3], Wellesley has a "shadow-grading" policy for first years, who receive grades of Pass or No Pass [2]. And Swarthmore records grades of Credit or Non-Credit for first years in their first semester, while similarly providing students with "shadow grades" for advising [1].

Insofar as CS50 at Harvard is historically a fall-semester course, a plurality of whose students are first years, our envisioned implementation of SAT/UNS within CS50 alone was to be an approximation of these inspirations elsewhere. But it's worth noting that, as of 2019, CS50 was Harvard's largest course, which nearly half of the university's undergraduates ultimately take.

However, these initiatives are not without skeptics. Giometti [6] long ago asked "whether courses taken on a pass-fail basis are really worth taking in the first place? Perhaps if [students] desire merely an introduction to the subject matter, this could be done through other means: public lectures, planned reading lists, or independent study. Regular courses should be left for more serious study." Otto [13] found that pass/fail does not motivate students to learn, that students do not select it to explore outside their major,

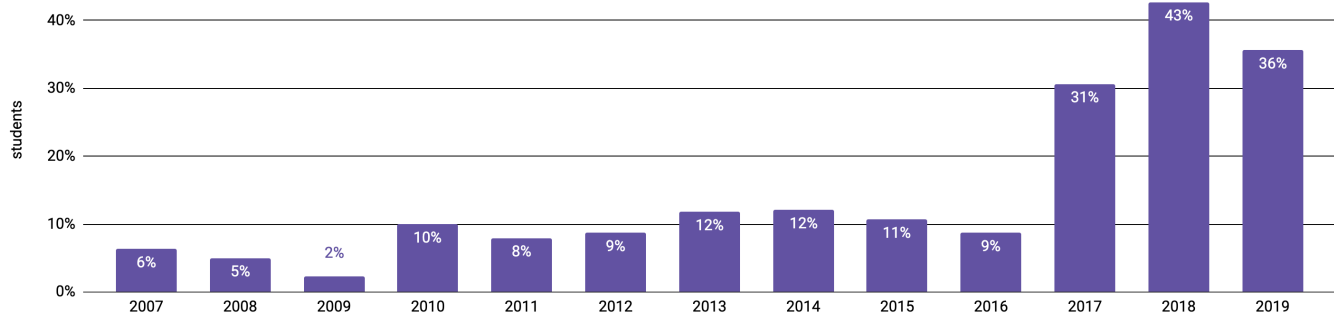


Figure 1: Percentages of students who took CS50 PA/FL (from 2007 through 2012) and SAT/UNS (from 2013 through 2019), based on the course’s end-of-term grades. Enrollments ranged between 282 (in 2007) to 779 (in 2019). Most significant was the increase from 9% in 2016 to 31% in 2017, when we made SAT/UNS the course’s default.

and that students complete fewer readings and attend fewer classes. Davidovicz [4] found that students do not take pass-fail courses to explore but, rather, to lighten their workload and cautioned that first years taking courses pass-fail tend to suffer academically unless provided with guidance. Sgan [14] similarly found that first-year students underperformed with pass-fail. Though as Harris [8] notes more recently, those findings “may not reflect current conditions or effects.” Indeed, Wellesley recently extended its own experiment with shadow grading. And this particular vision for SAT/UNS in CS50 at Harvard is also informed by the experience of this paper’s own author, who only took CS50 himself some years ago (and, in turn, discovered computer science itself) because he was allowed to take it, initially, PA/FL.

3 CHALLENGES

Our earliest proposal, that CS50 be graded (only) SAT/UNS, proved a non-starter. Multiple concentrations were simply unwilling to accept SAT in lieu of a letter grade for credit. And the university’s program in general education, at the time, required that all courses be taken for letter grades. Any changes to that policy, in particular, would likely have required a full-faculty vote.

Underlying those decisions was a presumption, it seemed, that SAT/UNS would impact learning outcomes for the worse as students might not exert as much effort. We, too, shared that concern, but only insofar as students would be taking other, letter-graded courses at the same time. We worried that students might (rationally) prioritize those courses, thereby spending less time on CS50. Ideally, a student’s entire semester would be graded SAT/UNS, not unlike MIT’s Pass or No Record (P/NR) grading for first years [10], but change of that magnitude is beyond the scope of this particular initiative (and CS50 on its own).

