

Dear Education Committee,

The [Physics Graduate Student Council](#) Oral Quals Task Force is writing with the results of the survey we administered to graduate students and faculty in March 2021, and to issue open-ended recommendations to the Department on the basis of these results. We make our recommendations about the [Oral Exam](#) based on the following underlying principles:

1. Academic requirements should have a meaningful purpose that is aligned with one or more of the [primary goals](#) of the graduate program in physics at MIT.<sup>1</sup>
2. The structure of a requirement and the measures by which we assess whether a student has fulfilled that requirement should be aligned with the requirement's stated purpose.
3. The structure of a requirement should be consistent across all sectors of the Ph.D. program and for all students.

Our surveys uncovered a number of issues with the administration of the oral exam, as well as with the paucity of information that the divisions provide students in advance about exam scope, grading, and expectations. We summarize a number of key points and include more data below:

- **Purpose.** Faculty have glaringly divergent viewpoints about what set of knowledge and skills the oral exam should ideally measure. Faculty largely agree, however, that the oral exam at present measures factors that are largely not high priorities for faculty, such as a “student’s ability to perform under pressure.” Student responses likewise reflect a range of assumptions about current and ideal exam purpose ([Secs. II, VII](#)).
- **Outcomes.** The majority of community members believe that the oral exam experience builds a student’s background in the exam area and enhances their communication skills. The data and anecdotes about whether the oral exam experience enhances students’ research skills and capabilities are more equivocal ([Secs. V](#)) and may depend on the research focus of the examinee, and how that relates to their exam’s focus ([Secs. VI, VII](#)).
- **Scope and communication.** Faculty from at least two research areas report that their area does not have an agreed-upon oral exam scope. Over half of faculty report that their area does not have an agreed-upon rubric for assessing students on orals. Faculty are not aware of how much oral exam content is taught in the specialty courses. Only ~15% of students “strongly agree” that their division explained the scope, purpose, and grading of orals to them, and most rely on word-of-mouth information from their peers ([Sec. IV](#)).
- **Fairness and consistency.** Students largely report that their orals committee members are respectful and want to see them succeed (with a few exceptions). Students largely believe

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<sup>1</sup> “The primary goals of the graduate program in physics at MIT are to solidify and broaden your knowledge of physics and to teach you how to do research, how to identify important problems, and how to communicate scientific information effectively. In short, you will be trained to become a professional physicist and a productive member of the scientific community.”

that the oral exam procedures are in principle fair and consistent. On the other hand, students largely believe that the scope, content, and grading of the oral exam are dependent on which faculty members serve on their oral exam committee ([Sec. IV](#)).

- **Student preparation and stress.** The faculty as a whole correctly estimate how stressed their students are by the oral exam, and 78% of faculty believe the oral exam should be made *less* stressful. Nevertheless, faculty underestimate how much time students spend preparing for orals, leading to a situation in which 40% of students feel they were only “somewhat” or not at all relieved of research duties while studying for orals ([Sec. III](#)).

Based on the survey data, PGSC recommends that the Physics Department Education Committee perform the following actions, in the following order:

1. **Establish a purpose for the oral exam.** Policies, procedures, and practices in the Physics Department should all flow from purpose. To maximize educational and career outcomes while decreasing *unnecessary* stress, the Department should create and commit to a common, shared sense of purpose for the oral exams rather than relying on unspoken norms and expectations that actually vary considerably between faculty and divisions.

We request that the Education Committee determine a set of at most 3-5 aspects of student technical skills, soft skills, or a body of scientific knowledge that the oral exam should measure. The more objectives one sets out to measure simultaneously, the more potential there is for confounding variables. The Committee should take into account how the purpose of the Oral Exam relates to and differs from the other required components of the PhD: the core courses, specialty courses, breadth courses, thesis, and thesis defense.

The Education Committee should start with a fresh slate and examine what qualities are most important for a developing physicist and how the Ph.D. program’s structure can best develop and measure those qualities, rather than trying to refine any one faculty member’s individual approach towards the oral exam. Our survey data from students and faculty ([Sec. II](#)) provides one starting point for discussion. We also include information about the structure and purpose of Orals at MIT and peer institutions on [pages 4-8](#).

2. **Create formal guidelines for divisions to structure the scope and administration of their oral exams,** based on the agreed-upon purpose of the requirement. At the moment, divisions differ on everything from exam duration, to content covered in coursework, to even the degree of focus on a student’s research during the oral exam. These aspects should be consistent across divisions. If oral presentation skills and ability to perform under pressure are not among the primary purposes of the requirement, the Education Committee should consider creating alternative ways than an oral exam for students to demonstrate skills and knowledge to their divisions and thereby fulfill the requirement.
3. **Partition the department into new exam divisions,** based on the purpose and structure of the exams. According to our [Physics Values Statement](#), “we value the multitude of

ways to be a physicist and the many paths through our field and Department... all areas of study are worthy of respect... we value the richness that interdisciplinary research brings.” In physics, disciplinary boundaries vary substantially across universities, funding agencies, and indeed evolve over time as we push forward the boundaries of knowledge.

If the purpose of the orals is dependent on students’ thesis research areas, and if a given examinee’s research area would merit approval for a physics thesis, then there should be an oral exam that is a reasonable match for that examinee’s research area. Stated differently, the fields in which we offer oral exams should fully cover all research being conducted by members of our community, including the 10% of students working with advisors outside of our department. Orals fields and scope should be constrained neither by longstanding tradition, nor by MIT’s particular ad hoc partition of physics research into divisions and departments, nor by what each new semester’s faculty on the rotating orals committee deem canonical (although small fluctuations are expected and excepted).

The PGSC suggests a method for determining whether a partition is appropriate: if we wrote a one-sentence description of the specific research area for all physics Ph.D. theses over the past 10 years and erased the names / divisions of the students, we should be able to find a reasonable match for an exam for each of these sentences.

4. **Align specialty courses with exam structure and areas.** Based on the determined purpose for the specialty courses and orals, we can bring class requirements, curricula, and exams into better alignment. The Education Committee should first decide whether specialty coursework should teach few, most, or all of the topics covered in an Oral Exam ([Sec. IV](#)). Next, depending on how degree requirements evolve, various changes could improve alignment: widening the set of classes that can fulfill the specialty and breadth requirements, possibly including options from other departments; tweaking specialty course curricula; tweaking the scope of current oral exams; or some combination thereof.
5. **Impose these changes top-down on the divisions; ensure compliance; and clearly advertise new exam policies, practices, and procedures.** Degree requirements should be consistent across the department, and not subject to individual faculty and divisions’ widely diverging views and inclinations towards proper exam scope and administration. Clearly stated requirements relieve pressure on students who might otherwise struggle to navigate unwritten rules and expectations; who switch research divisions before their orals and want to hit the ground running in a new area; or who work for research groups outside of the department that might not have as much knowledge of physics orals norms.

Per usual, the PGSC requests that changes take effect beginning with the incoming class, so that we can continue to make recommendations without conflict of interest or the appearance thereof.

Thank you for your consideration,  
Physics Graduate Student Council Oral Qualls Task Force

## Purpose and scope of oral exams at MIT and peer institutions

### Stanford Physics

Oral exam: Students write a one-page abstract and give a 45-minute talk at the advanced undergraduate level about a topic they choose outside their area of study (AMO, Condensed Matter, Particle Physics, or Astrophysics). The committee consists of three faculty members in the Physics Department, Applied Physics Department, or SLAC, one of whom must come from a standing oral exam committee. The student must make their first attempt at the exam at any time before the end of their second summer. If the student fails the exam, they must retake the exam between 3-6 months after the first attempt and for the second attempt, write a 5-7 page article about the topic. If the student fails the second time, an ad hoc committee is convened to “discuss further options with the student.”

Written exam: None

Required courses (grade of B or higher):

- 1 quarter of statistical mechanics, 1 quarter of electrodynamics, and 1 quarter of quantum physics (choose from QM 1-3 or QFT 1-3)
- 2 quarters of breadth courses
- Introductory courses about teaching and research

### Harvard Physics

Oral exam: Students are asked to select, prepare, and discuss in depth a topic in physics preferably related to their proposed area of thesis research for their thesis committee. A passing grade signifies that the committee believes the student has “demonstrated adequate comprehension of physics in the area of the chosen topic and in the larger field, as well as an ability to perform the thesis research required for the doctoral degree.” Students are “also judged on the clarity and organization of their expositions” and the committee “may take into account other information about the candidate’s performance as a graduate student.” Students should ideally pass the exam by the end of their second year and no later than their third year, and may make two attempts.

Written exam: None

Required courses (B- or higher):

- **4 core areas**
  - *1 intro quantum course*: Quantum Mechanics I, QFT I or II, AMO physics I or II, or Quantum Theory of Solids I or II
  - *1 advanced quantum course*: Quantum Mechanics II

- *1 electromagnetism-related course*: Advanced Electromagnetism, Optics and Photonics, or Modern Optics and Quantum Electronics
- *1 statistical physics course*: Statistical Physics or Statistical Thermodynamics
- **4 elective courses in Physics or other departments**, with at most 2 in any given field:
  - High-energy theory
  - Condensed matter
  - AMO
  - Relativity/astrophysics
  - Mechanics/E&M/applied math
  - Lab physics
  - Biological or biomedical physics
  - Earth and planetary physics
  - Can petition for other courses (100s of options across nearly a dozen departments)
- **For theorists**: 1 lab course or equivalent laboratory experience
- Teaching and Communicating Physics course

## Princeton Physics

Oral exams: First, in summer of their first year of graduate studies, students work on an experimental project for six weeks and write up a report structured like an article for a “letter-type journal,” at a level geared towards “physicists who are not expert in the field.” Then, students give a 15-minute presentation to two professors and are asked questions for 15 minutes afterwards, to be completed by October of the second year.

Second, students give a “Pre-thesis” oral exam about work they have performed in their research group. Students write up a report of at most 20 pages and give a 30-minute talk about an independent research project. Students present their findings to a committee consisting of the student’s research advisor and two other faculty members that they get to choose. This oral must be completed by winter of the third year. “There is wide agreement that these orals are fun...Come tell us what you’ve been thinking about!”

Written exams: Classical mechanics, E&M, statistical physics, and quantum physics

Course requirements (B or higher):

- 1 course in QM or QFT, 1 course in CM/AMO/biophysics, 1 course in GR/high-energy theory
- Communicating Physics course

## **Berkeley Physics**

Oral exam: Students give a 2-3 hour oral exam, beginning with a 45-minute presentation about the student's research goals and any necessary background material, as well as a schedule for finishing their PhD. Then, the committee asks the student questions about both their specific presentation topic and broader matters related to the student's research field. The student takes this exam in their third but no later than their fourth year of study, and chooses their exam committee consisting of three members of the Physics Department and one outside faculty member. At least one committee member must be an experimentalist and one a theorist.

Written exams: classical mechanics, E&M (including optics and relativity), statistical physics, and quantum mechanics

Course requirements (minimum average grade of B):

- Core courses: 1 quarter of E&M, 1 quarter of statistical physics, 2 quarters of quantum mechanics (transfer credit is accepted)
- 5 quarter-long elective courses
- Introductory courses about teaching and research

## **Caltech Physics**

Oral exam: Students have a “fairly informal” candidacy meeting with their thesis committee. Students give a 45-minute oral presentation about their proposed thesis research, including work done already and work the student plans to do in the future. Then, the student answers questions for roughly 45 minutes. Questions from the committee relate to the work the student has done so far, the work they plan to do, and general knowledge of their field of research. Students must take the exam by the end of their third year. Students choose their exam committee.

Written exams: classical mechanics and E&M; quantum mechanics, statistical mechanics, and thermodynamics

Course requirements: 6 quarter-long courses, chosen from at least 3 out of 4 areas. List of potential options, but can apply for substitutions.

- Elementary particles and fields
- AMO physics, condensed matter, or quantum information
- Gravity, astrophysics, and cosmology
- Interdisciplinary physics (e.g. biophysics, applied physics, chemical physics, mathematical physics, or experimental physics)

## MIT Physics oral exams

| Technical details |                |                   |   |
|-------------------|----------------|-------------------|---|
|                   | Duration       | Who schedules it? | Formal preparation?   |
| <b>AMO</b>        | 1 hour 45 min. | Committee         | None  |
| <b>ASTRO</b>      | 1 hour 30 min. | Committee         | Review sessions led by Al Levine; study guide with 185 questions circulated |
| <b>BIO</b>        | 1 hour         | Committee         | None  |
| <b>CMT</b>        | 2 hours        | Student           | None  |
| <b>CMX</b>        | 2 hours        | Student           | None  |
| <b>NUPAT</b>      | 2 hours        | Staff             | None  |
| <b>NUPAX</b>      | 1 hour 30 min  | Student           | None  |
| <b>PLASMA</b>     | 2 hours        |                   |   |
| <b>QI</b>         | 2 hours        | Staff             | None  |

| Student presentation on assigned topic |             |                               |                   |  |
|--|-------------|-------------------------------|-------------------|--|
|  | Preparation | Duration                      | Topic chosen by   | Topic  |
| <b>AMO</b>                             | 1 week      | 15 min                        | Committee head    | General AMO; can be research-related         |
| <b>Astro</b>                           | Few weeks   | 15 min                        | Student + advisor | Any topic in astro, including research       |
| <b>Bio</b>                             | 1 week      | 30 min                        | Committee head    | In the theme of 8.591/2                      |
| <b>CMT</b>                             | 1 week      | 30-60 min<br>(depends on Q&A) | Advisor           | Student's research area;<br>any topic in CMT |
| <b>CMX</b>                             | 1 month     | 60 min (with Q&A)             | Advisor           | Any topic in CMX                             |
| <b>NuPaT</b>                           | 2+ weeks    | 20 min                        | Committee head    | Standard Model                               |
| <b>NuPaX</b>                           | 1 week      | 30 min (with Q&A)             | Committee         | Any topic in NuPaX                           |
| <b>Plasma</b>                          | Few weeks   | 60 min<br>(30 talk, 30 Q&A)   | Advisor           | Generally a paper                            |
| <b>QI</b>                              | 2-3 weeks   | 20 min                        | Committee head    | General QI                                   |

| General details about scope |   |
|-----------------------------|---|
|                             | Scope of Q&A session  |
| <b>AMO</b>                  | The student's research + specialty courses  |
| <b>ASTRO</b>                | <ul style="list-style-type: none"> <li>- 185 questions provided in advance</li> <li>- Content from 8.901, 8.902, cosmology, current events in astro</li> <li>- Depth of questions goes beyond coursework</li> </ul>   |
| <b>BIO</b>                  | <ul style="list-style-type: none"> <li>- Biological physics, generally</li> <li>- 1 textbook (Phillips) is suggested, but it does not cover the range and depth of questions on the exam</li> </ul>   |
| <b>CMT</b>                  | <ul style="list-style-type: none"> <li>- 3 textbooks (Kittel, Huang, Ashcroft/Mermin)</li> <li>- Exam has sometimes included material not in those books</li> </ul>   |
| <b>CMX</b>                  | 1 textbook (Kittel)   |
| <b>NUPAT</b>                | The Standard Model of particle physics  |
| <b>NUPAX</b>                | <ul style="list-style-type: none"> <li>- 30 minutes about student's research</li> <li>- 30 minutes about nuclear and particle physics, experiments, and detectors generally</li> <li>- Scope/depth of the general portion is not contained in a well-defined set of textbooks and depends on who is serving on the committee</li> </ul> |
| <b>PLASMA</b>               | <ul style="list-style-type: none"> <li>- 1 textbook (Chen)</li> <li>- Sections of 2 other textbooks (Hutchinson, Frieberg)</li> </ul>   |
| <b>QI</b>                   | 1 textbook (Nielsen/Chuang)   |

