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Executive Summary

In preparing to assume his duties as President of the University, Peter Salovey asked the Yale student body, and the Yale College Council (YCC) in particular, to share with him students’ perspectives on a range of issues at Yale. The Science and Engineering Subcommittee (SES) of the Yale College Council submits the following report to present student perspectives on aspects of the undergraduate STEM experience at Yale.

The report draws from a survey conducted between March 6 and March 25, 2013. The survey was designed with the intent to establish concrete data on issues that are often spoken about in a less formal forum by students. A total of 542 students responded to the survey in full. Of these students, 71.5% are STEM majors, 17.1% are non-STEM majors, and 11.4% are undecided. No cross-tabulation to control for STEM/non-STEM majors was performed as we aimed to evaluate perception of STEM education for all students.

The following is a summary of our primary findings and recommendations.

1) Grading Transparency
   - Findings: Students report there is not adequate transparency of student grades in STEM courses larger than 20 students.
   - Recommendations: The University should standardize procedures for instructors to improve grading transparency.

2) End-of-Course Evaluations
   - Findings: End-of-course evaluations strongly influence course decisions for a majority of students.
   - Recommendations: Additional questions should be added to end-of-semester evaluations to improve their usefulness to students.

3) Midterm Evaluations
   - Findings: A majority of students reported no informal midterm evaluation of teaching performance was conducted in the past two semesters in their classes.
   - Recommendations: A standard midterm course assessments by students for the benefit of both instructors and current students should be implemented.

4) Academic Advising and Introductory Courses
   - Ratings of introductory classes and student placement in mathematics, chemistry, biology, and physics suggest room for improvement across the board.

1 The Office of Institutional Research reviewed and approved the survey.
5) **Quality of Instruction**

- An increase in the number of qualified professors who aim to inspire student learning and achievement through teaching will enhance the state of STEM education at Yale.

Superscripted figures throughout the report direct the reader to supplemental material that can be found in two appendices:

1) Appendix A: The Pre-Med Experience, which includes any differences in the report’s results between students who are and are not pre-med.

2) Appendix B: Survey Comments, which includes valuable input from respondents to supplement quantitative data presented throughout the report.

Example: a superscript ²b indicates supplemental material in part 5 of Appendix B.
Grading Transparency

Students report there is not adequate transparency of student grades in STEM courses larger than 20 students. We exhort the University to standardize procedures for instructors to improve grading transparency. The following are survey questions presented on this topic and student responses.

*In how many of your classes did your professors use Classes*+v2 or another method to allow you to monitor your grades throughout the past two semesters?*

![Graph showing grading transparency survey results](image)

Based on these results, most professors do not release grading results online via Classes*+v2. Over 50% of students responded that professors “rarely” or “never” publish class performance indicators on Classes*+v2. Less than 20% of students reported that professors “often” or “all of the time” release grading results. In 2012, the Science and Engineering Subcommittee proposed the use of a grading transparency form following a model proven effective in MB&B 300, taught by Professors Thomas Biederer and Michael Koelle. In MB&B 300, Professors Michael Koelle and Thomas Biederer post a .pdf file of the class raw score distribution, by quintile (20% blocks), after each midterm and final exam, on the course’s Classesv2 page. In addition, a final scaled grade distribution, and corresponding final grade raw scores, is posted in the Resources section of the course’s Classesv2 page.
At the end of the Fall 2012 semester, in classes with more than 20 students, how often did your professors return final exams, make final grade distributions available, or publish raw score conversions to final grades?

Students were asked whether in their classes in which more than 20 students were enrolled professors distributed graded exams on a consistent basis and how many of those published grading curve information. Only 9% of students indicated that professors always returned final exams, made final grade distributions available, and published raw score conversions to final grades. Students were asked only to evaluate courses with enrollments larger than 20 students because publishing grade distributions in classes with enrollments under this size would conflict with student privacy.

How many of your final grades from last semester (Fall 2012) differed from what you expected?

We then asked students if there was any discrepancy between the final grades they received and their expectations and/or awareness of their class performance. Out of 542 responses 64% indicated that their final grade differed from their expectations in at least one class.
If there were one or more grades you did not understand, did you contact your professor to resolve your concern?

Over 70% of students who had at least one unexpected grade did not contact their professors to resolve their grading concerns. While we exhort the University to take measures to improve grading transparency, we also note it is important for students to take initiative to resolve grading concerns.
End-of-course Evaluations

End-of-course evaluations strongly influence course decisions for a majority of students. Additional questions should be added to end-of-semester evaluations to improve their usefulness to students. The following are the survey questions presented on this topic and student responses.

