

Report of the Committee on Course Registration

March 2019

Executive Summary

The Current System

In the current system of course enrollment, students do not register for courses, nor do they signal their preferences for courses, prior to the semester in which they take courses. The first week of the semester is a “shopping” period, at the end of which students enroll in courses yielding actual enrollments. The FAS is committed to permitting as many students as possible to enroll in courses with unlimited enrollment, and makes every effort to support courses with resources such as instructional support allocation and classrooms through a combination of advance enrollment predictions and adjustments after the course registration deadline, usually the fifth day of classes.

The current system provides several benefits, including: students can make decisions based on full information about available courses, including finalized syllabi and introductory lectures. They have the attitudinal benefit of being open to new experiences and intellectual paths through the University. Faculty have the flexibility to design and redesign courses immediately prior to the semester in which they are offered.

Three features drive the case for change: loss of instructional time during shopping period, uncertainty around enrollments and the allocation of resources to support them, and the stresses imposed by the myriad ways and times that lotteries are run.

Many courses currently cannot begin serious instruction until the second week of classes due to fluctuation in attendance and enrollment. For courses that only meet once per week (e.g., seminars), this is a significant loss of instructional time. Scheduling sections and labs often drags even further into the semester.

Uncertainty around enrollments creates significant costs for many stakeholders in the University: graduate teaching fellows face uncertainty over which courses they will teach, and in some cases, whether they will be employed as teachers at all. Faculty cannot make pedagogical decisions that turn on enrollments, e.g., whether to use museum collections, to teach in a seminar or lecture style, to plan field trips, or what style of assignments to give. Administrators have trouble assigning rooms, and non-academic events cannot be given spaces at the start of the semester.

Students, meanwhile report stress because they have to negotiate the different timings and procedures for lotteries. Jointly and individually, these aspects of the current system undermine the teaching mission of Harvard College and the FAS.

Findings

All systems of course registration we considered ineliminably rely on prediction. The current system relies on prediction when the FAS makes initial allocations of resources, including some teaching assignments and initial room assignments, prior to the start of the semester. So long as there is a fairly liberal add/drop period, any early registration system will have to rely on predictions, as well, since actual enrollments will differ from the results of early registration, perhaps significantly so. Students may well use early registration to retain the option of enrolling in the most popular classes. Early registration is therefore just another way of collecting information on which to base a prediction of actual enrollments.

The uncertainty around course enrollments derives from FAS's commitment to accommodate student demand as much as possible, not the presence of shopping period. Enrollment in some courses may be significantly larger or smaller than predicted under the current system because FAS is committed to shifting or hiring teaching fellows to accommodate student interest as much as possible. So long as this commitment is in place without a reliable way of predicting enrollments, courses will experience variability. In a system of early registration, the commitment would allow for significant changes in enrollment during add/drop. Variability will be reduced precisely when the FAS makes binding commitments about course sizes prior to the start of the semester, resulting in hard caps. A central goal of any system of course registration must then be an allocation of resources where anticipated demand for seats in courses matches actual demand as closely as possible, so that the caps bar as few students as possible from taking a course they want to enroll in.

Therefore, whether FAS retains a "Shopping" period is separate from managing the variability of enrollment numbers. The main cost of the current system of shopping, once it is decoupled from our commitment to maximally flexible enrollment, is the loss of instructional time at the beginning of the semester.

Charge of the Committee

Any system that relies on students' engaging with the course selection mechanism in advance of the semester for which they are enrolling must be very carefully and deliberately designed, including incentives for students to take the mechanism seriously, and to provide useful information. This is very difficult.

If the FAS moves to such a system, it also needs to keep in view its many downstream requirements. This includes a new advising calendar, a new time frame for faculty to design their courses, and the provision of the required technical infrastructure. We provide a fuller list of challenges in the main report.

We make the following specific recommendations. The Standing Committee on Undergraduate Educational Policy and the Graduate Policy Committee should form a joint subcommittee charged with at least the following tasks.

- (1) **Implementing an improved system for predicting enrollment in courses so as to allocate classrooms and instructional support more efficiently.** In particular, we recommend creating sophisticated algorithms, based on data that are currently available, including historical enrollments, Q-scores, and the like. There have been promising preliminary efforts in the past, but these algorithms were never implemented on a large scale. Because prediction is involved in any system of course registration, the FAS's investment of resources in developing these algorithms will see a return, no matter what system is adopted in the long run. We recommend that these algorithms be created and deployed as soon as possible.
- (2) **Reviewing the current system of shopping classes and propose alterations if necessary.** We recommend a two-day course presentation period on the model of the Harvard Graduate School of Education's Course Preview. That would allow FAS to reclaim the first week of classes for full instruction, while retaining many of the benefits of shopping for students. The end of the Course Preview period would also provide a natural point for course lotteries to run.
- (3) **Implementing a management and registration system for courses with limited enrollment.** This includes reviewing the current system offered by the Registrar, publicizing it, and making any changes it deems necessary.
- (4) **Reporting to the Faculty, in the spring of 2022, on the current state of registration.** By that time, two foreseeable exogenous shocks to the system have been absorbed: the new contract with the graduate student union and the addition of the Allston campus. This requires gathering data on the scale of problems with the current system and developing metrics to evaluate its impact on such things as student exploration and pedagogy.
- (5) **Recommending to the Faculty, if necessary, an alternative system.** Such an alternative system should be developed alongside the other work of the committee so that a detailed plan will be available by the time the system is evaluated.