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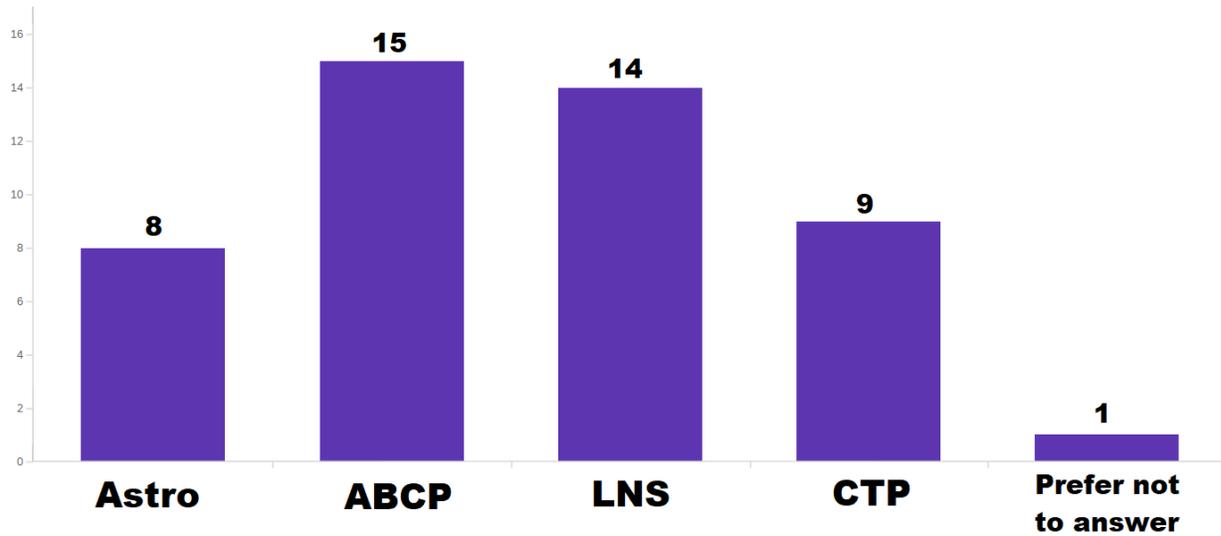
We attach a rather large data set with this note, that includes the following:

- I. [Demographics of survey respondents](#)
- II. [Faculty and student perception of the purpose of the exam](#)
- III. [Statistics about exam preparation](#)
- IV. [Exam scope, grading, and expectations](#)
- V. [Perception of student growth and outcomes from the oral exam experience](#)
- VI. [Areas in which we offer oral exams](#)
- VII. [Quotes from the free response portion](#)
- VIII. Appendices
  - A. [Full set of survey questions given to the faculty](#)
  - B. [Full set of survey questions given to the students](#)

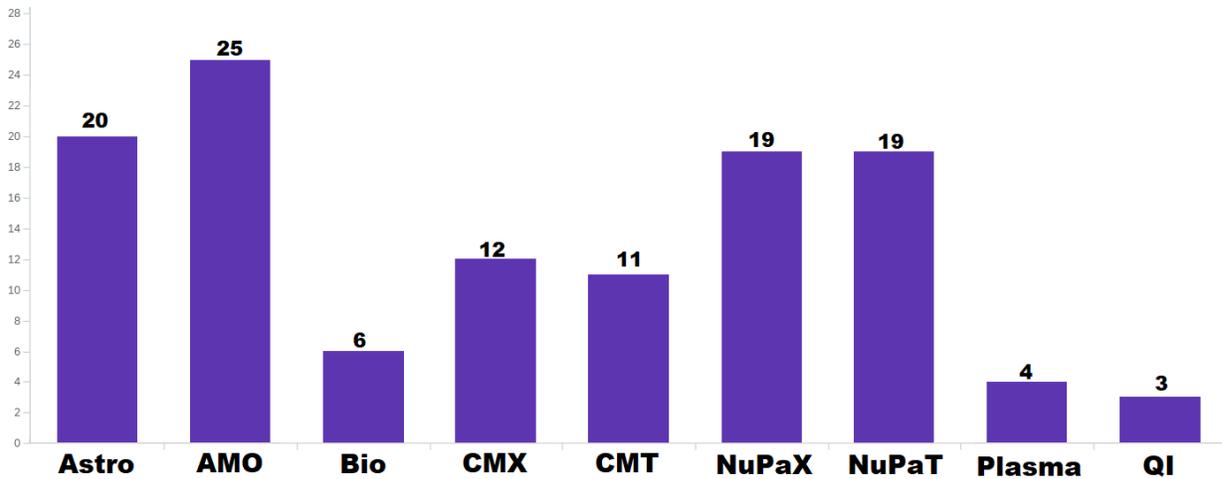
## I. Survey Demographics

### I. Demographics of survey respondents

**47 members** of the faculty took our survey, with good representation from all divisions:



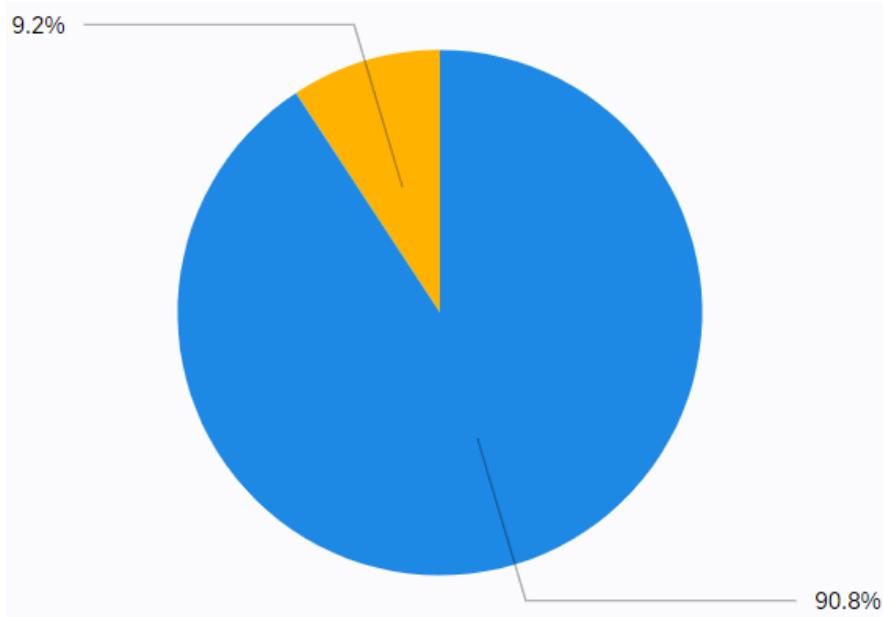
**121 graduate students** responded to the survey, from all subfields of research in which we currently offer an oral exam:



## I. Survey Demographics

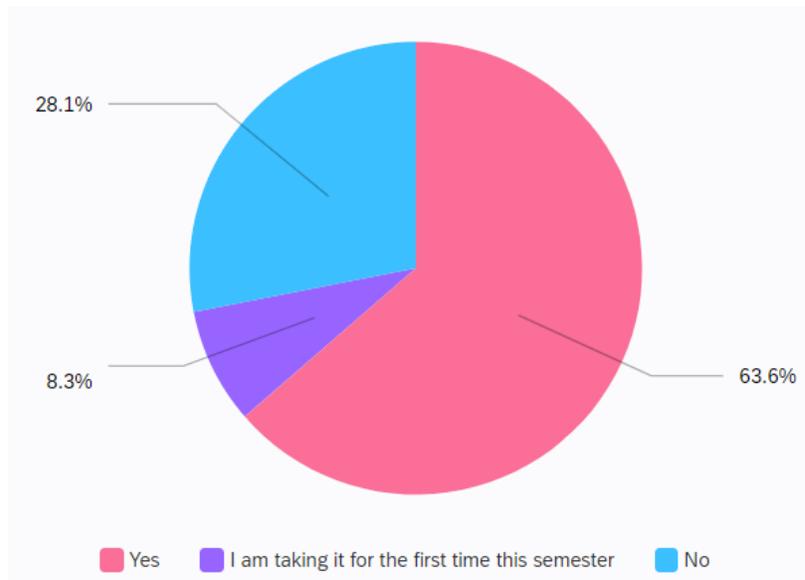
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About 1 in every 10 graduate student respondents works for a faculty member home-based outside of the Physics Department:



We had a fair number of junior students respond as well. Anyone who had not yet taken the exam or was not planning on taking it this semester did not see any of the questions about their exam preparation or exam taking experience.