These challenges resurfaced in 2013, alongside others as well, when we instead proposed to allow students to take CS50 either for a letter grade or SAT/UNS, deciding sometime before the term’s fifth Monday. Among the university’s concerns then were that students might select the wrong option. We assured, though, that we could make clear in the university’s course catalog as well as in the course’s own syllabus, website, and lectures that students who might need concentration or general-education credit for CS50 should select a letter grade. We have since even added a checkbox

to the course’s earliest (form-based) assessments requiring that students acknowledge their understanding thereof.

Within the university’s engineering school was there also a concern that SAT/UNS might affect accreditation by the Accreditation Board for Engineering and Technology (ABET). But we verified that “ABET has no policy regarding whether courses are graded or not. In fact, under ABET guidelines, a program is prohibited from using course grades as a measure of student outcomes.” [5]

Perhaps most challenging was the administrative concern that students might take CS50 SAT/UNS and decide after the term’s fifth Monday to concentrate in a field that requires that students take CS50 for a letter grade to receive credit. Longstanding policies preclude students from changing grading selections after that date and from re-taking courses (that they have already passed) for credit. We suggested that exceptions should be made in such cases. That students might discover fields of such interest to them via SAT/UNS, we argued, was a successful outcome. We even offered to provide departments with unofficial letter grades for such students, a la shadow grades. After all, letter grades of A through C- would only be converted to SAT (and D+ through E to UNS) for SAT/UNS students at term’s end. SAT/UNS students’ term-time work would be evaluated no differently from letter-graded students’. And, to avoid bias, we would not inform the course’s graders of students’ grading selections until term’s end. We also emphasized that concentrations already offer credit for letter grades of C- or higher (and, in some cases, D- or higher). Insofar as SAT represents C- or higher, we argued that SAT should receive credit as well.

Ultimately, our proposal was approved, but no changes to long-standing policies would be made. Latent, we sensed, was simply a belief, whether historical or philosophical, that all concentration courses should be letter-graded. But as of 2013, students could take CS50 either for a letter grade or SAT/UNS. If students selected the latter, though, and decided after the term’s fifth Monday to concentrate in a field that not only requires that students take CS50 (or a related course) but also that all courses be taken for letter grades, they would have to take, after CS50, an additional (related) course letter-graded for credit. That caveat would not apply to CS concentrators, as CS, as a concentration, agreed to accept a SAT in CS50 for credit, provided we nudge prospective concentrators toward letter grades with conditional language like: “If you intend

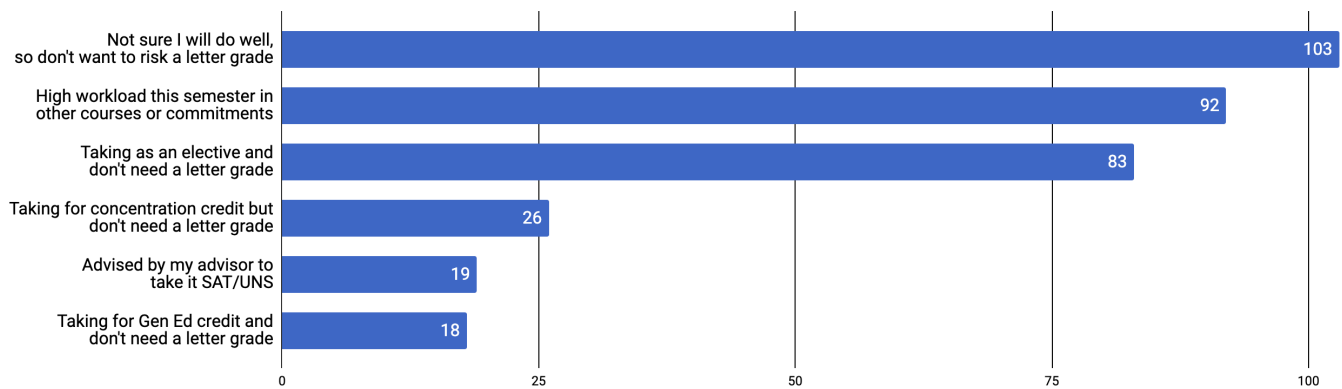


Figure 2: At term's end in 2017, we asked the 208 (out of 671) students who ultimately took CS50 SAT/UNS why they did so. Risk aversion dominated their reasons. Students could check multiple boxes.