Because the charge of the committee is quite broad, we strongly recommend that the committee recruit both a broad range of perspectives, and a broad range of expertise.

Preamble

This report describes the findings and recommendations of the committee on course registration which was created in September of 2018 at the direction of the Faculty Council to study the option of implementing a system of early registration for the undergraduate and graduate students in the Faculty of Arts and Sciences.

The committees members are:

- Bernhard Nickel (Committee Chair), Professor of Philosophy; Director of Undergraduate Studies
- Mike Burke, FAS Registrar
- Kiran Gajwani, Associate Director of Undergraduate Advising; Lecturer on Economics
- David Hwang, Associate Dean for Education, SEAS
- Lauren Kaminsky, Director of Studies and Lecturer on History and Literature; Senior Advisor to the Dean of Undergraduate Education; Interim Associate Dean of Undergraduate Education
- Scott Duke Kominers, MBA Class of 1960 Associate Professor of Business Administration; Affiliate of the Department of Economics
- Michael Mitzenmacher, Thomas J. Watson, Sr. Professor of Computer Science; co-Area Chair for Computer Science; Continuing Education/Special Prog Instructor

They were joined by the Subject Matter Experts:

- Carolyn Brzezinski, Director of Enterprise Student Systems
- Bryan Jones, Associate Registrar for Enrollment Services
- Lisa Laskin, Assistant Dean of Undergraduate Education, Director of Studies for Special Concentrations; Associate of the Department of History

In its work, the committee drew on input from the community, including listening sessions with undergraduate and graduate students, and input received through the course registration website (<https://courseregistration.fas.harvard.edu>). We thus heard from stakeholders across the University: Undergraduate Students, Graduate Students, Faculty, and Administrators. We also took into account the paths that Harvard's peer institutions have taken and previous proposals about course registration relevant to the report.

We want to urge that any newly formed committee to study these issues draw its membership from an even broader base than the current one to benefit from a diversity of views and perspectives. We want to particularly highlight the importance of including undergraduate and graduate students, as well as representatives from the resident deans who see a broad range of undergraduates and know them well.

Throughout the process of gathering information, we have been impressed by the commitment to realizing the potential of undergraduate education, a commitment shared by all members of our community. Our report attempts to live up to that commitment.

This shared commitment has been crucial because during our work on the proposal, it has become clear that the problems that attend the current system are difficult to solve without losing some of the system's benefits; moreover, all candidate solutions have the potential to introduce new problems, some of them significant. *There is no easy solution.*

The committee recognizes that how students register for courses affects many parts of the University. As we discuss below, the system of registration (1) has an impact on the pedagogical choices that teachers make, (2) affects how and how much students explore, and (3) impacts which courses students ultimately enroll in. Any system of course registration will have numerous knock-on effects, many of which will be difficult to anticipate. For this reason, this report is in the nature of a charging document for a newly formed committee that can study the problems in the depth and detail they require.

Three options have crystallized as importantly distinct, each with their own benefits and challenges.

[SHOPPING + PREDICTION] Students do not interact with any course selection mechanism prior to the semester for which they are registering, but we use predictive algorithms to project demand for courses and set course size caps if needed.

[PRE-TERM PLANNING] Students register their interest in which courses they want to take in advance of the semester for which they are registering, but they do not actually enroll in classes at that time.

[EARLY REGISTRATION] Students register for classes prior to the semester for which they are registering and are assigned to classes. Students can change classes through an add/drop mechanism at the beginning of term.

We take the most urgent issue facing the current system to be uncertainty about enrollment. This affects faculty who do not know how large their classes are, teaching fellows who do not know for which classes they will teach---and in some cases, whether they will teach at all---and undergraduates who do not know which limited-enrollment courses they will get into. Variability also affects the University's ability to provide suitable classrooms and accommodations.

We should note that the precise extent of these impacts is hard to measure right now. There are data on some measures that give imperfect information on the amount of actual course enrollment variation, some of which we mention below. But there is no systematic assessment of how the uncertainty around course enrollment impacts the choices of teachers and students, even if a given course has the enrollment it was predicted to have. In other words, we currently do not have good information on the cost of the actual variability of enrollments, let along the uncertainty around enrollments.

Academic advising is a related issue. Students systematically report unhappiness with advising on their senior surveys.¹ This strikes us as a missed opportunity, because advising can help

¹According to the 2018 Senior Survey report, the mean answer in the College to the question "Overall, how satisfied have you been with the academic advising in your concentration?" has hovered around 3.0 out of 4 for about a decade, significantly lower than any other concentration-related question (even once the numbers are normalized to take into account different scales).

students realize the full potential of an undergraduate education at Harvard. Successful advising can help students explore academic trajectories beyond the ones they consider “safe”—a notion that means different things to different students, but in many cases has the effect of concentrating enrollments in a few large classes in a semester and a limited range of concentrations.

We applaud any efforts by the Advising Program Office to pursue this goal. Depending on the final shape of course registration, the structure of academic advising may well need to change significantly, and a greater burden will be placed on advising should course shopping become de-emphasized. This issue needs to be taken into account upfront—if the FAS adjusts course registration substantially, it is essential to plan in advance how concentration advising will work, since many departments’ mid-semester calendars are already quite tight. Overarchingly, whatever system the University ultimately adopts should make it easier, not harder, for students to move beyond “safe” course choices.