**Have you taken  
the oral exam yet?**

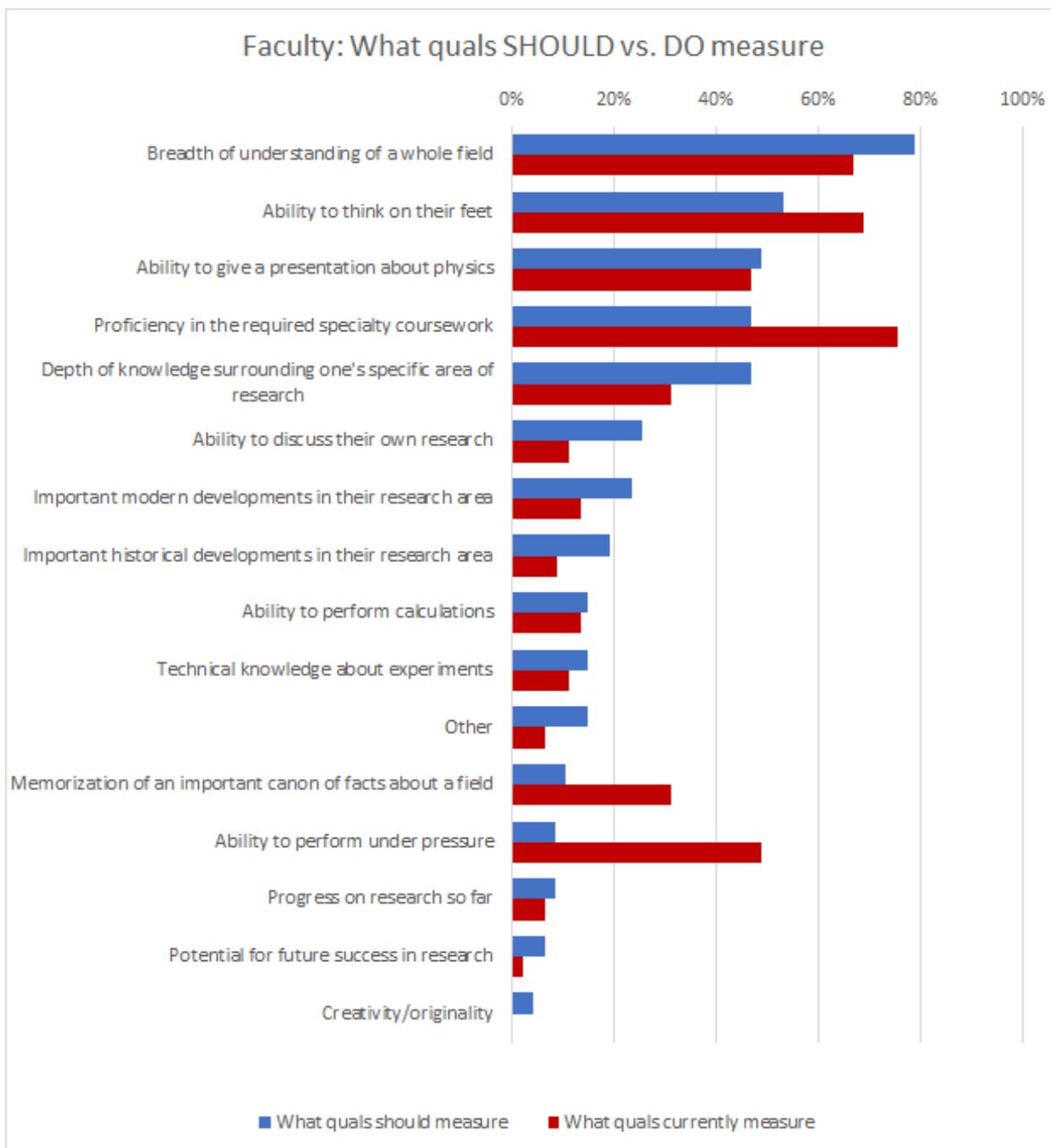


## II. Purpose of the Oral Exam

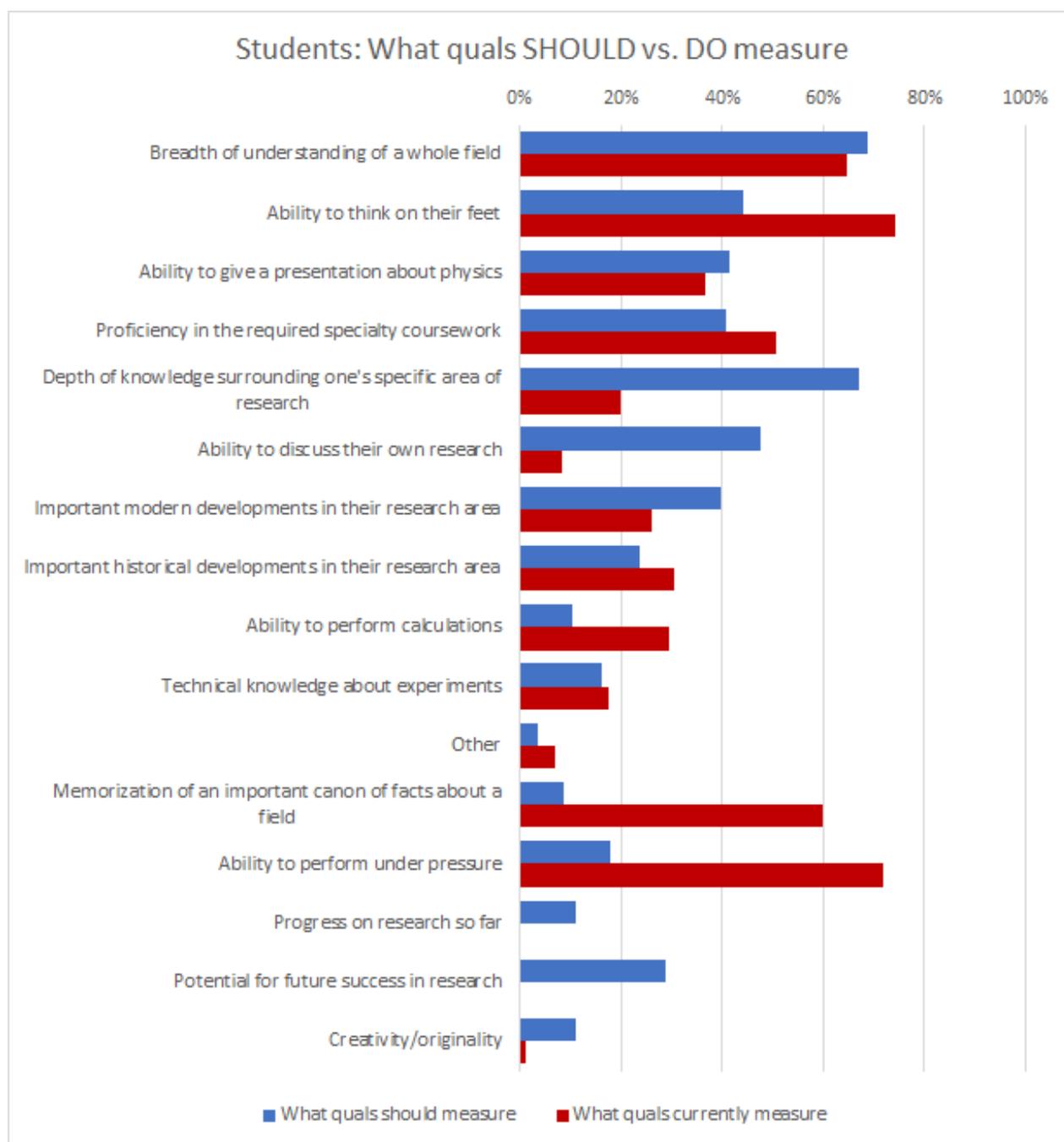
### II. What is, and what should be, the purpose of the oral exam?

Faculty do not agree amongst themselves about what the oral exam should measure about a student, and they certainly do not think the oral exam currently serves as an adequate test of those measures. Student responses reflect confusion over the purpose of orals.

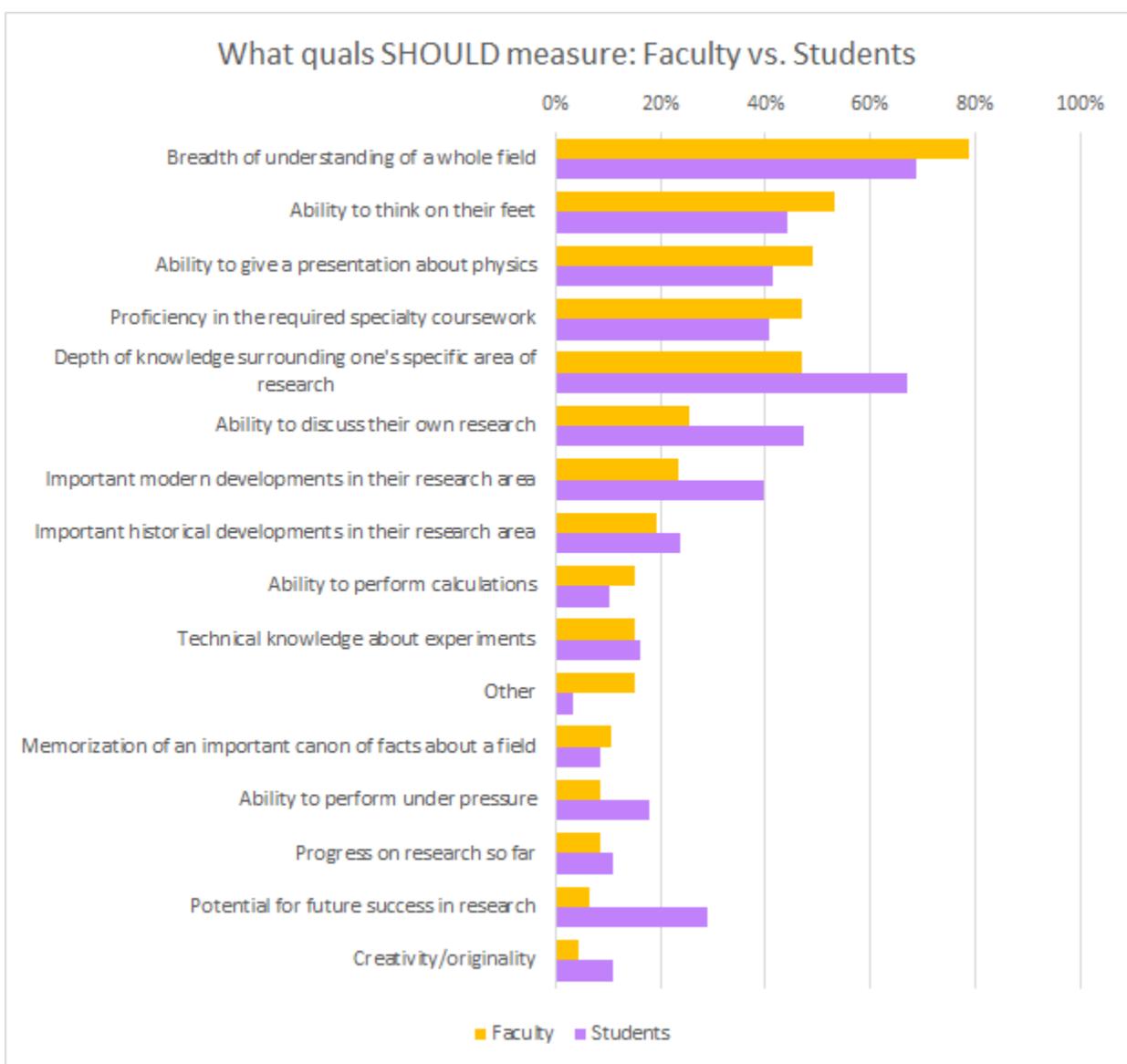
Respondents could select **up to five** choices for each question or write in their own response to “The most important aspects the oral qualifying exam **SHOULD** measure are a student’s” and “At the moment, the aspects the oral qualifying exam **actually** measures are a student’s”. From top to bottom, responses are ordered by what faculty think orals should measure most.



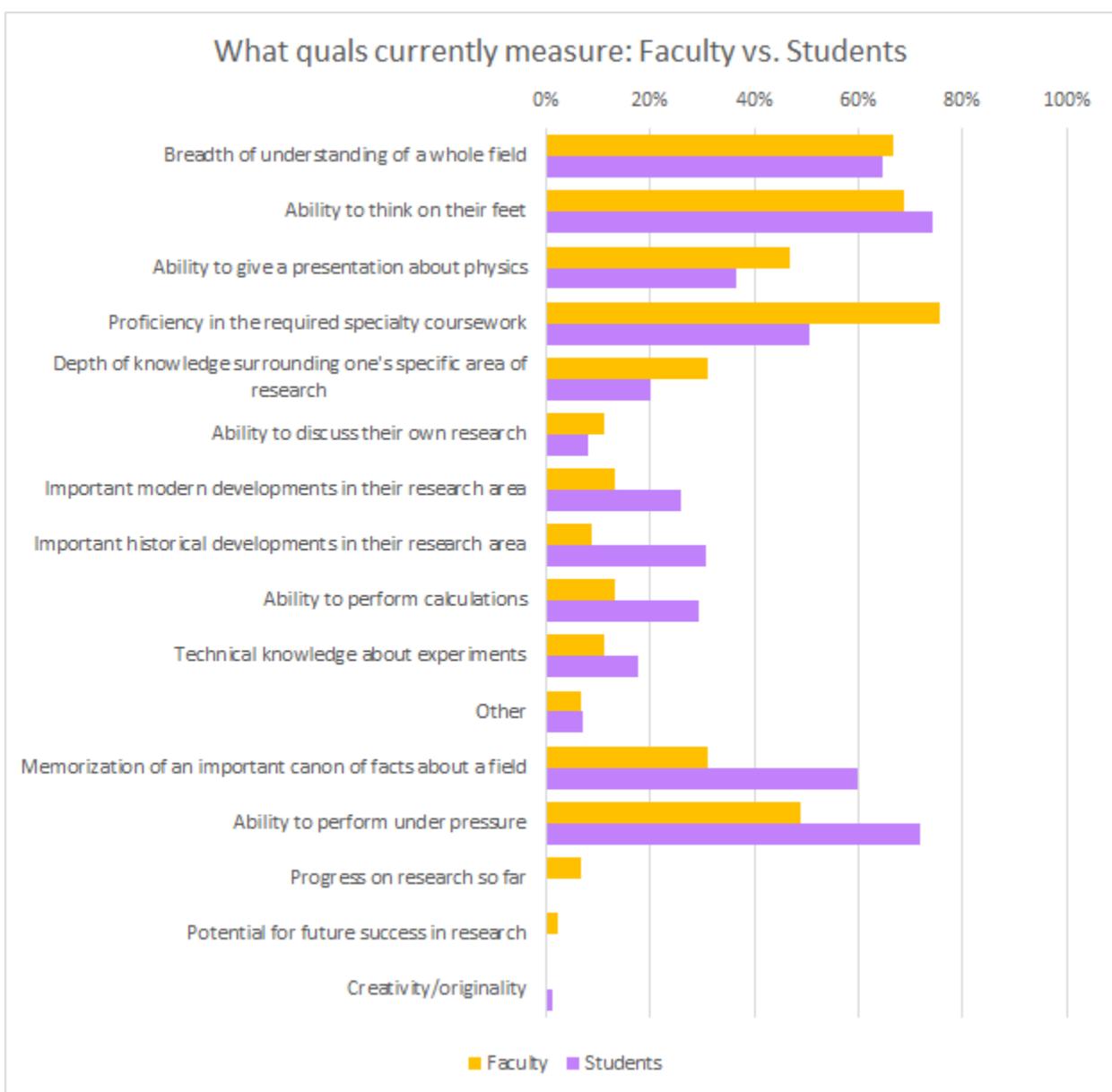
## II. Purpose of the Oral Exam



## II. Purpose of the Oral Exam



## II. Purpose of the Oral Exam



## II. Purpose of the Oral Exam

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The “other” responses for what quals SHOULD measure were:

- **Faculty:** “understanding of the basic ideas and principles underlying their field of interest”
- **Faculty:** “fundamental understanding of basic concepts in broad area of research”
- **Faculty:** “ability to communicate physics concepts and ideas in a clear and engaging way”
- **Faculty:** “ability to explain known physics concepts in a format that is similar to teaching, since we are training students to be proficient future physics educators”
- **Faculty:** “We try to ask questions about canonical paradigmatic problems in the field that students would have been exposed to through the standard course-work.”
- **Faculty:** “Reason from First Principles, not memory”
- **Student:** “ability to proficiently discuss topics from ones broader research area, portray a general understanding of concepts important to the field”
- **Student:** “merge the oral exam with the thesis committee and make it a presentation of your planned thesis work”
- **Student:** “critical thinking to synthesize topics related to their field”
- **Student:** “these are all abysmal options”
- **NUPAT Faculty:** “Understanding of the Standard Model, its theoretical underpinnings, and how to connect it to predictions for experimental measurements and/or natural phenomena”

The “other” responses for what quals CURRENTLY measure were:

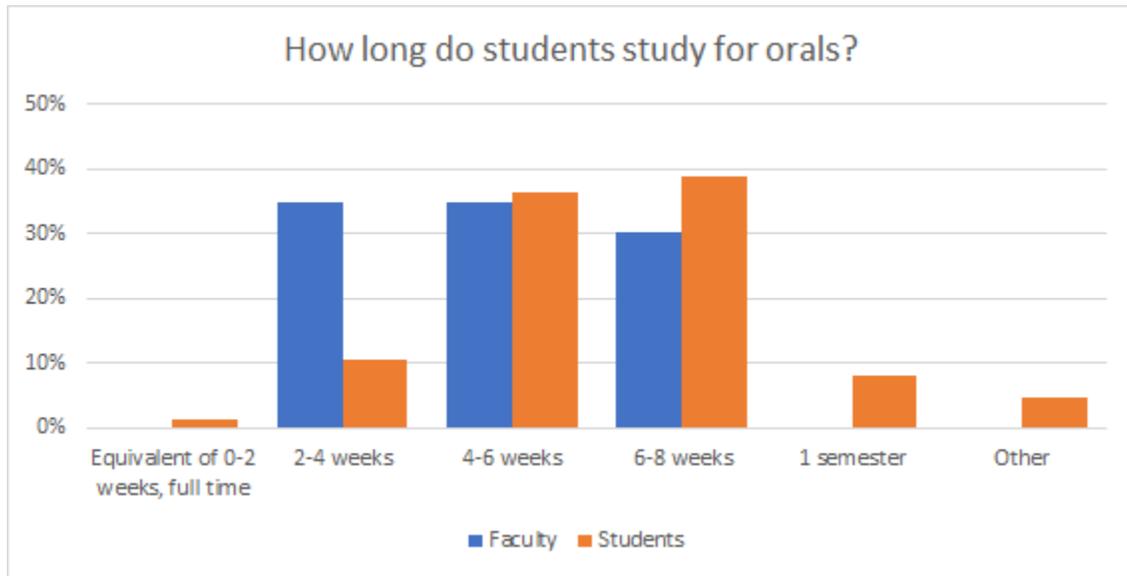
- **Faculty:** “see above”
- **Faculty:** “Reasoning from First Principles”
- **NUPAT Faculty:** “Understanding of the Standard Model, its theoretical underpinnings, and how to do calculations that use the physics of the Standard Model to predict experimental measurements and/or natural phenomena”

The NUPAT faculty collectively having a strong sense of what their exam *currently* covers will be a recurrent motif throughout this document.