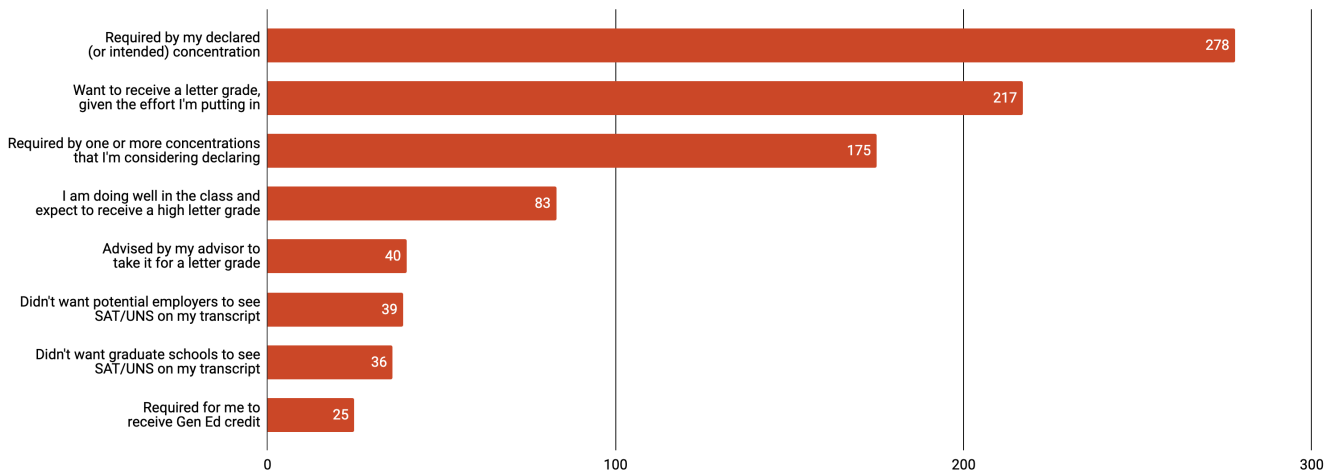


Figure 3: At term's end in 2017, we asked the 463 (out of 671) students who ultimately took CS50 for a letter grade why they did so. Concentrations' requirements dominated their reasons. Students could check multiple boxes.

to concentrate in CS, you should take CS50 for a letter grade. But should you decide to concentrate in CS only after taking CS50, a SAT in CS50 would count for concentration credit.”

When we later proposed (successfully again) in 2017 to make SAT/UNS the course's default, in hopes that it would become a new norm, the challenges were primarily logistical. Students could opt out of SAT/UNS and into a letter grade, but policy required that they submit a “change of course” form that itself required three signatures: from the student's advisor and residential dean as well as from the course's instructor. (Fortunately, that process is now web-based.) But there remained a concern that some students might not select (or decide too late to select) a letter grade as needed, but we again reassured that we would mitigate that risk with communication.

4 RESULTS

When we transitioned in 2013 from PA/FL to SAT/UNS, with the latter self-service online, sans signatures, the results were surprising and, daresay, negligible. Whereas 9% of students had selected PA/FL in 2012, only 12% of students selected SAT/UNS in 2013. That percentage remained the same in 2014, fell in 2015 to 11%, and fell further in 2016 to 9%. Far more significant had been the jump from 2% in 2009 to 10% in 2010 when we decided to champion (unsuccessfully but vocally) the issue itself. Indeed, we suspect the fluctuations between 2007 and 2016 correlate with just how vocal we were, perhaps encouraging, as in lectures or emails, PA/FL (and, later, SAT/UNS) more in some years than others. Only when we made SAT/UNS the course's default in 2017 did those percentages jump sharply, from 9% in 2016 to 31% in 2017. The percentage then rose to 43% in 2018 and fell to 36% in 2019, again the result, we suspect, of variation in messaging. Figure 1 summarizes these results.