Similarly, we are keenly aware of the burdens university administrative staff face during shopping period since they have to juggle room assignments and TF assignments on very short notice. They also face the challenge of making adaptive technologies available to students who require them during and immediately after shopping period. We aspire to lessen these burdens, but we also acknowledge that different solutions may pose different challenges as we shift the process and timeline of registration.

This report focuses on uncertainty as the key issue to address. In this respect, all three options highlighted above have the same goals and underlying structure. Each is designed to remove uncertainty around enrollment at the point at which we finalize staffing and other resource allocations, irrespective of when students make their official course enrollment decisions.² But each brings with it its distinctive complement of strengths and weaknesses, which we outline below in order to aid the work of the newly-formed committee to study these issues in depth.

We will also offer some recommendations that are independent of which of the three options the faculty ultimately votes to adopt.

- (1) We recommend that shopping period be reconceived and more clearly separated from the regular class schedule in the form of a course presentation period.
- (2) We recommend that the University do more to help publicize courses during the course selection period.
- (3) We recommend that the newly formed committee investigate a range of issues around lotteries.

In the sequel, we will outline the benefits of the current system along with the case for change. This will lead us to the desiderata for a system of course enrollment. We then outline the three types of intervention mentioned above with an eye to how well they help us retain the benefits and address the reasons for change.

²Currently, students enroll at the end of shopping period. In a system of early registration, enrollment would be mostly set in advance, but finalized at the end of the free add/drop period.

Benefits of the Current System

The current system creates benefits for undergraduate students, graduate students insofar as they are course enrollees, and faculty.³ As far as we can see, graduate student teaching fellows do not harvest any distinctive benefits from the current system, nor do administrators.

The following considerations are given in the spirit of directing the attention of the newly-formed committee to issues to keep in mind. We currently cannot tell how widespread these benefits are. The list is based in significant part on the results of listening sessions, feedback through the course registration website, and personal experience.

Undergraduates can make course decisions based on quite complete information about which courses are available and what the formal requirements (readings, problem sets, assessment structure are). Crucially, this includes courses that are new to the curriculum and may only have been added to the course catalog during the preceding semester's break, e.g., when new faculty are hired.

In addition to this specific information about the formal aspects of the course, the current system also gives undergraduate students a suite of fine-grained information that can be quite valuable. This includes what the real level of a given class is. Some courses that are introductory to a field may still presuppose knowledge and skills that a student does not yet have. But that the course presupposes this knowledge and skill only becomes apparent once the class begins, as much through what the course head does not say as through what they explicitly announce on the syllabus. This also includes information about the demographics of the course, measured along dimensions of ethnicity and gender, but also class standing.

A second major benefit of the current system is broadly attitudinal. It's important that students can explore the curriculum and revisit the broad outlines of their educational plans, especially early in their education when many students come to Harvard and engage with a much broader curriculum than they had access to in high school. More specifically, that means that students should have the ability to imagine themselves in different courses from the ones they experience as "safe" or "expected".⁴

The current system of course registration with its emphasis on shopping supports this type of open-mindedness. Students can attend a class without any feeling of commitment, so that there is very little potential downside should the student find that the course doesn't work for them. This is in contrast to a system where a student has to enroll in the course and then potentially drop it, even if there aren't any logistical barriers to dropping the course, just because dropping a course can have the psychological significance of failure.

Relatedly, the current system of course registration normalizes not having a schedule of courses

³Though this document primarily focuses on experiences of undergraduate students registering for courses, master's students (and to a lesser extent, PhD students) have similar issues when registering for courses. That said, graduate courses often do not have heavy TF support, lotteries, etc. so the issues described in the document may not be as acute for graduate students registering for courses as for undergraduate students.

⁴Of course, the system of course registration is not the only relevant factor. For example: Are course requirements, especially in the first year, so fixed as to leave little room for exploration?

set in stone so that students need not feel any pressure to psychologically commit to a set of courses before the semester begins.

The current system of course registration also supports the relevant kind of open-mindedness because it allows students to think about the upcoming semester's courses without being caught up in the day-to-day routine of regular class work.

Shopping also emphasizes exploring courses based on considerations other than conformity with one's plan prior to the semester. Students run into each other, chat in dining halls, and can immediately act upon the impulse to try out a course on a whim. And there are cohort effects, as well. When students take courses with their friends, this may support learning since they will engage with the material after class, enhancing overall learning.

The current system also embodies what we will call a commitment to maximally flexible enrollment. Students not only have the opportunity to explore many different courses, the University also makes every feasible effort to hire as many teaching support staff as is required to accommodate all of the students who want to enroll in a course and thereby minimizing, as far as is possible, the number of involuntarily enrollment limited ("capped") courses. The University of course cannot remove all limits on course enrollment, such as the availability of physical resources or limits imposed by pedagogical choice.

The current system thus attempts to realize two distinct notions of undergraduate freedom of choice. The system attempts to remove psychological barriers to freedom by not requiring students to enroll prior to the semester. And the system attempts to remove limitations on resources through its commitment to maximally flexible enrollment.

For many faculty members, the current system also holds important benefits. Faculty can prepare their courses "just in time," designing and finalizing their classes over the break that immediately precedes the term during which they are teaching. That means that they need not do prep work for a future class at the same time they are teaching a previous semester's class, or while they are on leave. It also means that they can react very quickly to developments inside and outside within and without the university, offering courses on timely topics.