### III. Oral exam preparation

#### III. Oral exam preparation

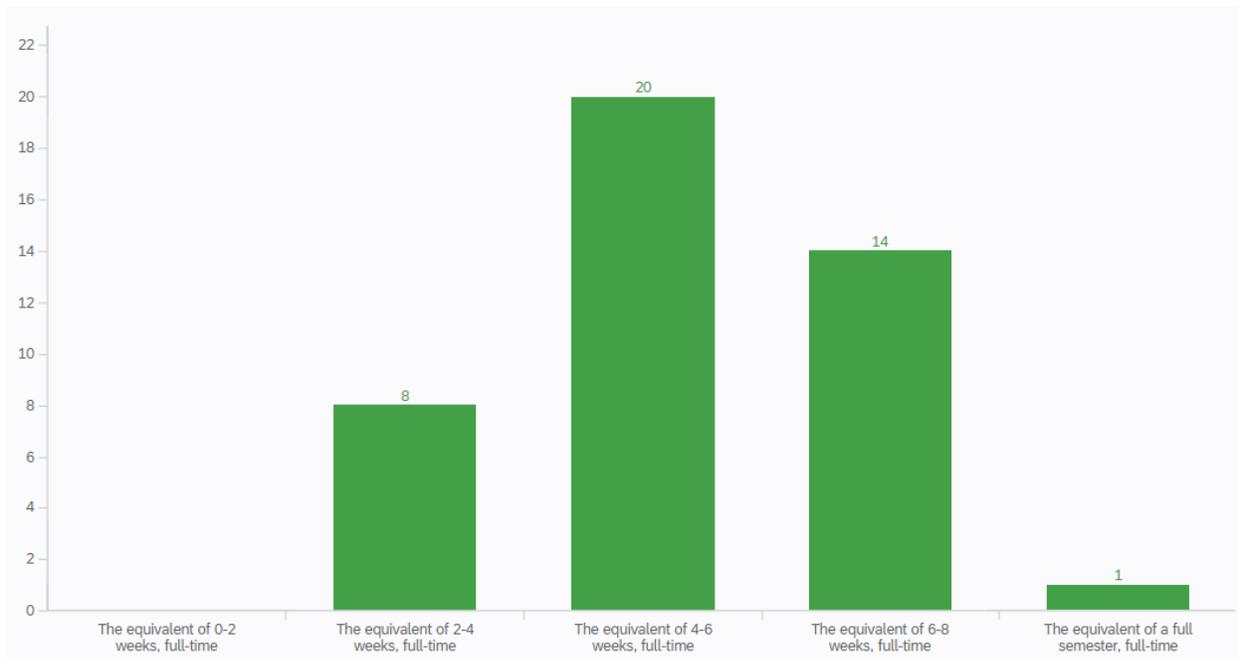
Faculty woefully underestimate how long their students prepare for the oral exams:



The students' "other" responses were: *more than the equivalent of one full semester, full semester but about 8 weeks full time, I am still preparing, and equivalent of approx 3 months, full time.*

#### How long do faculty allow their students to study for their oral exams?

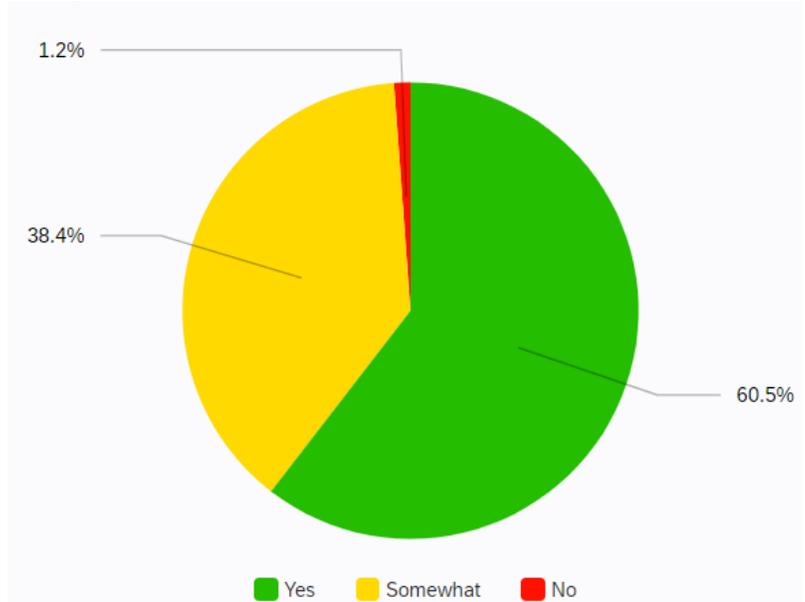
Unfortunately, these differences are reflected in how long faculty allow their students to study in lieu of doing research, which is inadequate for a large portion of the student body.



### III. Oral exam preparation

This might be why about 40% of students feel that their advisor only “somewhat” relieved them from research duties while they were studying for the exam:

**Did your advisor relieve you of research duties while you were studying for the oral exam?**



**How stressful is the oral exam for students? (10 = most stressful life event)**

Luckily, faculty are pretty in tune with their students’ feelings:

**Average student response:**

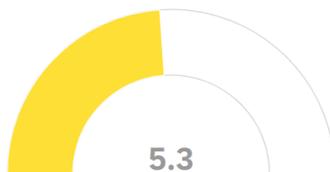


**Average faculty response:**



Answers ranged from 2-10 for students and 3-10 for faculty, with multiple members of both groups answering the most stressful option, 10.

**For “the ideal oral exam”** faculty generally “think students should rate the average stress” a few notches below where it is right now:



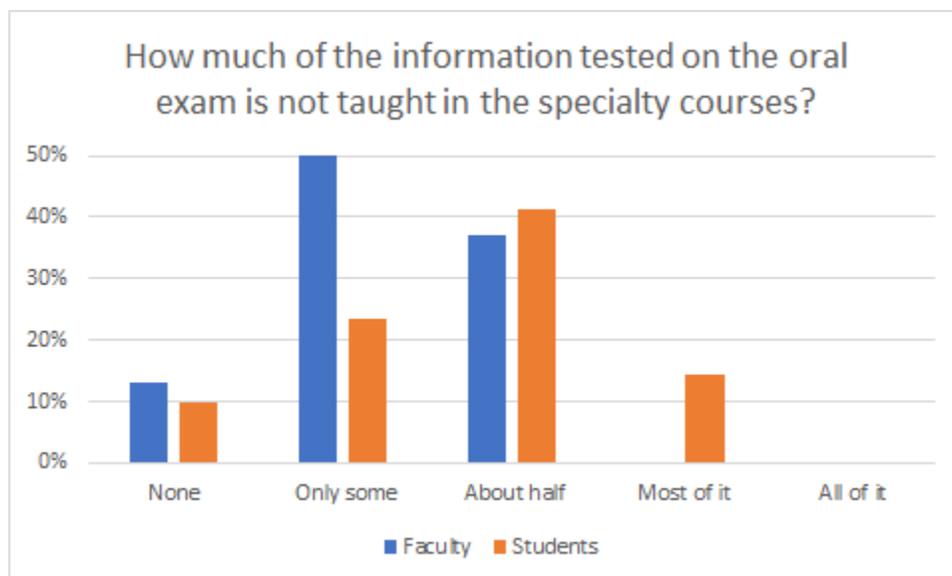
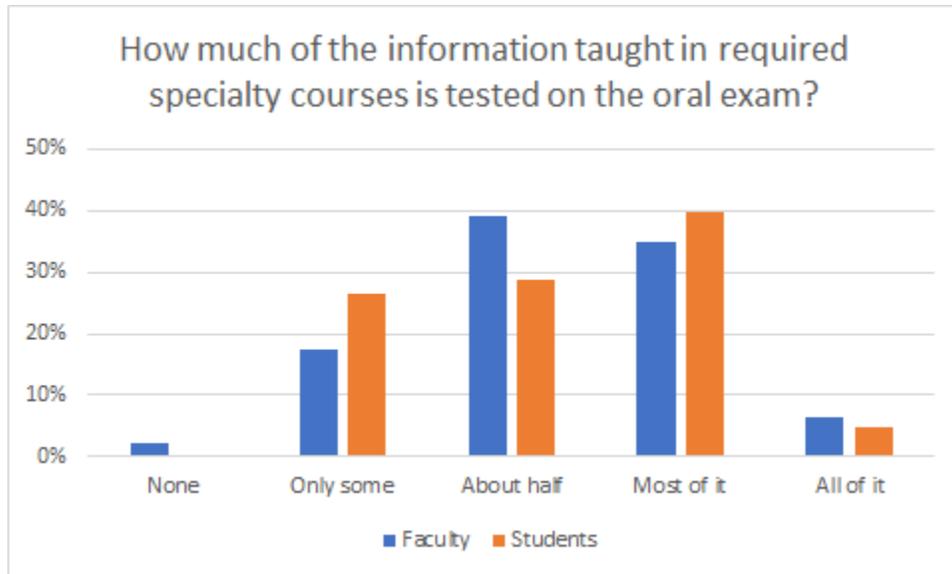
Most faculty cluster from 3-7, with one 1, three 8’s, and two 9’s.

78.2% of faculty think the stress of the oral exam should decrease, 19.6% think the current stress level should be maintained, and the remaining one faculty member thinks the oral exam should be made more stressful (increase from 8 to 9).

## IV. Oral exam scope, grading, and expectations

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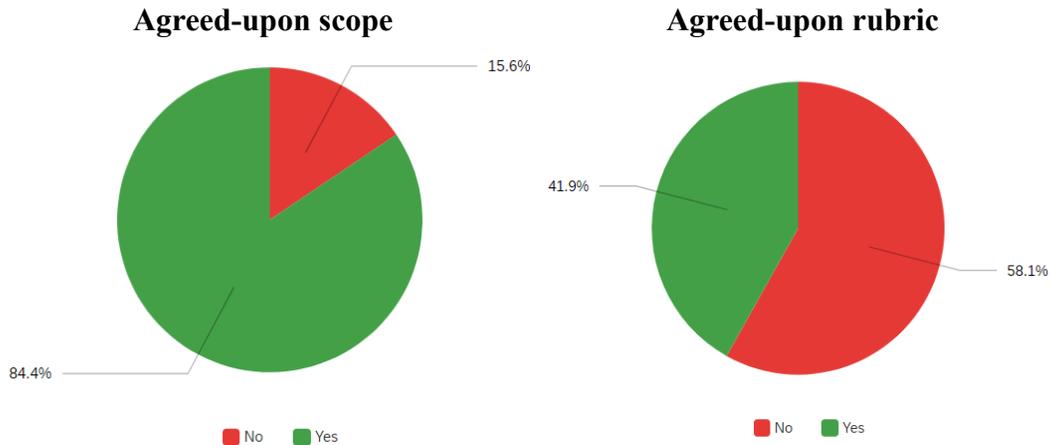
Nobody seems to agree on how the oral exams relate to the required specialty courses, neither among the students, nor among the faculty, nor between the two groups. On the faculty side, this is problematic because it means exam committee members might be testing material they think the students learned in class but they actually did not. Specialty course instructors might also teach material they think will be on the exam, but it isn't. This makes it difficult for students to study, or to even get accurate guidance from their faculty advisor about exam preparation.



## IV. Oral exam scope, grading, and expectations

### Faculty perception of oral exam scope

About 16% of faculty respondents say that their division does not agree on the scope of the oral exams! 4 of the no's were from LNS, which is currently in active discussions about the exams; ABCP had 2 no's; and the other faculty member did not indicate their division. Most divisions do not have a grading rubric, either. This seems like an area that would be worthwhile to discuss.



Then we asked a series of free response questions to determine:

- How often divisions meet to discuss/determine exam scope
- How divisions prepare new committee members for giving the exam
- How divisions let students know about scope and rubric, if any

To make a long story short, the answer to most of the above could be summarized as “not really.”

### How often do the faculty in your division meet to discuss what topics should be covered on the oral exam?

Astrophysics:

- “As a whole group, maybe once a decade. I suspect the division head and chief examiner discuss this much more often.”
- “I am not aware of any such meetings”
- “Never”
- “Not very often”
- “Every 5-10 years”
- “Rarely if ever. Every few years we discuss, but the work largely falls to the exam chair each year.”
- “About once a year there is enthusiasm and some motion for updating the topics. This has tended to get derailed as the semester goes on, with the result that updating is often planned.”