*How great an effect do end-of-semester evaluations have on your decision to take a course?*

![Graph showing percentage of students and their responses to the question about the effect of end-of-semester evaluations on their decision to take a course.](image)

Students make extensive use of end-of-semester evaluations in deciding which courses they will take (42% reported that evaluations have a large effect and 45% reported that evaluations have some effect on their decision to take a course).¹⁴

*How useful are end-of-semester evaluation questions in telling you what you want to know about a course?*

![Graph showing percentage of students and their responses to the question about the usefulness of end-of-semester evaluation questions in telling them what they want to know about a course.](image)
While almost all students make use of course evaluations (1 individual in 542 indicated that he/she does not make use of course evaluations), only 39% indicated that they find evaluations very useful in telling them what they want to know about a course. Based on other data collected in the survey and individual comments from students, we propose a through review of the current evaluation questions to improve their usefulness to students.\textsuperscript{28}

To that end, we asked students to indicate how useful they would find seven additional proposed areas of assessment for a course.

\textit{The Teaching, Learning and Advising Committee, in collaboration with the YCC, is considering a revamp of the current evaluation questions. Please indicate whether you think each of the following evaluation questions about professors would be useful. (On the evaluations, students would be asked to respond with scores from 0-5.)}

<table>
<thead>
<tr>
<th>End-of-Course Evaluation Question</th>
<th>Not very useful</th>
<th>Somewhat Useful</th>
<th>Very Useful</th>
<th>Essential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness of lectures/presentations</td>
<td>16</td>
<td>61</td>
<td>220</td>
<td>244</td>
</tr>
<tr>
<td>Instructor Overall</td>
<td>31</td>
<td>89</td>
<td>147</td>
<td>271</td>
</tr>
<tr>
<td>Gives useful feedback</td>
<td>46</td>
<td>152</td>
<td>192</td>
<td>148</td>
</tr>
<tr>
<td>Accessibility outside of class</td>
<td>52</td>
<td>190</td>
<td>196</td>
<td>101</td>
</tr>
<tr>
<td>Generates enthusiasm</td>
<td>67</td>
<td>180</td>
<td>179</td>
<td>114</td>
</tr>
<tr>
<td>Returns assignments in a timely manner</td>
<td>77</td>
<td>176</td>
<td>171</td>
<td>116</td>
</tr>
<tr>
<td>Facilitates discussion and encourages participation</td>
<td>102</td>
<td>197</td>
<td>156</td>
<td>81</td>
</tr>
</tbody>
</table>

While according to students the two most useful additional areas to evaluate were “Effectiveness of lectures/ presentations” and “Instructor overall,” we note that some students supported all additional proposed areas of assessment.\textsuperscript{26} The current evaluation system makes extensive use of relative assessments (e.g. ranking workload and class overall: much more work/much better, same, much less work/much worse). We suggest a more quantitative assessment would be more beneficial (e.g. workload in number of hours per week).
If grade distributions for a course from previous semesters were available with end-of-semester evaluations, how great an influence would they have on your decision to take a course?

![Bar chart showing responses to the question about the influence of grade distributions on decision to take a course.](image)

The survey indicated that if grade distributions were made available with end-of-semester evaluations, such data would have some influence on 43% of students and a large influence on 39% of students. In the comments, many students voiced concerns that making grade distributions available with course evaluations would “deter students from taking classes with excellent instructors who may happen to grade with stricter standards” and add to a “grade-obsessed” culture. However, the ability to monitor one’s grade and its relation to the class average throughout the semester, and knowledge of how the final grade will be calculated, remains important to many students, especially in large lecture courses.
Midterm Evaluations

A majority of students reported no informal midterm evaluation was conducted in the past two semesters in their classes. We suggest the implementation of standard midterm course assessments by students for the benefit of both instructors and current students. The following are the survey questions presented on this topic and student responses.