In addition to these benefits that are specific to the faculty, they also enjoy benefits that are the mirror image of those enjoyed by undergraduate students. Just as shopping aids exploration for students, it aids faculty teaching in areas that aren't considered "safe" by helping with discovery. Likewise, because students choose courses right at the beginning of the semester, faculty who join the University over the preceding break are not disadvantaged in recruiting students to their courses.⁵

Insofar as shopping allows students to identify courses that represent a good fit for them, faculty have the benefit of teaching students who choose the course because it is a good fit.

We should emphasize that this is a list of benefits that certainly accrue to *some* members of these

⁵There is a certain irony to this fact. We suspect that many of the courses and fields that are most affected by volatile enrollments are also the courses and fields most aided by the students' ability to explore courses they do not experience as "safe," such as classes in the humanities.

groups. We currently do not have a clear sense of *how many* members of the groups experience these benefits. We offer this list in the spirit of directing the newly formed committee's attention to a range of issues to keep in view and study further.

The Case for Change

While the current system yields benefits to undergraduates, graduate students in their roles as course enrollees and faculty, it also gives rise to enough concerns to warrant considering changes. In some cases, the very same constituencies that reap the benefits also have to shoulder the costs, but this is not true across the board.

In the current system, many students spend the first week of the semester visiting a larger number of courses than the four or five in which they will enroll by the registration deadline at the end of the first week of classes.⁶ While first-year advising and concentration advising practices vary, many students meet with an adviser in the first week of the semester, after which the adviser clears the student to register on my.harvard. Many courses have limited enrollment by design or by necessity, and the haphazard nature of uncoordinated selection processes constrains students' abilities to plan and advisers' abilities to offer guidance. This makes for a hectic first week of the semester for students and advisers, and also for graduate students whose teaching assignments often cannot be confirmed until enrollments stabilize in the second week of the semester.

Enrollment Variability

The current system produces significant and unpredicted variability in some courses' enrollment. A course head may expect one hundred students to enroll and end up with fifteen. A course head may expect ten students to enroll and in fact find fifty. Such variability detracts from the quality of instruction through several pathways.

- Instructors may have to adjust pedagogical strategies after the start of the semester. Seminar-style discussions aren't viable in a class of fifty, and a scripted lecture is artificial in a room of ten.
- Some instructors make pedagogical choices based on this uncertainty: they refrain from organizing field trips and including work with collections because they don't know whether the final class size will in fact allow for these events.
- Additional TFs may have to be hired during shopping period. At that point, many departments have trouble finding qualified teaching fellows or teaching assistants, and even when a qualified teaching fellow can be found, that TF has to catch up on the materials for the

⁶According to an informal survey conducted by the Harvard Undergraduate Council (n=1332), students on average shop between seven and eight courses per semester during shopping week.

class with insufficient time. For courses with a lab component, TFs may need to be trained in safety procedures on an unreasonably accelerated schedule.⁷

- Since TF appointments are not guaranteed, there is less incentive for TFs to prepare for a course they may not end up teaching.
- With the variability in enrollment comes variability in how many different section meetings and/or labs a course will have. Many courses can only schedule sections or labs after study card day. But at that point, students' schedules have become so constrained that it is difficult at times to find section times that the instructor and all of the students can make.
- The variability in number and scheduling of sections in turn makes it impossible for non-course events to be assigned rooms prior to the course registration deadline. This includes conferences, symposia, meetings, as well as student group meetings.⁸

In the current system, many courses experience a change in the number of sections assigned after the enrollment deadline, compared to predicted allocations. These changes in numbers of section reflect, albeit only imperfectly, changes in TF-assignments. They also reflect, albeit only imperfectly, changes in the mechanics of a course. Finally, it is likely that these changes are largely driven by differences between the predicted and realized course enrollments, though some are likely influenced by considerations of priority status for potential TFs.⁹

It's also important to keep in mind that *actual* variability understates the scope of the problem, since for many faculty and graduate students, the uncertainty around enrollments itself is a major concern. So even if a course happens to come in with roughly the predicted enrollments and ends up with exactly the predicted number of sections, faculty will still plan for the possibility that it won't.

Shopping is not a Uniform Experience

Shopping is not a uniform experience. Some classes begin covering course materials from the first meeting of the class. Some classes require interested students to attend the first meeting of the class and either bindingly accept or reject a spot in the class after the first meeting. Some classes have assignments due during shopping period. Other classes accommodate shopping by not starting teaching "material" until the second week. That also means that in the current system, a student's ability to shop courses is constrained by classes they have to attend from the beginning of the semester. We expect this problem to be compounded by the introduction of

⁷We should mention that here, too, it's important to develop data. On the one hand, we have heard informally from teaching faculty that it is often difficult to find qualified teaching fellows. On the other hand, Harvard's Institutional Research has suggested that "While there is a statistically significant difference in scores between TFs with early and late appointment dates, these differences are very small. The timing of appointment and the division of course each play a relatively minor role in the variation in TF Q scores (each explaining approximately 1% of variation in Q scores), whereas teaching experience/ability plays a substantial role in TF Q scores (explaining 17% of variation in Q scores)." (Karen Pearce, Harvard Institutional Research, emailed report February 2019)

⁸For each semester from Fall 2016 through Spring 2018, 30-35% of classes had a final room location that was different from the original room location.