## IV. Oral exam scope, grading, and expectations

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CTP:

- “Rarely”
- “Rarely.”
- “The oral exam committee meets to discuss this each term, sometimes with discussion with the division head.”
- “The topics have been the same since I’ve been at MIT.”

NuPaX:

- “We have never had this discussion, I really wish we had.”
- “Rarely, but the scope has been quite constant over time. A real change to the scope/format was quite a while ago that I do not even remember when. It was a change to formally have 3 dedicated sections in the exam.”
- “The special topics are chosen by the committee, not the faculty as a whole. The core topics are consistent from year-to-year so not discussed much.”
- “Yearly”
- “Every few years”
- “The committee meets on a regular basis (2-3 times/term)
- “Never”
- “We do not discuss the topics but we should.”

ABCP:

- “Never”
- “Every two years”
- “Once a year”
- “We do not follow a pre-arranged script, generally each committee member asks a question and there is a tacit understanding among members that a certain range of topics should be touched upon (for instance, if after the first 2-3 questions nothing has come up on the topic of optics, chances are the member asking the next question will choose something in that area)”
- “Typically faculty members bring up topics during exams that draw upon the student’s presentation or other areas of research within the subfield.”
- “Once every year”
- “We do not really meet just to discuss oral exams, there’s just general understanding that the questions should be at the level of certain textbook.”
- “We meet whenever there’s need to”
- “Every few years”
- “It has been the same. So not much discussions”
- “Every 5-10 years”

## IV. Oral exam scope, grading, and expectations

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### How does your division prepare new faculty for administering the oral exam?

Astrophysics:

- “Not at all”
- “Best preparation is by teaching one of the specialty courses. Most of the oral examiners have taught one of the specialty courses recently, or a closely related course like graduate cosmology.”
- “Not sure that we do other than providing them with the list of questions, and advice on how to structure questions.”
- “By showing them the study guide and other documents, and having them be a committee member (one of 3 examiners) before they become chair. Also, I think these faculty will have taught or be teaching one of our required subjects whose content appears on the exam (8.901 or 8.902).”
- “Some have the opportunity to teach specialty courses”
- “Passed down with rolling committee membership”
- “Short talk with chair”

CTP:

- “Trial by fire”
- “New faculty are advised by faculty who have administered the exam before, in particular by the chair of the exam committee”
- “Meeting with chair of oral exam committee”
- “Informal discussion. The first few exams they pay attention to the other examiners.”

NuPaX:

- “Informally, this should be improved.”
- “Through discussion with the oral exam committee”
- “N/A (never administered one)”
- “They do not.”
- “There is documentation on how the oral is performed and faculty can read up.”
- “There are always carry-over faculty on the committee that administers the quals.”
- “Learning on the job”
- “Explanation and participation in exams with experienced examiners”
- “Teaching specialty subject. Substituting into exams prior semester.”

ABCP:

- “We just tell them to ask questions about general condensed matter physics, thinking of Kittel/Ashcroft as basis.”
- “Brief consultation, examples”
- “Instructions from chair”

## IV. Oral exam scope, grading, and expectations

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- “I am not aware of any official protocol for preparing new faculty members. Generally new faculty members join the committee and learn on the field”
- “Meet before exam series, topics and typical questions are discussed.”
- “I just tried to follow the style of questions that other faculty ask.”
- “Usually, a senior faculty member will talk with the junior faculty member to let the junior faculty member know how the system works.”
- “There is not much preparation, they sit on the exams and after participating in a few of those, they get the idea
- “A briefing about the exam, and participating in the exams with the ‘old’ faculty”
- “Writeup on grading them, and discussions after each exam”

### **Does your division’s faculty have an agreed upon scope for the oral exams? If so, how do students receive this information in your division?**

#### Astrophysics:

- “180 sample questions, prep course”
- “The catalog is provided to them”
- “Study guide”
- “When done right, communicated by the committee chair at the start of the ‘exam season.’”
- “Questions for the exam come from a pre-approved list of possible subjects.”
- “List of questions”

#### CTP:

- “They ask faculty.”
- “Via grad student guidelines document”

#### NuPaX:

- “Website, meeting with chair at start of term”
- “Description of the exam, but needs to be updated and could be better contained.”

#### ABCP:

- “Collection of topics sent to students”
- “Information given by faculty advisor”
- “Email from chair”
- “Not aware of an official document defining scope of oral exam”
- “Topics list sent to students”
- “It's a pretty canonical set of topics, we update it only every few years.”
- “There is a list of textbooks that is agreed upon.”
- “They usually expect questions at the level of a specialty textbook”
- “It is on department web site”
- “List & discussion with chair”

## IV. Oral exam scope, grading, and expectations

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**Does your division's faculty have an agreed upon grading rubric for the oral exams? If so, how do students receive this information in your division?**

Astrophysics

- “But we informally have a scale going back years”
- “When done right, the chair reviews expectations and makes it clear that the committee is looking for a level consistent with the specialty coursework across a wide range of different areas. Sometimes this has not been communicated clearly; COVID stresses in particular are leading to communication flubs.”

ABCP

- “Expectations sent to students”
- “We have common standards, but differences of weight”

NuPaX

- “Description of the exam, and consistent feedback form.”
- “Meeting with chair at start of term”

## IV. Oral exam scope, grading, and expectations

### Student perception of oral exam scope

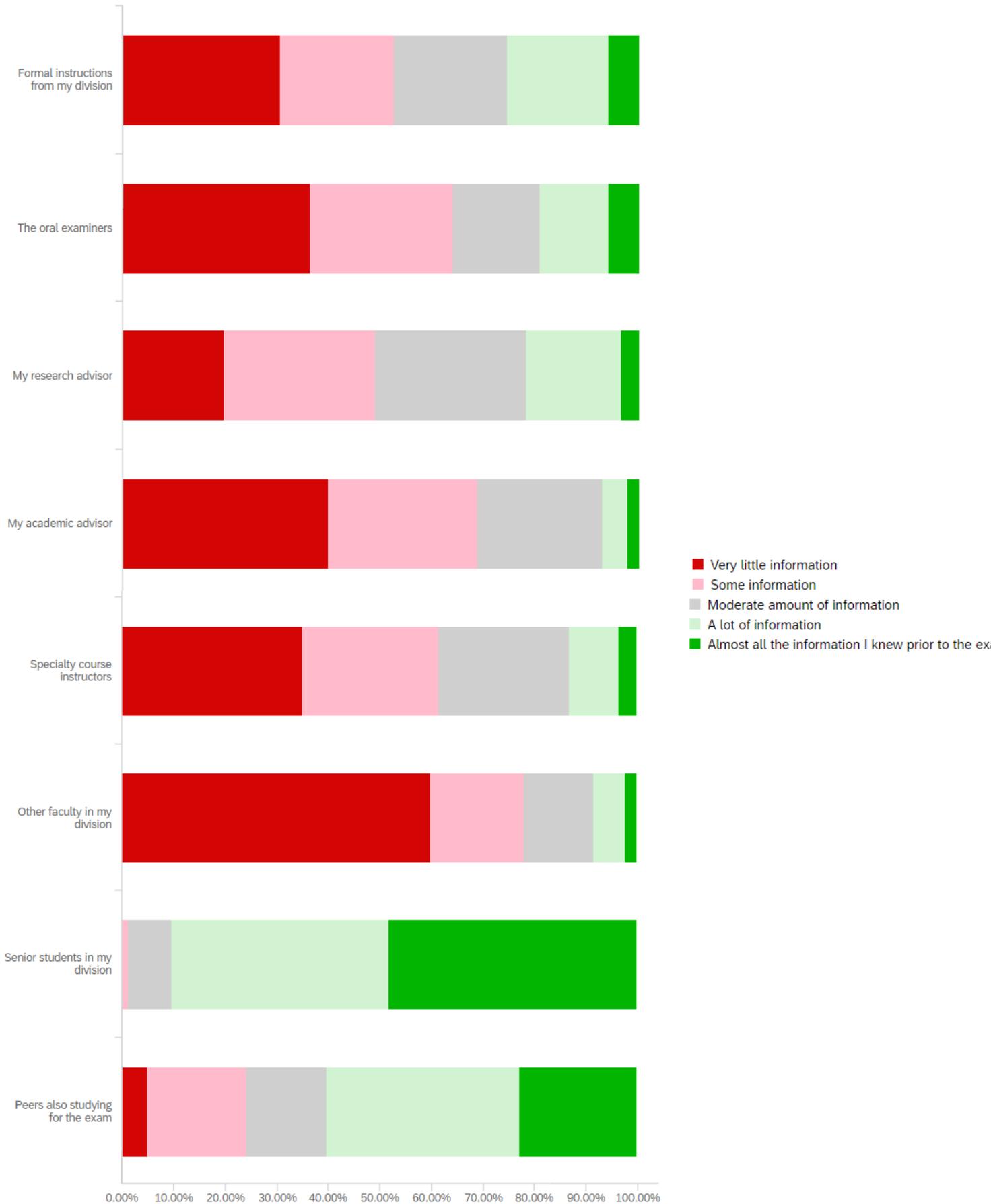
Divisions do not do a great job of communicating to their students information about the scope, purpose, or method for assessing student performance on the oral exams. Students generally go to their peers for this information, but would prefer to have the department clearly state expectations up front.

### Prior to the oral exam, the department/division formally explained to me:



## IV. Oral exam scope, grading, and expectations

How much helpful information about scope, content, grading, and expectations did you learn from the following:



## IV. Oral exam scope, grading, and expectations

### How do students perceive exam fairness and consistency?

PGSC often hears concerns from graduate students about the oral exams being unfair and inconsistent. This section of the survey tried to narrow down the source of this feeling.

We begin by showing that students largely do not have issues in their personal interactions with committee members (though there are exceptions). Students largely believe that the procedures for administering the oral exam are also both in principle and in practice fair and consistent.

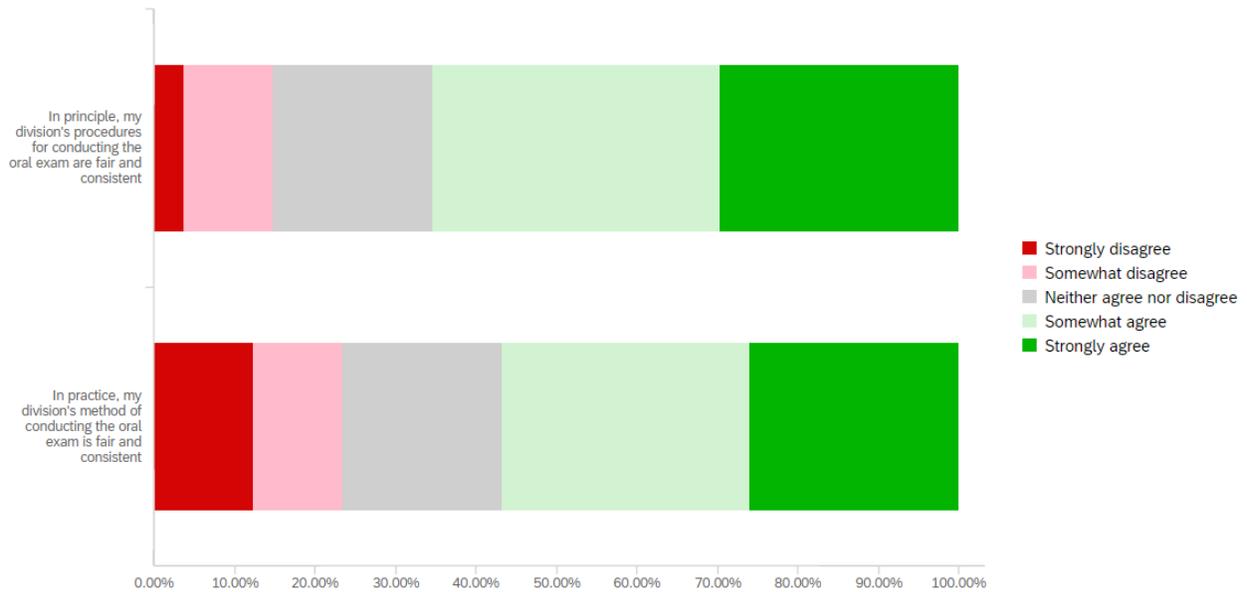
On the other hand, students largely believe that the scope, difficulty, and grading of their oral exams are highly dependent on which faculty members serve on their oral exam committee. Therein lies the problem.