_How many classes the past two semesters have you taken in which the professor has conducted an informal course evaluation mid-semester?_

![Bar chart showing student responses]

With regard to evaluations and course improvement, we have received positive responses from many faculty members such as Michael Frame indicating that commentary from students mid-semester about how the course is going would be useful. Still, few professors presently conduct informal evaluations at midterm (in the past two semesters, 55% of students reported that no midterm evaluation was conducted, while 29% saw only one).\(^4\)\(^8\)

We propose the implementation of a standardized method for collecting anonymous midterm evaluations, perhaps through Classes*v2. Midterm evaluations conducted through Classes*v2 would provide a set of standard questions for the professor’s convenience with a customization option. To that end, we asked students to indicate how useful they would find seven additional proposed areas of assessment for a course. The table below shows the perceived usefulness of each potential assessment, ordered from most useful to least.
Perceived Usefulness of Additional Ways to Evaluate a Course: The YCC seeks to address the lack of improvement in courses that consistently receive poor reviews and is considering the implementation of midterm evaluations. Please check two of the following topics to address for a midterm evaluation:

<table>
<thead>
<tr>
<th>Answer</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness of lectures/presentations</td>
<td>406</td>
<td>75%</td>
</tr>
<tr>
<td>Fairness of exams/grading</td>
<td>306</td>
<td>56%</td>
</tr>
<tr>
<td>Workload</td>
<td>243</td>
<td>45%</td>
</tr>
<tr>
<td>Applicability of problem sets to course</td>
<td>192</td>
<td>35%</td>
</tr>
</tbody>
</table>
| Accessibility of professor/others resources for help outside of class | 130 | 24%

While more students believe assessing their professors in the areas of “effectiveness of lectures/presentations” and “fairness of exams/grading”, we note that professors may find some of the lower-scoring questions useful in improving their teaching style and class dynamics as well. We suggest this information would be available to the professors and their department heads only, and not distributed to the class nor made widely available to the student body through sources like Bluebook.
Academic Advising and Introductory Courses

Ratings of introductory classes and student placement in mathematics, chemistry, biology, and physics suggest room for improvement across the board. The following are the survey questions presented on this topic and student responses.

*In your freshman fall, did you feel adequately informed to make a decision about which series of intro class in the sciences you should take for your major or pre-professional track?*

Students assessed whether they believed there was adequate information in their freshman fall semester to choose which introductory courses to take for their intended major and/or pre-professional track. Only 14% of students felt fully informed.

*How would you rate your experience in intro classes in each of the following departments? (Please leave blank if not applicable.) Results Aggregated by Department*
Students were asked to rate their experience in introductory classes in the STEM subjects on a scale of 1-10 with 10 being the perfect class setting. There were noticeable differences between student ratings of the introductory courses in chemistry, biology, physics and mathematics. All four subjects received ratings from 5.6 to 6.6, leaving much room for improvement. Students demonstrated higher satisfaction for chemistry and mathematics and lower approval ratings for biology and physics. Because introductory courses are students’ first impressions of a subject, it is important to ensure that these classes are structured effectively.\(^5\)

*How would you rate your placement in intro classes in each of the following departments? (1 is the worst and 10 is the best). – Results Aggregated by Department*

![Student Ratings of Introductory Class Placements](image)

Students were also asked to rate how appropriately placed they were with the same introductory classes on a scale of 1-10 with 10 being the most ideal placement. Overall, these ratings were 1-2 scale points higher than the actual class satisfaction. Chemistry and mathematics performed better in placement than did biology and physics. There is a notable trend that chemistry and mathematics both had fair and structured placement exams that could access student’s knowledge directly while physics had a more arbitrary scale. Perhaps it would be beneficial for Yale College to consider the addition of a physics placement exam to better access students’ knowledge. We also strongly recommend an evaluation of the current biology placement exam. Perhaps with a newly designed placement test, the students will find themselves in an environment with a maximized capability for progress.\(^6\)
Quality of Instruction

An increase in the number of qualified professors who aim to inspire student learning and achievement through teaching will greatly enhance the state of STEM education at Yale.

Quality of current STEM teaching was not an area this survey particularly set out to address, but an overwhelming number of students commented on teacher quality in the comments section, many pointing to uninspiring and seemingly uninterested professors as an underlying source for many of the problems they find in STEM education at Yale. We encourage readers to review the additional comments provided by students on how to improve the Yale STEM student experience."
Acknowledgments

This report was edited by Yale College Council’s Academics Chair, David Lawrence ’15 and written by members of the Yale College Council Academics Subcommittee on Science & Engineering:

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We would like to thank the students who participated in the survey and contributed valuable additional comments.
Appendix A: The Pre-Medical Experience

In creating this report, SES hoped to determine if there were any differences in these results between students who are pre-med and students who are not pre-med. Notes correspond to the areas of the report where significant differences were found.