⁹According to information compiled by the registrar's office, during the 2017 calendar year:

classes on the Allston campus, when increased distances may make it very unlikely that students will travel back-and-forth between the two campuses repeatedly.¹⁰

Many courses now have enrollment caps that are below student interest, necessitating a system of determining who is offered a spot in class. One common method is lotteries, alongside the less common application-and-interview process of some courses. Currently, some lotteries run late and unevenly. Since students only officially have to register for classes by the end of shopping period, usually the fifth day of classes, many lotteries run in the second week of classes. Students usually only find out which classes they can actually enroll in at this point, and some never learn of the results of the lottery. Should a student be lotteried out of a class, they need to add a class which in all likelihood has already covered significant material. According to the Undergraduate Council's Fall 2018 survey (1332 respondents), almost 70% of students reported having to wait for the results of a lottery before finalizing their class registration, an experience reported as moderately stressful (5 on a scale of 10).

The Burden on Graduate Students

In the section on benefits, we pointed out that the current system embodies a commitment to exploration and maximally flexible enrollment through course staffing flexibility. That flexibility has to be provided somehow, and in the current system, the burden falls most clearly on graduate students who are uncertain where, and in some cases even whether, they will be teaching.¹¹

We want to highlight that the burden on Teaching Fellows can be significant. Being moved from one course to another at the beginning of the semester is a significant burden for those students who face it. Students have to prepare to teach a course on very short notice. In extreme cases, they may have to design a full course from scratch with no advance warning. But even for students who do not actually lose their teaching appointments, the current system is a source of anxiety and stress. Until registration, graduate student instructors often do not know whether they will be lucky enough to retain the appointments for which they were tentatively assigned. As in the case of faculty who make plans that take into account uncertainty about enrollments, students are impacted by the current system not just when an actual change occurs, but simply by the uncertainty itself.

Graduate Student TFs also face a very direct financial burden. When TF/TA assignments are made after the beginning of term, graduate students often begin receiving their pay late, sometimes months late.

Here, too, the burden is not uniformly distributed among graduate students throughout GSAS. In some departments, undergraduate enrollment is so robust that graduate students effectively have guaranteed teaching assignments. In other departments, the uncertainty is very high. There is also a significant difference between international graduate students and the rest, since under the terms of most visa statuses, international graduate students cannot work off-campus. Finally,

¹⁰Especially in the spring semester, i.e., late January.

¹¹31.3% of TF appointments in AY 16-17 and AY 17-18 were made after the start of the term. The fraction was lower in science courses (18.2%) and higher in arts & humanities courses (40.3%) and SEAS courses (42.0%).

graduate students are, somewhat perversely, more insulated from the variability in enrollment if their expertise is so specific that they are unable to teach anything but a small number of courses. For these graduate students, the University's commitment to guaranteed funding during their priority status years means that they are guaranteed low-enrollment teaching positions in their area of expertise.

We should mention here that given the complexity and different approaches to assigning teaching support staff across disciplines, departments, courses, and faculty, it is difficult to unravel the myriad factors that lead to the allocation of a TF/TA to any particular course. We cannot easily tell how much of the shifting of TF/TA allocations is due to enrollment variability.

Remark

The discussion of benefits and drawbacks hopefully makes it very clear that the different models of course enrollment do not represent one group winning and another group losing. Instead, on many issues, the groups we identify--undergraduate students, graduate students, faculty, and administrators--in fact have coincident interests, so that a particular system represents significant benefits for more than one group.

Is there a Purely Financial Solution?

We want to briefly address a proposal we have often heard in conversation. Could the problems with course registration be solved if the University were to simply commit significantly more funds to paying teaching support staff? The idea behind this suggestion is roughly: the University could guarantee teaching assignments for graduate students to specific classes completely independently of actual enrollment. If the enrollment is such that the TFs will have students to teach, they do so. If the enrollment is not, they don't and simply get funding for their research. For classes where enrollment exceeds predictions, TFs would be hired once enrollments are finalized. This would obviously lead to a much higher financial outlay.

We recommend against this course of action for a number of non-financial reasons.

- (1) This proposal does not solve the problem of finding qualified teaching fellows for classes. In fact, it will only exacerbate the problem, since otherwise qualified TFs who could teach a class in their area of expertise are instead assigned to a course that does not have enrollment. This in effect reduces the pool of qualified teachers available to teach courses that actually require teaching support. Indeed, it might even lead to the creation of perverse incentives.
- (2) This proposal would lead to very unequal distributions of workload among graduate students, with attendant negative consequences on graduate student morale. Some graduate students would get "lucky" and essentially have an extra semester of fellowship support; other graduate students would get "unlucky" and have to teach. It is unclear to us what

impacts down the road such a system would have on the ways that graduate students are assigned to classes.

Desiderata for a System of Registration

A system of registration should retain the benefits of the current system and avoid its drawbacks as much as possible. To frame the subsequent discussion of the three approaches, we will briefly summarize the discussion so far in the form of a list of desiderata. They include benefits to retain and drawbacks to avoid.

Desiderata:

- Give undergraduates access to relevant information about courses, both formal and informal.
- Provide psychological and logistical support for open-mindedness and serendipity in course choices among undergraduates.
- Provide timely information on availability of spots in capped courses to undergraduates.
- Match teaching resources to student demand.
- Allow faculty to design courses with very short lead times and thus respond to current events through their course offerings.
- Allow faculty to make pedagogical choices that will work given their actual course enrollment.
- Give graduate student TAs appointment certainty.
- Allow administrators to do their jobs with a reasonable level of stress and free up unused resources as quickly as possible.

Criteria for Success

As this discussion shows, pursuing the educational mission of the FAS requires bringing a number of desiderata into harmony. In order to properly assess the current system of course registration, supplemented with more sophisticated predictive mechanisms in the future, the newly formed committee needs to have systematic rather than merely anecdotal information about the different aspects of the course registration system. This committee also needs to develop metrics by which to assess a system of course registration.