### When asked, students expressed that the committee:

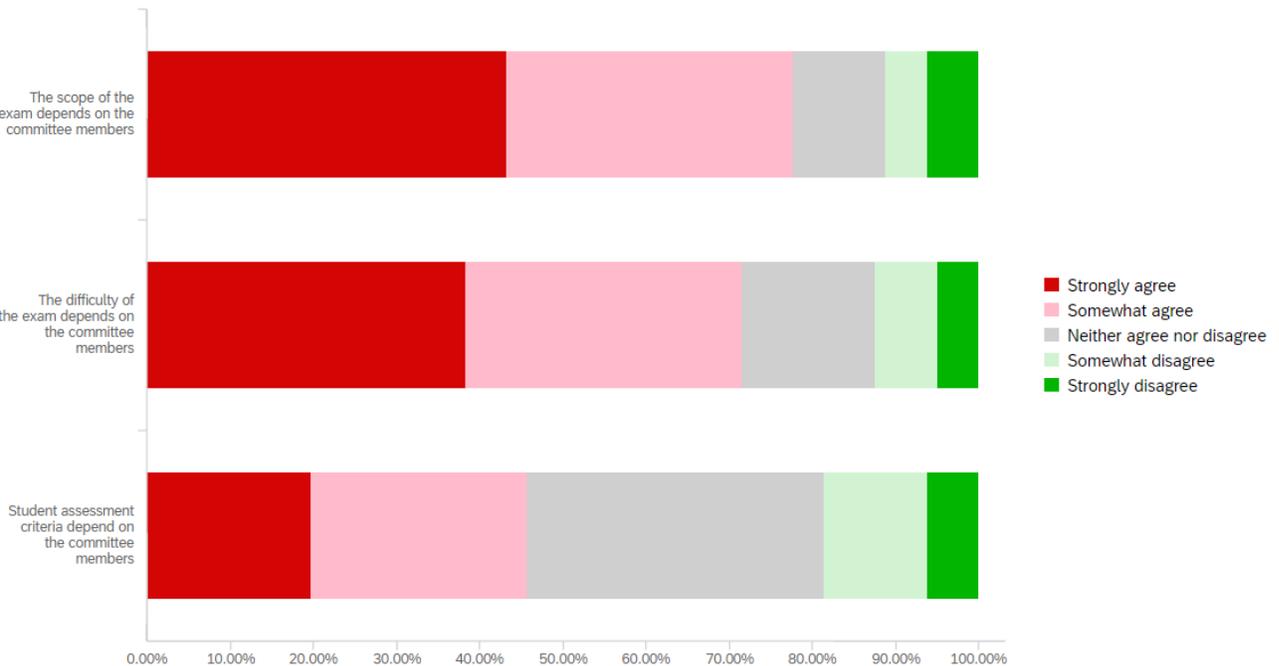


## IV. Oral exam scope, grading, and expectations

Students largely think **procedures for conducting the oral** are fair and consistent as well:



Aside from division-specific issues, when graduate students say that the exams seem unfair, they generally seem to be referring to the **lack of consistency amongst faculty about the scope, difficulty, and grade assessment criteria** for the oral exams:



## V. Educational Outcomes

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### V. Faculty and student perception of educational outcomes

On the following two pages, we report on faculty and student perception of student gains from the oral exams on eight selected metrics:

1. More informed about specific line of research
2. Better at carrying out technical aspects of research
3. Better at developing creative, novel research proposals
4. More independent of researchers
5. Better at giving technical talks and presentations
6. Better able to communicate with scientists at conferences
7. Better able to communicate with scientists in one's division at MIT
8. Better at teaching

For an optimally structured oral exam, one would expect that a clear majority of faculty and students would agree that students exhibit gains on the metrics that best match the stated purpose of the oral exams.

In the current manifestation of the oral exam, all survey respondents tend to think students grow most in their communication skills and breadth of knowledge, as opposed to skills more directly oriented towards research output. The trends of faculty and student responses mirror one another, though students are on the whole more pessimistic about what skills and knowledge they gained from the oral exam, compared to their faculty advisors.

A majority of faculty and students “somewhat” or “strongly” agree that students exhibit gains on five out of eight metrics. Surprisingly, though, neither faculty nor students reach a 50% threshold of **strong agreement** that students exhibit gains on *any* of the eight metrics. The maximal level of strong agreement for any one item is 35% for faculty and 30% for students, both for item 1.

There is clear room for improving the structure of oral exam preparation and administration to better help students develop the skills and knowledge that this exam is intended to develop.

## V. Educational Outcomes

### Faculty perception of outcomes

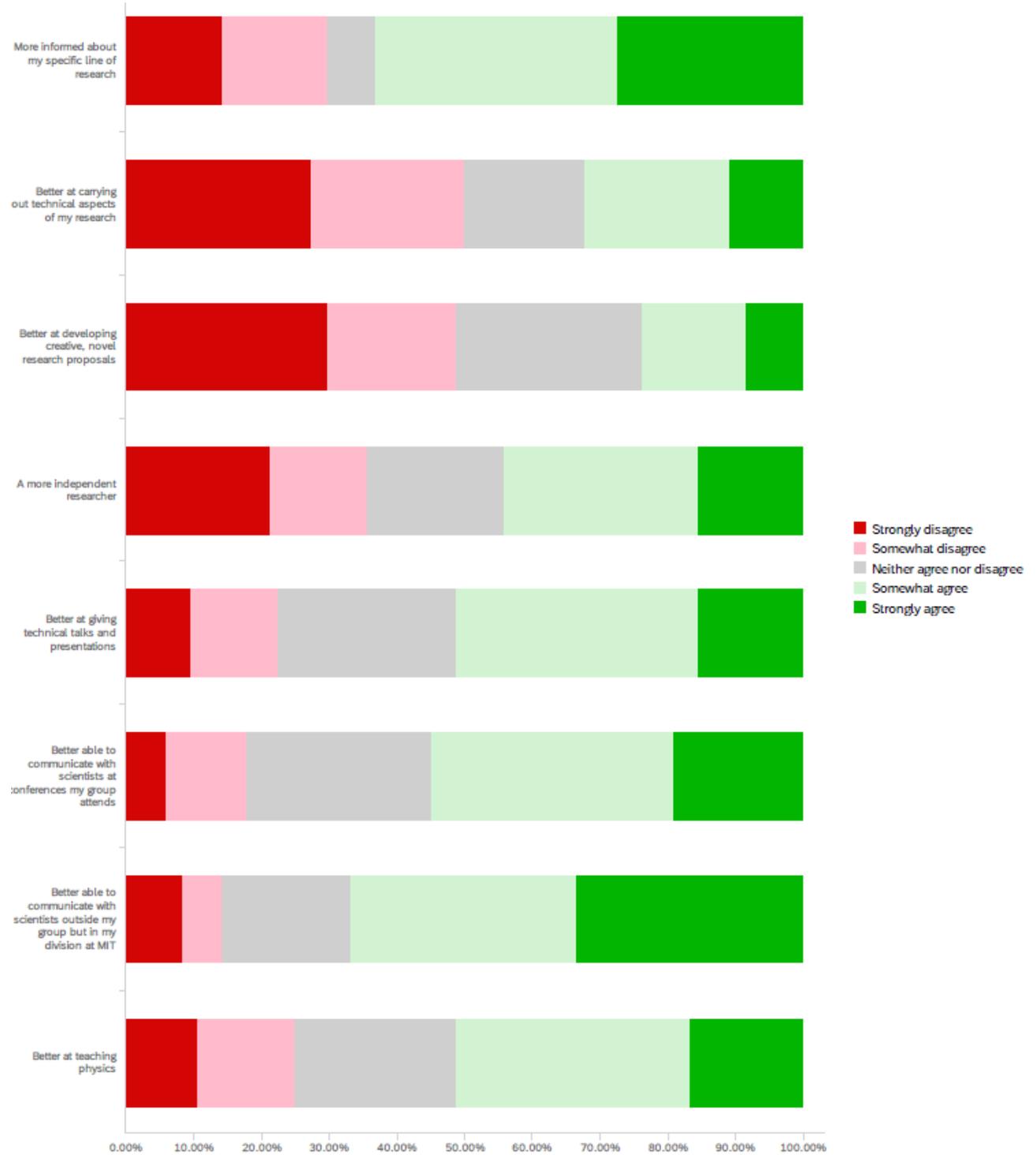
“In the past, preparing for the oral qualifying exam has made grad students in my group...”



## V. Educational Outcomes

### Student perception of outcomes

Preparing for the oral qualifying exam made me:



## VI. Oral exam areas

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### VI. Which areas should we offer an oral exam in?

How do we partition the field of physics into a set of subfields? The answer to this question is not obvious. Disciplinary boundaries vary substantially across universities, funding agencies, and indeed evolve over time as physicists push forward the boundaries of knowledge.

We wanted to gauge what members of our community believe constitutes a separate research area or method worthy of its own exam. At the moment, the Department divides up fields based on 7 major **topics of study**:

- Astrophysics
- Atomic, molecular, and optical physics
- Biophysics
- Condensed matter physics (experiment or theory)
- Nuclear and particle physics (experiment or theory)
- Quantum information
- Plasma physics

The Department further subdivides two of these fields based on **research approach**, by holding separate theoretical and experimental exams.

Participants were offered 25 choices, including the option to write in their own response. These options contained the current exams, with the exception that we split QI into theory and experiment. We also renamed the NuPaT exam to better reflect what it currently tests, quantum field theory (though some may have construed it to be particle phenomenology).

In addition, we chose 3-4 new subfields for each broad research area, based on research taking place at MIT, to get a gauge for where our community thinks oral exam expansion may be warranted. We also offered two options for cross-disciplinary research approaches that cut across the fields of astrophysics, high-energy theory, and ABCP; as well as an individualized exam.

- **Nuclear and particle physics** - collider physics, particle phenomenology, string theory, nuclear theory
- **Astrophysics** - planetary science, cosmology/gravity, instrumentation
- **ABCP** - applied physics/devices, biomedical physics, materials science, optics
- **Cross-disciplinary** - AI and physics, applied mathematics, individualized exam

The results were quite interesting. To make a long story short, the top physics faculty members in the world *do not agree* how to partition the field of physics into individual disciplines.

## VI. Oral exam areas

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### Results

At least 1 out of 10 **faculty** supports each exam option, with **minimum 11%** support (for an individualized exam) and **maximum 62%** support (general astro, CMT). In contrast, at least 3 out of 10 **students** support each exam option, with **minimum 30%** (materials science) and **maximum 67%** support (AMO). In addition, 13% of students and 46% of faculty checked a box labeled “other” and wrote in a free response answer in addition to or in lieu of other responses.

For context, please note that **all but three exams receive faculty support of less than 50%**.

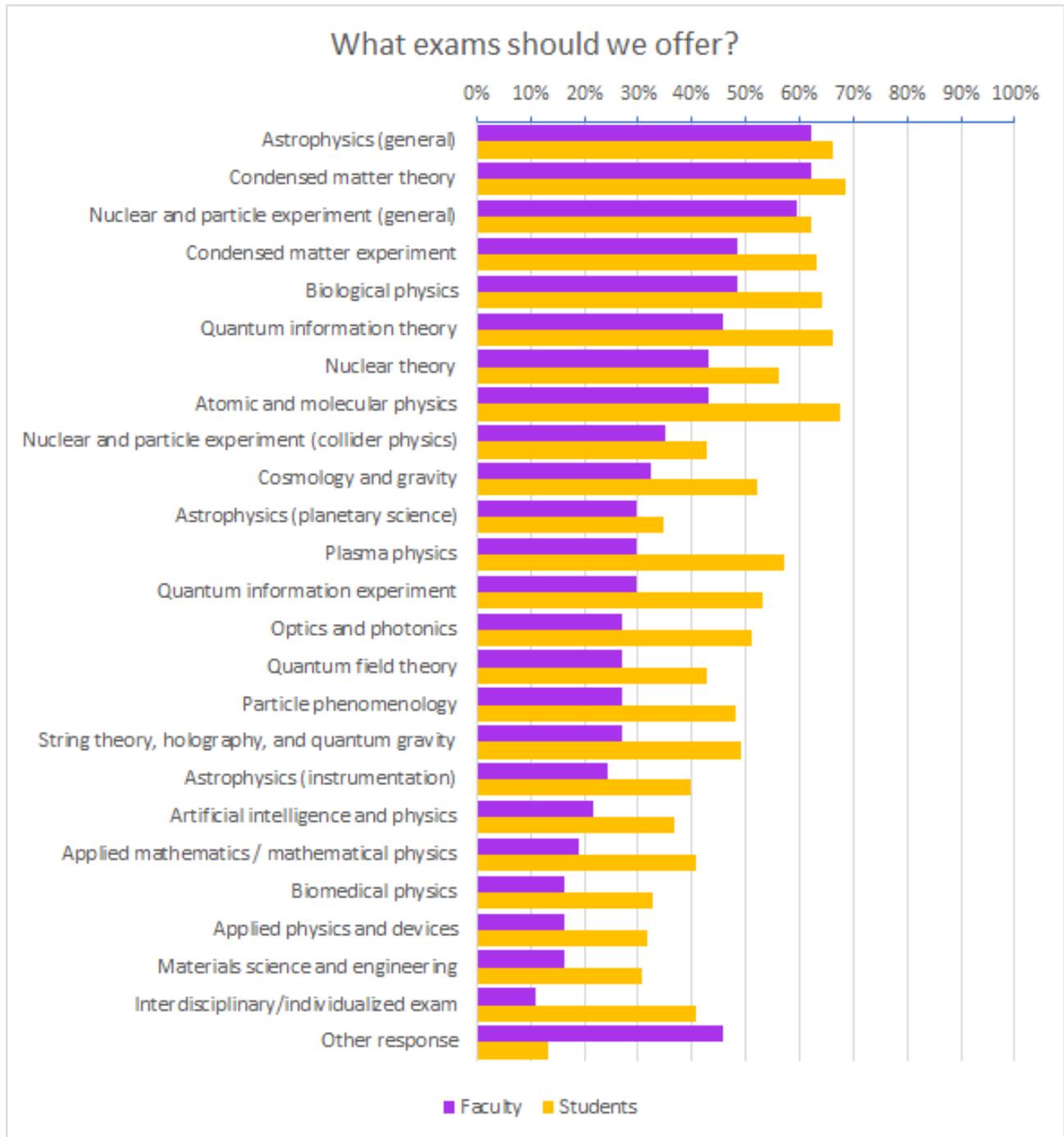
New exams on cosmology, collider physics, and nuclear theory receive high faculty support, of greater than 30%. Planetary science closely trails at 29.7% and optics at 27%. Faculty support for a string theory exam is 27%, exactly equal to faculty support for exams on QFT and particle phenomenology.

Exam areas that center around the development of technical methods rather than the study of a specific physical system (applied math/mathematical physics, artificial intelligence, and astrophysical instrumentation) receive a non-negligible amount of faculty support, yet this level is generally lower than for exams centered around the physical motivations of a student’s work. Exceptions to this are medical physics, materials science, and applied physics/devices, which receive the least faculty support of any options.

Only 11% of faculty support an individualized exam, but over 40% of students do.