But that change in 2017 yielded other results. Whereas 27% of men took the course SAT/UNS, 34% of women did the same. (Among undergraduates alone, excluding graduate students and cross-registrants, the percentages were closer, at 26% and 29%, respectively.) And 44% of that year’s 671 students were women, a 29-year high, up from 36% the year prior. Among students of all genders that year, 66% described themselves as among those “less comfortable” with computing, a 10-year high, up from 62% the year prior. (For privacy’s sake, we, as an individual course, do not collect demographic data besides gender and comfort level.) But that was not the start of a trend. A slightly higher percentage of men (44%) than women (41%) took the course SAT/UNS in 2018, while a slightly higher percentage of women (38%) than men (33%) took the course SAT/UNS in 2019.

To be fair, some students might not have opted out of the new default because of the friction involved in submitting a “change of course” form with so many signatures. But students cited other reasons when surveyed. Among students who took the course SAT/UNS, fear of “failure” (or risk aversion more generally) motivated their decision to take the course so. When we surveyed those 208 (out of 671) students at term’s end, per Figure 2, 103 (50%) reported that they were “not sure I would do well, so don’t want to risk a letter grade,” 92 (44%) reported that they had “high workload this semester in other courses or commitments,” and 83 (40%) reported that they were “taking the course as an elective and don’t need a letter grade.” This end-of-term survey allowed students to check multiple boxes as well as input their own reasons.

Among students who took the course for a letter grade, concentrations’ requirements dominated their reasons. When we surveyed those 463 (out of 671) students at term’s end, per Figure 3, 278 (60%) reported that they were “required by my declared (or intended) concentration,” while 175 (38%) similarly reported that they were “required by one or more concentrations that I’m considering declaring.” Also common was a desire for the letter grade itself, with 217 (47%) reporting that they “want to receive a letter grade, given the effort I’m putting in” and 83 (18%) reporting that “I am doing well in the class and expect to receive a high letter grade.” Students could again check multiple boxes and input their own reasons.

Meanwhile, among the course’s 671 students in 2017, 86 (13%) ultimately took CS50 because I could take it SAT/UNS,” while 33 (5%) “initially took CS50 because I could take it SAT/UNS, even though I later decided to take it for a letter grade.”

Contrary to popular belief, students who ultimately took the course SAT/UNS did not spend less time on the course. In fact, SAT/UNS students reported spending slightly more time on most problem sets (i.e., programming assignments), per Figure 4. Nor did SAT/UNS students seem to take the course any less seriously, instead reporting slightly higher stress levels each week, per Figure 5.

With that said, students who took the course SAT/UNS in 2017 did underperform their letter-graded classmates on that semester’s test and quiz (by 9pp), though only slightly (4pp) on the course’s problem sets and not at all on the course’s final project, per Figure 6. Had those SAT/UNS students instead taken the course for a letter grade, ceteris paribus, they would have received letter grades one or two thirds (6pp) lower than their letter-graded classmates (e.g., B+ or A- instead of A).

But it’s worth emphasizing that those same SAT/UNS students entered CS50 with less prior experience than their letter-graded classmates. Whereas 80% of SAT/UNS students in 2017 had never taken a CS course before, only 62% of letter-graded students reported the same. In fact, 9% of letter-graded students had already taken two prior courses (versus 3% of SAT/UNS students), and 5% of letter-graded students had already taken three or more courses (versus 0% of SAT/UNS students). It’s not surprising [7], then, that letter-graded students’ letter grades skewed higher than SAT/UNS students’ hypothetical letter grades. Indeed, when we compared 2017 with 2016, when only 9% of CS50’s students took the course SAT/UNS (versus 31% in 2017), we found that those grading gaps narrowed in 2017 as CS50’s SAT/UNS students became more representative of CS50’s students overall. Insofar as the course’s problem sets, by design, primarily define students’ experience in CS50, collectively requiring more time than its other assessments, we were pleased that the gap was as slight as it was (4pp) in 2017. And, by