- How can we measure whether a system allows for enough exploration?
- How can we measure whether a system puts teachers in the best position to offer excellent courses?

- How much variability in course enrollments is desirable or acceptable?
- How much are early registration or pre-term planning systems likely to lower variability?

What all Course Registration Systems Have in Common

The Committee has identified three types of course registration systems on the basis of their distinctive benefits and drawbacks. Before we turn to outlining the issues each raises, we describe a set of universal features.

It's important to recognize that all of the solutions we looked at, in order to be successful, require a significant commitment of resources. This includes augmentation of my.harvard and dealing with the costs of potentially economically inefficient allocations of TF-assignments, but also the funding of advising resources and the IT infrastructure to handle course presentations, lotteries, waiting lists, etc.

Prediction, Course Caps, and Lotteries

Predictions. We recommend that the newly formed committee begin by overseeing the creation and implementation of more sophisticated prediction mechanisms. We describe the benefits of this intervention below. Here, we point out that this will be a worthwhile investment no matter what shape the final course registration system Harvard adopts will take, since prediction is a crucial element in any system of course registration we considered.

This is clearly true of the current system in which preliminary allocations of teaching staff and facilities is made on the basis of predictions of enrollment, based largely on the experience of administrators in the Office of Undergraduate Education and in the departments and programs offering courses. Allocations made on the basis of these predictions are then altered to fit actual enrollments in line with the FAS's commitment to maximally flexible enrollment.

The need to rely on predictions will persist so long as a system of registration allows students to shift freely between courses at the start of the semester. This will of course be true if the current system is supplemented by more sophisticated predictive mechanisms. But it will also be true of a system of early registration or pre-term planning, so long as such a system includes a fairly liberal add/drop period. For in that case, actual enrollments will differ from the results of early registration, perhaps significantly so. For example, students may well use early registration to retain the option of enrolling in the most popular classes. The results of early registration would therefore need to be treated as one more data input in making predictions about enrollment.

Course Caps. While we do not recommend capping more courses, it is quite possible that in the future, capping more courses may be deemed desirable, either to accommodate emerging pedagogies, or to ensure proper allocation of teaching resources. Were this to happen on a broad scale, it would address many of the problems raised by volatility of enrollment, but it would likely create new ones.

An increase in the number of capped courses does not *necessarily* lead to an increase in the number of lotteried courses. If predicted enrollments were to match actual student demand at the course-registration deadline (“Study Card Day”), these new caps would never prevent a student from enrolling in a class they wanted to enroll in.¹² However, we suspect that in a system in which course caps are more prevalent, more courses will be lotteried if only due to the movements of students between courses during the add/drop period. That means that, though course caps do not necessarily lead to more lotteries, in practice they may well.

For these courses, we propose that the newly-formed committee investigate the resources that are already present for *centralizing and coordinating lotteries (and waitlists) to run simultaneously, and to improve these mechanisms if necessary*. Ideally, this centralized system would allow the lotteries to not just run simultaneously, but for the lotteries for different courses to be sensitive to each other. Perhaps students could have the opportunity to rank courses in terms of preference. Perhaps the system should be set up so that no student will “lose” more than three lotteries. It could also include weighted elements to make the process less random, such as preference according to student standing, especially graduating seniors for whom the course would satisfy an outstanding requirement, or rules that remove a student from one lottery if they are chosen in another. Along with the coordination of random lotteries, we recommend the centralization of waitlists in my.harvard to provide departments and the Registrar with information that would be useful for the purposes of better enrollment predictions in a future semester.

Academic Advising, Course Search, and Course Presentations

This committee shares the Undergraduate Council’s view that any change to our current registration system should include a significant overhaul of current advising programs. For that reason, the Committee has conferred with colleagues in the Office of Undergraduate Education and Advising Programs Office, which is in the process of proposing a revision of first-year undergraduate advising at Harvard. Because discussions about the future of advising are ongoing, and because advising is outside this Committee’s purview, this report does not address advising at length. That said, we wholeheartedly support ambitious reform to improve the academic advising experience for all Harvard College students, which we consider a necessary part of any solution.

To better assist students in finding, exploring, and selecting courses, any future course registration system should include improvements to the course search system in my.harvard (Brown’s system is one model) and in the course information made available to students on Canvas before classes begin (including the syllabus and other means of providing the fine-grained information we mentioned above). We recommend exploring other technological enhancements to my.harvard and other systems to improve the course search and exploration process for students and advisers.

¹²We emphasize that we’re only discussing caps that are the result of guaranteed teaching allocations. Caps that are imposed due to limitations of physical resources, such as lab space, will continue to be in place and cannot be adjusted in light of predictions of enrollments, no matter how accurate the predictions are.

We recognize that different departments face very different demands and constraints, so we want to emphasize that there should be a whole range of tools for departments to use to address the various issues that a system of course registration raises. This can include

- course trailers to publicize courses
- recorded lectures
- different mixes of advising resources and ways of timing advising meetings in advance of registration

Moving from Shopping Week to a more Compressed Course Presentation Period

We have heard from students that there is no substitute for hearing an instructor introduce a course in person, and for that reason we suggest retaining a course presentation period no matter what other changes to the course registration system are ultimately adopted. Under the current system of shopping, many of the class meetings that take place during the first week of the semester are not representative of the courses because students have not prepared assigned material, because “shopping” alters some course formats, and because the instructor’s emphasis is sometimes on recruitment of prospective enrollees rather than on course content. Instead, these course presentations could be accomplished through an abbreviated course presentation period at the beginning of the term that runs for two days, where each class can be presented to students for 30 or 45 minutes at multiple times to account for conflicting presentations. Such a two day class presentation period could perhaps be accommodated under the current system by extending the semester by abbreviating reading period by two days. Such a two-day course presentation period would also be an excellent opportunity for students to become aware of courses that were late additions to the curriculum.