## VI. Oral exam areas

### Data



## VI. Oral exam areas

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### Written responses when choosing the option “other(s)”

General remarks:

- **Faculty:** “I think this question is trying to move to more custom exams. I think some research areas are suffering from being between subjects. More thought should go into what are the independent areas of study.”
- **Faculty:** “I’m not sure how to answer this question. All students should have an oral exam that is relevant to their research area, but some of the choices here suggest a higher degree of specialization than I would want ideally.”
- **Faculty:** “I think for many areas it might be helpful for have a 50/50: half for stuff in the field and half for their specialty but both with clear boundaries as to not double the workload”
- **Faculty:** “The categories should be kept broad, focusing no more than is necessary to silo it into main divisions”
- **Faculty:** “I think this is too many. The general exam is not a candidacy exam. It’s meant to be broad.”
- **Faculty:** “all of the above”
- **Faculty:** “all, this is a departmental requirement”
- **Faculty:** “This seems to be a rather random list of areas”
- **Student:** “There should be an option for an individualized or patchwork topic exam for those whose research is not neatly in a category or whose field can’t be put into one of the traditional categories”
- **Student:** “my preference that more specific is better”
- **Student:** “All of these seem like valuable fields of equal weight to me”

Specific topics

- **Faculty:** “nuclear and particle theory (general)”
- **Faculty:** “Nuclear and Particle Theory”
- **Faculty:** “The Standard Model”
- **Faculty:** “I think one astro exam is fine. Overly specific exams become too close to thesis defenses”
- **Faculty:** “Quantum information should be a category on its own; don’t separate into theory and experiment, QI students should be able familiar with both.”
- **Student:** “I took the CTP exam and feel that it should be split into two exams, one for pheno and one for strings/gravity”
- **Student:** “I think the CPT SM exam covers a lot of the NUPAT students who do nuclear theory and pheno quite well, but it would be nice to add a QG/String version for some of the students who spend their time thinking about things not related to the SM”
- **Student:** “Astroparticle physics”
- **Student:** “Gravitational waves”
- **Student:** “Metrology”

## VI. Oral exam areas

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- **Student:** “Nuclear and particle experiment (non-collider)”

I really don't know...

- **Faculty:** “Not sure what this question is asking, i.e. whether we are asked to comment on what is appropriate for other divisions.”
- **Faculty:** “I don't know enough to comment outside my area”
- **Faculty:** “I can't answer this further without a better understanding of how other divisions are structured.”
- **Faculty:** “I'm not as clear on other divisions”
- **Student:** “You don't even list the current options???”
- **Student:** “I don't have an opinion about what other divisions do.”
- **Student:** “don't really know what is best for the other divisions”

## VII. Free responses

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### VII. Free responses

“Do you have any ideas for improving the exam or any other comments you would like to share?”

Comments are lightly edited for privacy, broken apart, and separated into sections based on topic addressed.

#### General impressions

- **Faculty:** “I am not convinced that oral exam is such a great thing to do in the first place. Some students are much more nervous than others, so we are basically measuring (quite a bit) how well they perform under pressure. Reality is that in real life (hopefully) they do not have to perform physics under pressure often.”
- **Faculty:** “I do feel that the oral exam provides an essential structure for learning broadly about our field and articulating it in a clear way similar to what one experiences in teaching (which is also a very high pressure/stressful environment). I feel that the goals of our PhD program are to train students to become teachers and to become researchers. The classes show students how to teach, with the oral exam as a capstone. Their thesis cements the research portion. The oral studying also allows students to understand the first ~third of any colloquium in our division, even those outside their research specialty.”
- **Faculty:** “The exam is an essential part of the student's preparation to be a Ph.D. graduate of MIT. A redo is frequent when deficiencies are identified and invariably makes the student stronger. Some of my strongest students were in this situation. However, it is a stressful for the student. Young people are increasingly more stressed out about life's challenges. In-person interaction with unfamiliar people, particularly in relative authority, is one of those. I have seen my own students ‘freeze’ and be unable to engage on material I am certain they understand and know.”
- **Faculty:** “I personally believe the oral exam takes too much time away from research. There should be such an exam, but it would be better if the preparation needed were more like 3-4 weeks”
- **Faculty:** “Reduce stress on students.”
- **Faculty:** “The oral exam is an integral part of "quality assurance" - having an MIT PhD in physics means having become an expert in one's field of research. The oral exam sets a standard where students demonstrate that they have become experts in their field, so able to make a well-reasoned presentation, able to think on their feet about novel problems thrown at them, and being able to connect different ways of looking at the same problem. That is opposed to how a novice thinks, who would take memorized equations and try to apply them without being able to see the connections, simple ways, reason by fundamental principles (energy conservation, momentum conservation) etc.”

## VII. Free responses

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- **Faculty:** “I don't love the idea that it is the source of so much stress for the students, but I think these events are unavoidable (thesis defense, first conference talk, first job talk, etc.). Having these high-pressure experiences first in an environment where everybody wants you to succeed can be beneficial.”
- **Faculty:** “I think oral exam is an important part of graduate school education and should continue. It certainly adds some stress to the students, but they should learn how to think and function under pressure.”
- **Faculty:** “I think students stress a little too much about it. They also overprepare a bit but the preparation is broadly useful in learning the background of the field.”
- **Student:** “If one of my goals in grad school is to learn broadly about (astro)physics then I think the oral exam can be tweaked but in general is pretty much fine as is. That being said, it's only been a relatively short time since I took the oral exam and I've already forgotten a significant chunk of the material details... In some ways I wish I could just be a grad student forever and endlessly indulge in all the different topics, and I really appreciate that the oral exam forced my hand. On the other hand, I also somewhat resent having to pass the oral exam because it significantly delayed my progress in research.”
- **Student:** “The oral exam was the most important learning experience in my PhD. I can give killer seminars now, because I am prepared to think on my feet, under pressure, with audiences members telling me I'm wrong even (or especially) when I'm right. Not only am I ready for those challenges, I can even convince the people assailing my research of the validity of our work. If any changes should be made to the oral, it should be explaining its purpose - to prepare one to communicate effectively in the real world, with all of the challenges therein.”
- **Student:** “I believe it is an extremely stressful moment for the student, who is subject to a big pressure. While the oral exam preparation may be helpful to deepen the student's knowledge on the field, the time commitment (and stress involved in the process) call for a revision of the format of this exam, in my opinion.”
- **Student:** “It helped me see more clearly the general framework within which my research field lives, and helped me get a good understanding of several aspects of the framework. Being taught some things in class once does not compare with carefully re-teaching them to myself. It also helped me learn how to discuss these topics with both my peers and with professors in and out of my field...”
- **Student:** “[The exam] was very stressful and isolating, especially working from home in a pandemic. I often found myself thinking about jobs outside of academia while studying for this exam and had many conversations with peers similarly considering dropping out of graduate school.”
- **Student:** “If the exam is supposed to showcase your creativity or ability to do research I don't think it necessarily does that, but I think it really does force you to learn the ‘basics’ of your research area... extremely well which is helpful just in making your way through literature and discussions in physics...”

## VII. Free responses

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- **Student:** “I like the general scheme of this exam. My understanding of it is that it is not as much about knowing specific details, but about being able to effectively communicate with researchers in related areas. As such I think it is natural that the "scope" of the exam is somewhat ill-defined.”
- **Student:** “I don't think the general concept of the exam needs to change much. It's fine to tell students to study a general area of physics, based on the material covered in the specialty courses and in certain textbooks. A guiding list of specific topics would be nice. I do think I learned a lot about my field while studying for the exam.”
- **Student:** “I think it's good as-is. It should be difficult and it should require students to prepare intensely. It's should not be a joke and it's not something you should be able to breeze through... I think it's extremely fair and well set-up.”
- **Student:** “If my goal in grad school is to pursue a single minded focus on research, publishing, and graduating then I have a hard time seeing any utility in the current oral exam.”
- **Student:** “I was very stressed because of my general low confidence, but there was enough time for me to deal with the stress and turn it into something productive.”
- **Student:** “While stressful, I think the oral exam experience made me a better physicist, and was actually fun.”
- **Student:** “The exam was a source of great stress but I do feel that it was well worth it given how much I learned while studying.”
- **Student:** “The exam was valuable because it helped me gain an overall understanding of my field, and it gave me practice in quickly answering hard questions in presentations or job interviews.”
- **Student:** “Taking the exam made me a better astrophysicist and has helped me better understand talks and papers outside my direct field of research.”
- **Student:** “Not sure why I picked this horrible department riddled with hoops to jump through on the sheer basis that a white man jumped the hoop 40 years ago.”
- **Student:** “I heard universally from friends and agree, that the main cause of mistakes or missteps during the exam itself was just anxiety and nerves in front of the examiners.”
- **Student:** “As soon as the exam is over we forget everything gleefully.”

### Potential changes to exam structure

- **Faculty:** “I think if we're going to keep the exam, we should standardize it much more. Currently, both for students and the faculty, the range of questions can vary wildly, I feel that some of them are too specific, perhaps we should Simply constrain them to textbook level things only”
- **Faculty:** “How about the oral exam committee and the candidates meet weekly as a group with some snacks and refreshments for a semester and conduct ‘exams’ on a specified list of topics? If deficiencies are identified, then they could be revisited some

## VII. Free responses

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weeks later when the student had time to address the deficiency. The exam committee and the candidates get to know each other. It is assumed that all candidates will pass at the end.”

- **Faculty:** “Being up against a "pass or you're going for a MAsters" exam. I'd like to say that we allow three exams, but on the second give (as we sometimes do) conditional passes - e.g. on taking grad QM (which the student tested out of)”
- **Faculty:** “If it ain't broke, don't fix it”
- **Student:** “Choose student's [presentation] topics in a more personalized manner so there is some overlap with their research. Also talk to the student's advisor to see what they actually work on... even within a subfield there is huge variation in... techniques and physics. A personalized topic with some overlap (and some difference) from the student's research will make the exam more consistent between students and actually teach people things that could be relevant to their research/future work in some capacity.”
- **Student:** “Having a broad knowledge outside research is a good aim, and the oral exam should test just that, to test if a student has a broad knowledge outside of their research. If a question is from outside of a student's main field of research, it should be about general knowledge or asking if a student can figure things out logically, not asking for a very specific piece of knowledge and checking if a student has this piece of knowledge memorized. This makes the exam about rote memorization, and actively wastes student's time by forcing them to memorize facts that will practically never get used in their research and forgotten.”
- **Student:** “There's no reason that I can see not to make the first time pass /no record. I did not find this reduced the study I required to succeed on it for me or my fellow students who took it during covid when this was in effect, but it did reduce the stress a little and that can only help people with their performance.”
- **Student:** “Professors... have varying knowledge of your research area, and can't usually ask intelligent questions about it. My research talk was very broad and general and basic and I wasn't asked anything interesting... Why even ask about our research if no one knows the answers to what they're asking?... [maybe] the advisor could grill the student a bit or they could be there to provide answers in case the committee is wrong about something.”
- **Student:** “One suggestion is that students be allowed to choose a subtopic which relates to their research in which to have one question asked and leave the other two as covering the wider field... This makes the exam more useful for students, both before in studying and after in knowledge gained, and more useful for evaluating their capacity to do research.”
- **Student:** “It would be way better if the format is so that it's more of a back and forth discussion on a predetermined topic (some schools use this method: make students choose 5 papers out of 20 papers to choose from and discuss those 5 papers together) , and judge a student based on the quality of the discussion.”

## VII. Free responses

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- **Student:** “I think the oral exam would be more useful if it were focused on someone's research, more like a research proposal rather than an exam. We're here to do research; not memorize things to regurgitate.”
- **Student:** “I have heard from peers at other institutions that their oral examinations are usually more closely based on presenting on their thesis work. I think it would be good if MIT incorporated this into the current system.”
- **Student:** “The expectation to know every standard formula and constant in my field took a huge amount of brain power and distracted from learning useful concepts.”
- **Student:** “In some disciplines, exams need to be more specialized, the scope of the exam is too broad.”
- **Student:** “I think it's appropriate that there's an exam for [my division] but beyond that I don't really know which areas should have an exam”
- **Student:** “Maybe overhaul the exam so it is just about your research and subfield + basic general knowledge and have experts on the committee.”
- **Student:** “I had a hard time judging which topics should have their own exams for research areas I'm not as familiar with. My thought process on that question was that the topics should be fairly general.”
- **Student:** “It's much better to customize the exam on top of what the student is actually researching, instead of five or six divisions.”
- **Student:** “Have advisors sit in in all divisions exams (currently only Astro I think). Have a set of rules that applies to everyone to make it uniform across divisions.”
- **Student:** “This mold thwarts the success of people with disabilities”

### Helping students prepare for their exams

- **Faculty:** “There is a large variability in the amount of time and support advisors give about preparation for the exam While most advisors behave similarly, some will coach their students while others will not. A general set of guidelines would be useful.”
- **Faculty:** “In general we should think about more opportunities for students to give formal oral presentations to faculty and get feedback on them, like brief talks on their research progress to a group that includes faculty other than their supervisor.”
- **Faculty:** “I think that we might improve the exam by allowing divisions to teach more specialty courses relative to the core courses.”
- **Student:** “I know this would be impossible to produce... but a video recording of an example ‘successful’ oral exam and an example ‘failed’ oral exam would be really amazing as a way to communicate the expected level of understanding, particularly because the words used to describe expectations of level of understanding have so much latitude in their interpretation.”