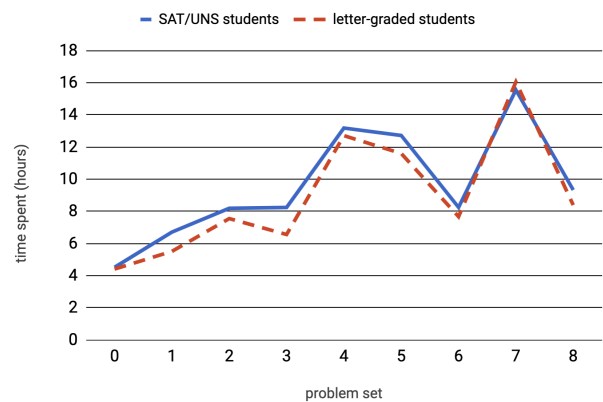


Figure 4: Students taking the course SAT/UNS in 2017 spent slightly more time on most problem sets than students taking the course for a letter grade.

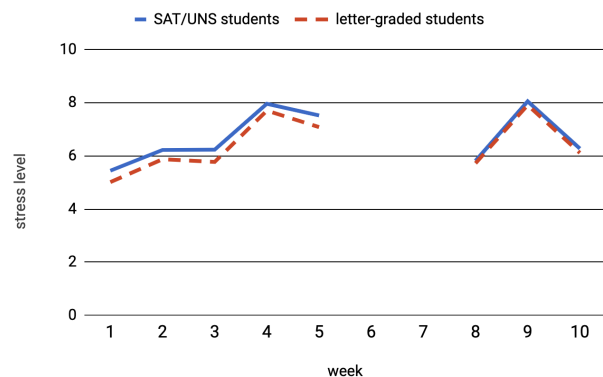


Figure 5: Students taking the course SAT/UNS in 2017 reported slightly higher stress levels (on a scale of 0 to 10) each week than students taking the course for a letter grade. Students were not surveyed in weeks 6 and 7 because of a test and break, respectively.

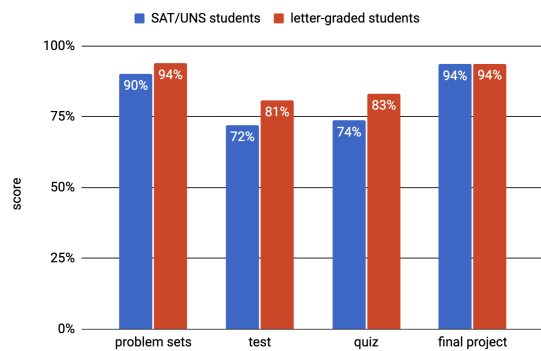


Figure 6: Students taking the course SAT/UNS in 2017 scored 9pp lower on the course’s test and quiz than students taking the course for a letter grade and 4pp lower on the course’s problem sets. But students taking the course SAT/UNS entered the course with less prior experience than their letter-graded classmates. And students’ performance on the final project was the same.

course’s end, some of those students had even decided to concentrate in CS. Indeed, in each year since 2017, among students who took the course SAT/UNS, an average of 7% (totaling 56 students) have reported that their concentration “is or will be CS,” while another 12% (totaling 95 students) have reported that their concentration “might be CS.” Meanwhile, 7% of the same (totaling 57 students) have reported that their secondary field (i.e., minor) “is or will be CS,” while another 30% (totaling 244 students) have reported that their secondary field “might be CS.” While some of those same students may very well have taken CS50 and, in turn, concentrated in CS even if SAT/UNS had not been an option, our intent was to signal to those who would have been otherwise inclined that they were indeed welcome in the course and the concentration. And, with the course’s expectations the same for all students, irrespective of grading status, we found no evidence that students taking the course SAT/UNS invested any less time.

5 CONCLUSION

In 2010, we set out to eliminate letter grades in CS50 altogether, toward an end of empowering students without prior background to explore an area beyond their comfort zone. Irrespective of prior background, too, we hoped to keep all students focused not on grades but on the work at hand. As at Wellesley [9], “the more time students spend thinking about getting an A, the less time they’re thinking about what it is they should be learning.”