This course presentation period would not be the same as the initial segment of the semester during which students can freely register for courses. The latter would still take place during the first several days of classes. The change to the course presentation period the committee recommends only has the effect of compressing the presentation period and allowing classes to start on Day 1.

Finally, the conclusion of such a two-day course presentation period would be a natural moment to run lotteries.

More Sophisticated Predictive Mechanisms

We recommend that the FAS retain the student and faculty-facing current system of course registration for the next three years, at least through the Spring of AY 2021/22. We do so for two reasons. First, the FAS is currently experiencing a significant system-wide shock in the form of the new course schedule. The FAS will experience another such shock when instruction begins

on the Allston campus. We recommend against making major changes to the course registration system at the same time.

Second, we have been encouraged by two investigations into predictive algorithms for course enrollments in the past: one conducted by Professor Stuart Shieber in the context of his class CS 96 in the fall of 2003, and one by Professor James Waldo when Harvard moved from the HERS system to the current my.harvard. If these initial experiments turn out to be reproducible, this proposal will solve the problems connected to enrollment unpredictability, while retaining the benefits of course shopping.¹³

Finally, not asking the students to register preferences or enroll for courses early avoids incentives for students to "game" the prediction system because enrollments are predicted based on actual past enrollments, not on any indication of preference which students might otherwise be incentivized to represent strategically.¹⁴

The principal requirement for an effort at enrollment prediction, of course, is a carefully designed, production-level predictive algorithm. As inputs, the algorithm will need streamlined access to a variety of data about courses, such as information on: shopping and enrollment histories/trends (preferably with information about enrolled student demographics); Q Guide scores; changes in course heads; and undergraduate class composition demographics. The prior efforts of prediction had a high degree of accuracy while using relatively simple models (mostly linear regression); we expect that the more complex predictive models available today will do even better.

Secondarily, the new committee overseeing the development of these predictive mechanisms will need to understand the limitations of these predictive mechanisms based solely on data that doesn't rely on students registering their interest in courses beforehand. How will a system that relies on these types of predictions handle new courses? Are there identifiable types of courses for which predictions go awry on a regular basis? When a prediction goes wrong for a course, how likely is it that the prediction is massively wrong, on the order of a course coming in with an enrollment of a hundred students above or below the prediction? How disruptive would such a "black swan" event be?

Nota Bene: In this discussion of the next steps for the course registration, we remain silent on how this system will interact with the new graduate student contract since the terms of that contract are currently unknown.

¹³For example, in an initial "proof of concept," Professor Waldo was able to predict over 95% of classes with an accuracy of +/- 5 students, using some statistical modeling techniques (p.c.)

¹⁴In the short-run, there may be slightly more gaming of lotteries at the enrollment stage, of the type we currently have today, in which students attempt to lottery into courses just to maintain the potential option of taking them. But in the long run, we hope that predictions will be accurate enough that claiming seats for this "option value" reason should be unnecessary.

Pre-Term Planning

We recommend reviewing the current system in the Spring of 2022. We recommend that, concurrently with developing metrics and assembling data for this review, the newly-formed committee also develop a detailed plan for a new system, should that review find that the current system, supplemented with more sophisticated prediction mechanisms, has not met its goals. In this section and the next, we briefly outline the key elements of two approaches, pre-term planning and early registration.

We should mention that PTP and Early Registration can help mitigate variability in course enrollment through two analytically distinct mechanisms.

- (1) To the extent that students give as accurate information about their planned courses as they can, predictions that rely on PTP or Early Registration data may be more accurate than predictions that do not rely on these data.
- (2) The act of going through PTP or Early Registration may lead to a psychological and/or logistical “lock-in”.

The first mechanism is self-explanatory. The second mechanism really consists of several related elements. When a student has expressed commitment to a course of action, they may be more likely to follow through on it, simply because of that act of commitment. They may also experience their schedule as set. Especially a system of early registration may also lock students into classes via a mechanism of course caps.

Pre-term planning (PTP) requires students--undergraduate *and graduate*--to submit their preferences for courses for the upcoming semester. These preferences are then used as additional inputs to a prediction mechanism. The crucial difference between PTP and early registration proper is that in PTP, students do not actually register for classes, which means that lotteries need not be run prior to the start of the semester. This in turn means that lotteries can take into account all students at the same time, a particular problem for first-year students in the fall semester. They can also take into account the full offering of courses, including courses that were only added to the catalog after PTP concluded, such as those offered by new faculty.

The additional data gathered during PTP may make for more accurate predictions. We describe a number of issues we've identified that a viable PTP system would have to address.

Incentives for Students and “Gaming” the System

Harvard had a system of pre-term planning until 2014, which failed in large part because the information gathered from the students during the PTP period did not improve predictions. This points to several alterations that another iteration of PTP would have to incorporate.