1A) There was a greater tendency among those who are pre-med to address some or all grades they did not understand than those who are not pre-med. Of pre-meds, 39% responded they addressed some or all grades they did not understand compared to 26% of non-pre-meds.

2A) On average, pre-meds indicated they find course evaluations more useful than non-pre-meds. (Pre-med Mean 3.35 v. Non-pre-med Mean 3.25)

3A) On average, pre-meds rated “returns assignments in a timely manner” as more important than non-pre-meds. Pre-meds rated on average “generates enthusiasm” as less important than non-pre-meds.

4A) The average class-size in which students would begin to feel uncomfortable raising their hand to ask a question was 43.19 (SD = 24.78) for pre-med students and 39.59 (SD = 28.83) for non-pre-med students.

5A) On average, pre-meds reported making final grade distributions available would have a greater effect on their decision to take a course than non-pre-meds. Of pre-meds, 39% reported making grade distributions available would have some influence and 46% said it would have a large influence. Of non-pre-meds, 45% reported making grade distributions available would have some influence and 37% said that it would have a large influence.

6A) On average, pre-meds rated “fairness of exams/grading” as more useful (64%) than non-pre-meds (54%) for mid-term evaluations. On average, non-pre-meds rated “accessibility of professors/other resources for help outside of class” as more useful (25%) than pre-meds (20%).
Appendix B: Survey Comments

1B) Student Comments on Grading Transparency:
- “Classes without a classesv2 page or who do not post handouts/practice tests/homework assignments online make life much harder than it needs to be, and greatly increase stress.”
- “I feel the physics and computer science departments in particular do not do a good job of providing final grade distributions, and that the physics department specifically does not provide adequate raw score-to-final grade conversions—last semester, I did unexpectedly well in PHYS 401 (as I had the previous year in PHYS 260), because I had no idea that my disappointing raw scores on exams and problem sets actually translated to decent final grades, which raised my anxiety unnecessarily throughout the semester.”
- “Professors should be encouraged to provide basic grade distributions at the beginning of the semester and use the Gradebook on ClassesV2 to help students decide whether they are going to remain in a class or not. It alleviates tension for students during times of midterms or finals, and it provides a goal for students to strive towards.”
- “Curves (especially in large science and math lectures) should be more transparent to students. The disparity between liberal arts and science grading systems at Yale is incredibly unfair and puts STEM and pre-med students at a marked disadvantage.”
- “I think in all courses at Yale, there need to be requirements that professors meet with TFs to standardize grading systems, that the make roughly 50% of coursework due and handed back before midterm, that they publish grade distributions for historical overall courses and for current individual projects, that students give formal feedback on the course before midterm, and that profs/TFs give substantial, constructive verbal feedback prior to midterm.”

2B) Student Comments on End-of-Course Evaluations:
- “I think it would be a helpful measure on the course evaluations to ask about major and pre-professional program separately.”
- “The most helpful thing of evaluations is when people write long responses about specifics of the workload, how the exams go, what the professor is like, etc. The yes/no or even 1-5 questions are really not that helpful at all.”
- “Evaluations should include the number of people who dropped the class and ask for their evaluation of the class.”
- “A lot of the questions concerning how the evaluations would influence my choice are not applicable because I am required to take the course. The evaluations just tell me how bad it will be, but I have no choice as I have to take the course.”

3B) Student Comments on Making Past Grade Distributions Available:
- “I do not think that publishing past grade distributions is necessary or constructive for STEM classes. The pool of students may vary greatly from year to year, as may the quality of instruction (especially in a team-taught lecture). Posting distributions will likely encourage students to take
fewer risks and deter them from taking classes with excellent instructors who may happen to grade with stricter standards. We are at Yale to learn, not to get straight A’s because we feel entitled to them, and posting grades shifts students’ focus from the material being presented to the actual substance of the course. I do think it is helpful when professors explain their grading policy at the beginning of the semester and post grade distributions after each midterm. This helps students gauge where they stand in the class and accurately compares them with their peers, not people who took the class in semesters past. I do not think that setting grade quotas is effective in all situations, particularly when professors write exams that yield high raw scores; students should not be penalized for mastering the material expected of them.”