We failed in 2010 to navigate longstanding barriers on campus, among them expectations of letter grades for some concentrations and Harvard’s program in general education. Though it’s worth noting that some concentrations on campus do allow students to take some courses SAT/UNS (or PA/FL). And, as of 2016, so does the program in general education now also allow students to take some courses SAT/UNS (or PA/FL), CS50 among them.

We proposed successfully in 2013 to introduce SAT/UNS alongside letter grades in CS50, though uptake of SAT/UNS among students was little different from PA/FL. Only once we made SAT/UNS

the course’s default in 2017 did we seem to signal successfully to students that the option is not only allowed but encouraged, a new norm. Students who might not have otherwise considered the course and, in turn, computer science enrolled. Not only did SAT/UNS students spend at least as much time on the course than letter-graded classmates, they performed nearly as well. SAT/UNS remains CS50’s default as of 2020.

We ultimately reject the presumption that students taking a course SAT/UNS (or PA/FL) will not work as hard or learn as much as their letter-graded classmates, provided, however, that the same expectations are set for all students. In our own CS50, all students must still meet all expectations in order to be eligible for a satisfactory grade, be it SAT or A through C-. And because students taking CS50 SAT/UNS are assessed throughout the term no differently from students taking the course for a letter grade, they receive just as much feedback, including scores on every assessment (and, for the test and quiz, course-wide statistics), via which to form their own opinion on whether subsequent courses are for them.

We still hope to convince other concentrations on campus that a SAT in CS50 is indeed a successful outcome, ever more so if it leads students to a concentration that they might have otherwise assumed beyond their reach. In the decade ahead, we aspire for SAT and UNS to become CS50’s only grades.

ACKNOWLEDGEMENTS

Many thanks to Doug Lloyd, Brian Yu, Joe Blitzstein, and the FAS Registrar’s Office for their assistance with this work. And to Rob Lue, in memoriam.

REFERENCES

- [1] Swarthmore College. 2013. The Credit/No Credit First Semester. <https://www.swarthmore.edu/new-students/grades>
- [2] Wellesley College. 2014. Shadow Grading Policy. https://www.wellesley.edu/registrar/grading/grading_policy/shadow_grading_policy/policy
- [3] Lee Cuba, Nancy Jennings, Suzanne Lovett, and Joseph Swingle. 2016. *Practice for Life: Making Decisions in College*. Harvard University Press.
- [4] H. M. Davidovitz. 1972. *Lpass-Fail Grading - A Review*. Technical Report. Hofstra University.
- [5] Accreditation Board for Engineering and Technology. 2010.
- [6] Thomas Giometti. 1976. One Experience with the Pass-Fail Grading System. *Hispania* 59, 2 (1976), 302–307.
- [7] Dianne Hagan and Selby Markham. 2000. Does it help to have some programming experience before beginning a computing degree program? *ACM SIGCSE Bulletin* 32, 25–28.
- [8] Gregory A. Harris. 2010. The Impact of Hidden Grades on Student Decision-Making and Academic Performance: An Examination of a Policy Change at MIT.
- [9] Liz Johnson. 2014. High Marks for No Marks. *Wellesley Magazine* (2014).
- [10] Massachusetts Institute of Technology. 2020. First year grading. <https://registrar.mit.edu/classes-grades-evaluations/grades/grading-policies/first-year-grading>
- [11] Massachusetts Institute of Technology. 2020. Sophomore Exploratory Option. <https://registrar.mit.edu/classes-grades-evaluations/grades/grading-policies/sophomore-exploratory-option>
- [12] Committee on the Undergraduate Program. 2008. *Review of Pass/No Record Grading and the Sophomore Exploratory Subject*. Technical Report. Massachusetts Institute of Technology.
- [13] David J. Otto and University of Alberta. 1972. *A Study of the Pass/Fail Grading System*. Distributed by ERIC Clearinghouse [Washington, D.C.].
- [14] Mathew R. Sgan. 1970. Letter Grade Achievement in Pass-Fail Courses. *The Journal of Higher Education* 41, 8 (1970), 638–644.
- [15] Princeton University. 2020. P/D/F and Grade Option Selection. <https://registrar.princeton.edu/student-and-alumni-services/course-selection/pdf-and-grade-option-selection>