The students need to have an incentive to not just report more-or-less randomly picked courses. The committee understands that this problem has bedeviled the previous attempt at PTP. A new system might include this crucial incentive: have the commitments the FAS will make on

teaching allocations turn, in large part, on the basis of information gathered during PTP. If the information were used to make binding TF-assignments, then the students would have a very strong incentive to report as accurate information as they can to ensure that enough seats are available in the classes they will want to take.

However, this leads immediately to another serious problem. The system should be set up in such a way that it is hard to “game.” We can foresee a situation in which students report preferences for courses that they anticipate will be limited enrollment in order to ensure that spots are available there, and where they do not report preferences for smaller courses that they can be sure of getting into, regardless of what enrollment is predicted.

Demands on Faculty

A workable PTP system also places significant demands on other parts of the university. Let us begin with faculty. Faculty need to have fairly detailed information about their courses available at the time that the students are asked to register their course preferences, which may well mean that they need to have significant aspects of their syllabi worked out months in advance of teaching their courses, covering the nature and dates of assessments, how final grades are computed, and a reading list. Some faculty may well decide to put brief videos “trailers” online for prospective students to view. If that practice becomes established, the university may well need to provide resources for faculty to put these together.

Faculty also need to give students in their courses meaningful feedback on their performance during the semester so that students can have a good idea of whether it makes sense for them to pursue a sequence of courses further.

Timing of PTP-Interactions with Advising

The timing of PTP would most likely take place in April after spring break for the fall semester and in November for the spring semester. The timing is determined by our attempt to fit PTP into the regular schedule of the semester.

In the spring, PTP for the fall should be late enough that students have at least taken and received their grades on their midterms so that they have relevant information about their own performance. Incoming first-year students would not participate in PTP for their fall semester. They would simply register for classes at the end of the fall shopping period.

In the fall, PTP for the spring should occur after the concentration declaration deadline, since concentration choice will heavily influence course choice for future semesters. Both PTP deadlines should be before reading period and finals.

Since course-preferences need to be registered during the semester, students should have access to advising about courses during the semester. In order to not overstretch the advising resources (esp. faculty, directors of study, etc.), it may be useful to ask students to engage in a staggered

PTP. Perhaps seniors engage in PTP first, since they are most experienced and have the clearest sense of what they need to do in order to complete their degree, then juniors, then sophomores, then, if applicable, first-year students. Graduate students enrolled in Ph.D. and Master's programs may engage in PTP on a separate timeline.

Timing of PTP-Interactions with Other Schools in the University

A PTP-system would also need to interact with the calendars of other schools in which FAS students cross-register, such as HBS, HLS, and GSE.

Early Registration

Early registration requires students to not only register preferences and plans, but to complete the enrollment process for classes for the subsequent semester, including going through the lottery process

We operate on the assumption that the early-registration process takes place in three steps. In the first, students register for classes and those classes that are capped voluntarily run their course-admission mechanism (be it a lottery or some other mechanism, perhaps via applications).¹⁵ In the second step, and based on the results of these lotteries, students register for the rest of their classes. Based on these registration numbers (and drawing on algorithms), TF positions are allocated to these courses. Courses for which demand for seats is higher than can be supplied by teaching resources run a second round of lotteries.

Lock-in and Exploration

We suspect that Early Registration may well lead to the most psychological and logistical lock-in. This has the upside of, most likely, leading to the least enrollment variability. But for the same reason of lock-in, the newly-formed committee should investigate carefully how to ensure that students still have comparable opportunities to explore the curriculum as they do under a system that features less such advanced lock-in.

We noted in the introduction of this report that we suspect that different departments are affected more or less strongly by enrollment variability. We likewise suspect that different departments will be affected more or less strongly by this type of lock-in. Specifically, we recommend that the newly-formed committee look very closely at whether a system of early registration biases students towards courses in particular fields or divisions, perhaps away from the humanities?

¹⁵By 'voluntary,' we mean to indicate classes that are capped either by decision of the instructor for pedagogical reasons, because of limitations on physical resources, and the like. We mean to contrast these classes with ones that are capped simply due to lack of qualified teaching support staff.

More generally, understanding how to give students the freedom to explore courses under a system of early registration is an incredibly important question.

Gaming

Empirical evidence using data from HBS's pre-registration system (Budish and Cantillon, *American Economic Review*, 2012) has shown that students actively strategize against the system, in ways that are consistent with game-theoretic predictions; moreover, the quality and equity of course assignment suffers as a result. We know anecdotally as well that students at HBS exert substantial energy in figuring out how best to "game" the pre-registration system, and report stress associated with the process. Students we spoke to who have attended peer schools with pre-registration programs (e.g., Penn, MIT, and Columbia) give similar accounts. (One particularly surreal example: at one peer institution, apparently the add-drop period is so chaotic that students have developed their own software for monitoring when positions open in courses so that they can "snipe" their "add" requests.¹⁶)

Issues Related to Timing

Lotteries especially for the fall semester have to be designed to allow incoming first-year students to have a chance to enter lotteried classes.

While it's possible to offload much of the logistical work of handling lotteries to a centralized and appropriately customizable automated tool, course heads will have to handle applications and interviews for courses where applicable.

The system has to accommodate courses that are added to the schedule only after the registration deadline.

Since the schedule has to be set for fall semester courses prior to the time that many new faculty are appointed, it may well turn out that new faculty have to teach in particularly early or particularly late time slots, depending on how much departments anticipate the courses offered by new faculty.

¹⁶Another student reported that their school had instituted a formal policy to reduce course-switching, because so many students were pre-registering just to claim in advance courses they thought they might want to take, and would fill up.