- “As someone who is very interested in grades, I think that it would be very unfortunate if there were access to a grading distribution for past classes. That would prevent me from taking classes whose curves are not very beneficial and add lots of unnecessary stress. I definitely don’t think Yalies need to be any more grade-conscious than they already are.”

4B) Student Comments on Midterm Evaluations:

- “We definitely should have midterm evaluations -- I’m in a poorly taught course now and would love the chance to give feedback -- that way there’s more of a chance that people in the class will be able to benefit from their own feedback while they’re still in the course.”

- “I have had the problem in a number of classes where even when the professor is given feedback (specifically negative) he or she does not actually change the way he/she teaches. I want to make sure that professors take it seriously to change the way they run their classes based on evaluations.”

- “I think another evaluation question for professors should be: ‘Takes interest in students as individuals.’”

5B) Student Comment on Class Size:

- “Yale needs to realize that the single biggest reason why Yale is lagging behind in math and science is because students are disappointed with their experience in math/science classes. It’s not because there isn’t a dining hall on science hill or because we lack an expensive design facility, though these things will certainly help. It’s because students are frustrated with their classroom experience. Why is it possible to take an intro english seminar with 15 people but not an intro science class? Too often, people have questions during class--and very often, multiple people have the same questions--but don’t feel comfortable asking these questions during class. And too often, science professors and classes are rigid and unapproachable. My friends majoring in the humanities build real relationships with their professors because smaller class sizes are conducive to investing oneself in the course and to building real relationships.”

6B) Student Comment on Introductory Course Placement:

- “During my first semester freshman year I had a particularly bad experience with one math class, and know a number of people who have had similarly bad experiences. This basically turned me
off from continuing with math at Yale and I think addressing issues surrounding this particular class as well as math/science advising for freshmen would be really helpful.”

7B) Student Comments on Quality of STEM Teaching:

- “Completing the end-of-term evaluations can be extremely frustrating because sometimes it feels futile. We give honest and thought-out feedback, but many of us often wonder what the point is since nothing seems to change. What bothers me the most is that we’re at Yale but still are often taught by people who are really just not good teachers, particularly (in fact, almost exclusively, in the sciences). I appreciate and respect that they are accomplished leaders in their fields, but when it comes to me trying to learn essential science for courses that I am required to take, I hate that I expect to be confused. It is the rare science course in which I am pleasantly surprised at actually understanding the material because it is well-taught and presented, thanks to the professor.”

- “The lectures for STEM courses are rarely helpful and I often feel as though I have to spend copious amounts of time teaching myself the material, which is frustrating because I feel as though I am not receiving the same kind of teaching quality as students in other disciplines. I also feel that grading is often unreasonably harsh in some of the STEM disciplines and this discourages me from taking certain classes. Additionally, especially in the math department, the quality of teaching is simply unacceptable and has actually managed to deter me from studying math, which was my original intended major.”

- “Not many professors provide meaningful exams or problem sets that are directly related to what we have learned in the class. As a transfer student, I do not see much difference between a previous institution and Yale at least in terms of depth of learning. I even felt that some professors are worse at teaching than those at other institutions, which was really disappointing actually. It is true that many professors are known for their great works in their fields, however, I have experienced that their individual research abilities have nothing to do with making them great lecturers.”

- “The courses that get the worst reviews are courses that are mandatory for the major. Thus, demand for the class is high despite the class/professor being terrible. I believe changing the way that Yale approaches hiring professors is how we can make a difference. Yale needs to hire professors that can teach these classes well, that are approachable, and that actually want to teach.”

- “I think one of the major problems is how faculty in the sciences are chosen— it has absolutely nothing to do with teaching ability, and everything to do with research and ability to acquire grant funding. If the purpose of this university is in fact to educate students, I believe this point should be addressed and much more energy should be spent on determining whether or not new faculty members can actually put together an effective presentation to students.”

- “I think many introductory science courses are taught by professors who cannot appropriately gauge the ability level of their classes and care too much about their research and not enough about teaching undergraduates their subject. I believe a qualified high school teacher could do a better job teaching most introductory science classes at Yale because they would teach at an
appropriate level and would not preoccupied by research. Perhaps there should be more teaching-focused teachers and less field-expert teachers.”

- “Evaluations are fine but I'd be more interested in an improvement in instructors.”
- “I understand that to Yale students the whole 'grades' thing may be a big deal, but I'd be sad if the result of this survey is student clamoring around that rather than the much larger issue of teaching skill and classroom engagement. Give me a C and a Michael Frame any day.”