## VII. Free responses

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- **Student:** “My only information was from older graduate students who often have the attitude of ‘If I had to go through it so do you’ which is often combative and unhelpful. The lack of anyone telling me the purpose of the exam made it seem like the only point of the exam was to be a hazing ritual, another hoop to jump through to prove you deserve to be at MIT.”
- **Student:** “I think it would be nice if there was an official description of the exact expectations, rules, guidelines, topics, format, etc of the oral exam you are going to take that you can look at even before you enroll as a graduate student at MIT physics.”
- **Student:** “I hope that the division can provide a more unified message to students taking the oral exam every year through a short group meeting of those who have not passed it yet. Ideally this meeting will cover scope, a mock question or two, what consists of a passing/failing performance, etc.”
- **Student:** “I would have really appreciated my division speaking to the students about the scope or purpose of the exam ahead of time. The lack of clarity made it feel like I had to study everything in my field in great detail, which was a huge source of stress.”
- **Student:** “While I received detailed feedback from the examiners after the exam, I would have benefitted from clearer expectations beforehand as to what was required to pass.”
- **Student:** “I think that the biggest improvement would be more consistent, clearly communicated guidelines for what will be covered and how performance will be evaluated. When I took the exam, nearly all my information about what to study came from other graduate students.”
- **Student:** “essentially all knowledge about the exam is passed down from senior grad students to junior ones via oral tradition”
- **Student:** “[The goals of the exam] could be achieved with much less stress if there was consistent rubric and clear statement of the material that should be studied.”
- **Student:** “If the 4 core classes are also fair game or other material beyond the difficulty of the specialty classes is, that should be clearly stated.”
- **Student:** “When I tried to meet with committee members before... one would not meet with me and the other two had [only] vague advice.”
- **Student:** “Make sure there are written guidelines provided about content, format, and expectations for oral exams in every subdivision, not just a few.”
- **Student:** “Have an official list of questions/categories that can be asked about on the exam. Presumably this stuff should also be taught in the [specialty] classes ... at least let the students know the limits.... The list should be updated yearly.”
- **Student:** “Worried that material to study >> material required for exam”

### Exam grading and committee members

- **Faculty:** “There is no formal way to handle a disagreement between members of the committee about passing a student. For example, a 2/3 consent to pass can lead to strange

## VII. Free responses

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unpredicted outcomes. In past experiences, this has been handled very poorly.”

- **Faculty:** “The variability in oral examiners is large. This is especially true between examiners educated in areas where oral exams are common (often in Europe) and where they are not. This leads to a dichotomy of assessment and demands amongst the examinee. A list of grading objectives should be made available to the students/faculty.”
- **Student:** “In my division, one of the first things that people ask when they find out you're taking the exam that semester is ‘who's on your committee?’. This is considered a key piece of knowledge in exam preparation as it changes the scope and difficulty of the exam. The asker then responds with whatever knowledge they have about those particular committee members, and how difficult they think the exam will be. I think this is pretty telling.”
- **Student:** “Faculty who are serving on the exam committee have approached me to ask who the research advisor of a student they were about to examine is. In context, it was strongly implied they were asking because they were concerned about the repercussions for a particular faculty member having a student need to retake the exam and/or they were concerned about retaliation from other faculty members against the members of the exam committee if that faculty member’s student failed.”
- **Student:** “the material covered was extremely dependent on the professors giving the exam, and a common suggestion was to study those professor's experiments to prepare for the exam. Professors would sometimes ask questions that were very specific to their research area, then fail students for not knowing the answer. This was especially difficult for the first students to take the exam in a given semester, because they had no idea how the current committee would administer the exam.”
- **Student:** “After I failed my first attempt, I got confusing verbal feedback from one professor (the other two committee members did not stick around to tell me I had failed). That feedback did not match the goals of the oral exam I had discussed with my academic advisor (the only professor who discussed the exam with me before I took it). Then, the form was turned into the department without any feedback / reasons for failing in the box.”
- **Student:** “Right now the exam is structured so that three committee members can ask whatever random questions that come to their mind. This gives total power and authority to the committee to steer the exam in whatever direction they want and to decide whether to pass or fail a student based on that. It's also prone to varying content and difficulty of the exam on a test-by-test basis, and also harassment. For instance, one faculty member can choose to ask a very specific piece of knowledge that is related to their own research and decide to fail a student based on that.”
- **Student:** “The oral exam represents an unusual situation for the examinee, in that many feel they cannot go against an incorrect statement/assumption made by the exam committee without incurring professional/reputational costs. This is exacerbated by the ‘rule’ that the student's advisor ought not to intervene on their student's behalf, and

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faculty members who do (especially junior faculty and/or faculty from underrepresented groups) may incur reputational/professional costs themselves.”

- **Student:** “The composition of the exam committee should include at least one faculty member with some knowledge of the student's subfield. For example, a recent iteration of [a division's] oral exam had [multiple] students who were studying [a broad field], but all of the faculty on the committee... [had] no practicing knowledge of [that broad field]”
- **Student:** “The questions you get asked on your exam and the way you are treated depends enormously on your committee. It is a well known problem that some professors have a chip on their shoulder about their field and will ask unfairly hard questions during the exam to trip you up. Obviously this is intimidating and unfair.”
- **Student:** “Allow an appeals process if a single professor is determined to fail you or if you feel you were treated unfairly during the exam. If the other two committee members agree with you, the result should be overturned. Even if the result is not overturned, students should be able to request an alternate committee member on their next attempt.”
- **Student:** “The scope of the exam depends entirely on the committee. Students find significantly more success studying based on the committee's areas of expertise/pet projects than working to acquire a broad base of knowledge in the field.”
- **Student:** “The department should consider the (possibly biased) impact of English language proficiency on student assessment.”
- **Student:** “The examiners were very friendly during my exam and genuinely wanted me to pass. They would ask guiding questions if I didn't understand the original question.”
- **Student:** “One main problem is that professors do not agree on what the scope of the exam should be. So a committee member may ask a question that is not in the scope of the specialty classes or list of textbooks (as happened on one of my attempts).”
- **Student:** “Professors should have a rubric for grading the exam that is known by the students in advance and should give students specific reasons when they fail with advice on how to study for the second attempt.”
- **Student:** “Give students an option to replace one of the committee members if they have reasons to do so.”
- **Student:** “Exams should be recorded, and students should have an option to request a review by a different set of faculty members.”

### Regular feedback for examiners

- **Faculty:** “At the end of each academic year, the graduate students who have taken the exam that year should be asked to review the exam in the same way that they are asked to review courses. The review results should be made available to all faculty in the relevant division and also to the education committee. While it would be better for this review to be executed by the department, the graduate students do not need to wait for the department to start this. This can be run by the grad students themselves. Graduate students should make it a point to present the review results with the various visiting

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committees. Just like students, faculty respond to grades.”

- **Student:** “Exit surveys.”
- **Student:** “The department needs to conduct exit surveys for students who fail the exam. If the mission of the physics PhD program is to educate, failing students are an indicator of flaws in the system, and it is critical that the department investigate every failure. Failing students have a unique perspective on the weaknesses of the system.”

### Criticism of PGSC and/or one’s peers:

- **NUPAX Student:** “Stop weakening the general exams. It is cheapening our degrees.”
- **NUPAX Student:** “Students, in my opinion, who complain at the difficulty, did not prepare enough and might have issues with a particular committee member.”
- **CMT Student:** “At the time, the oral exam seemed incredibly frustrating and unfair. But because real life is frustrating and unfair... this survey is heinously biased. It reads like a ballot in North Korea. I just hope that some of the ideas you collect with this survey survive your confirmation bias.”

### Division-specific comments

#### Comments about AMO

- **Student:** “I think the content of the AMO courses and exams is not relevant enough to modern AMO research. Most groups at MIT study ultracold quantum gases, yet we do not get to these topics in the courses nor are they tested on the exam. I would feel better prepared as a member of the AMO community if the AMO 2 course and the exam were restructured to have a major focus on BECs and degenerate Fermi gases.”
- **Student:** “It’s pretty good as is right now.”

#### Comments about ASTRO

- **Faculty:** “I can only speak for astro exam, but I think it is pretty good in general... I think it would be nice if we overhauled the questions more frequently, and if there was a better rubric for success. Though a rubric might be less favorable to students than the current qualitative system, where the students typically get the benefit of the doubt.”
- **Faculty:** “Finding some way to incentivize more frequent refresh of our list of questions would be helpful.”
- **Student:** “I think the way the exam is handled in astro is very fair. Everyone receives the same study guide, and almost everyone taking the exam in a given semester has the same examiners (unless one of the examiners is their supervisor).”
- **Student:** “It is frustrating that a lot of the material is not covered in the astro depth classes, but I felt like I was given enough information from the study guide and from

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more senior students to know which resources to use to cover those gaps in the coursework.”

### Comments about CMT

- **Student:** “The policy of having professors give their own students the prepared question... leads to very uneven questions and puts students at a disadvantage if their professor chooses something that doesn't seem to show off their knowledge in the field. It might be better if the chair chose the questions for all students.”

### Comments about CMX

- **Student:** “I felt like the examiners did a good job of asking me a wide range of questions about the field instead of questions based on their specialties... The exam was more focused on condensed matter physics in general and less on my research specialty (just an observation, I don't feel strongly about this one way or the other)”
- **Student:** “The admin for CMX (Monica Wolf, now retired) was actually the best resource for information about the oral exam.”

### Comments about NUPAT

- **Student:** “It focuses almost entirely on particle physics/phenomenology and this advantages students who work on this area while lot of students who work on gravity or cosmology are at a bit of a disadvantage. It also doesn't help them quite as much because it doesn't apply directly to their research after the exam. There should be a way to angle the exam a little more towards what is relevant to those students.”
- **Student:** “I think it needs to be updated to recognize that about half of CTP students do string theory, gravity, QG, or cosmology and not pheno.”
- **Student:** “I agree that the material covered in the exam is not suited for students who do formal theory/quantum gravity etc, so it would be nice to add a version for them as well.”
- **Student:** “The CPT oral exam was overall a very positive and helpful experience for me... Overall I benefitted a lot from the experience and I wish I had taken it even earlier, because it forced me to cover some ‘gaps’ that I would have never realized I had if it wasn't for the exam.”

### Comments about NUPAX

- **Faculty:** “I have concerns about the oral exam, but they are not addressed in the survey... Within NUPAX faculty there is no discussion about the exam topics. There are specific topics within the department that have a much higher failure rate than other

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topics. This statistic, along with related statistics should be seriously considered when constructing the use of these topics.”

- **Faculty:** “I think NuPax has started some important work but this survey will be very useful in guiding the next directions and some continued improvements.”
- **Faculty:** “I think the NUPAX exam is OK as it is.”
- **Student:** “In NUPAX, the main problem with taking the exam is the amount of bias and randomness... Topics are chosen from a collection I assume the committee maintains. They remove anything that looks, to them, to be close to your field of research and then choose from the rest with a random number generator. As you might imagine, this leads to a wide disparity in the topics students are assigned. [Some students get] a topic with [similarities to their] research, so it was pretty easy... other students frequently get topics that have no overlap at all with their research. Low-energy nuclear physics students have to talk about future high energy pp colliders and high energy physicists talk about FRIB. I imagine there is almost no overlap between these topics and their research, which is very stressful and also not useful to the student.”
- **Student:** “I think this is somewhat inherent in the exam, but the questions you get asked during the free-for-all segment vary A LOT. Most are reasonable but occasionally there is a really weird question, like asking about a piece of technology only used on 1 experiment you've barely know about because it has nothing to do with your research.”
- **Student:** “The exam committee... sometimes has acted in ways that could be seen as disrespectful, or that they don't really care much about administering the exam... Committee members who have biases against specific fields/topics have been known to show those biases in the exam.”
- **Student:** “There have been several sets of reforms [over the past several years]... the scheduling process (which was basically a black box when i took the exam) has now been somewhat reformed... the oral exam committee now meets with all students taking the exam in a particular semester to discuss scope.”
- **Student:** “The NuPaX head, Joe Formaggio, while not on the exam committee, was extremely helpful in helping students prepare for exams; he considered it part of his duty specifically as an impartial person not on our committees, and that was very beneficial and much appreciated.”
- **Student:** “Overall, I don't think there's a major problem that stands out for my division's oral exam.”

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### Appendix A: Faculty survey questions

1. In which division of physics do you work?
  - a. ABCP
  - b. Astrophysics
  - c. Nuclear and particle experiment
  - d. Center for Theoretical Physics
  - e. Other or prefer not to answer
2. The most important aspects the oral qualifying exam SHOULD measure are (select up to 5):
  - a. Proficiency in the required specialty coursework
  - b. Breadth of understanding of a whole field
  - c. Memorization of a canon of important facts about a field
  - d. Depth of knowledge surrounding one's specific area of research
  - e. Important modern developments in their research area
  - f. Important historical developments in their research area
  - g. Technical knowledge about experiments
  - h. Ability to perform calculations
  - i. Ability to think on their feet
  - j. Ability to give a presentation about physics
  - k. Ability to discuss their own research
  - l. Ability to perform under pressure
  - m. Creativity/originality
  - n. Progress on research so far
  - o. Potential for future success in research
  - p. Other (write in)
3. At this moment, the aspects the oral qualifying exam actually measures the most are a student's (select up to 5):
  - a. Proficiency in the required specialty coursework
  - b. Breadth of understanding of a whole field
  - c. Memorization of a canon of important facts about a field
  - d. Depth of knowledge surrounding one's specific area of research
  - e. Important modern developments in their research area
  - f. Important historical developments in their research area
  - g. Technical knowledge about experiments
  - h. Ability to perform calculations
  - i. Ability to think on their feet
  - j. Ability to give a presentation about physics
  - k. Ability to discuss their own research
  - l. Ability to perform under pressure
  - m. Creativity/originality

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- n. Progress on research so far
  - o. Potential for future success in research
  - p. Other (write in)
4. How long does a physics graduate student study for oral qualifying exams, on average?
    - a. The equivalent of 0-2 weeks, full-time
    - b. The equivalent of 2-4 weeks, full-time
    - c. The equivalent of 4-6 weeks, full-time
    - d. The equivalent of 6-8 weeks, full-time
    - e. The equivalent of a full semester, full-time
  5. How much time do you allow your students to study in lieu of doing research?
    - a. The equivalent of 0-2 weeks, full-time
    - b. The equivalent of 2-4 weeks, full-time
    - c. The equivalent of 4-6 weeks, full-time
    - d. The equivalent of 6-8 weeks, full-time
    - e. The equivalent of a full semester, full-time
  6. From 1-10, 1 being little added stress and 10 being their most stressful life event, how do you think students rate the added stress of the oral qualifying exam? (integer increments)
  7. From 1-10, for the ideal oral exam, how do you think students should rate the added stress? (integer increments)
  8. How much of the information taught in required specialty courses is tested on the oral exam?
    - a. None
    - b. Only some
    - c. About half
    - d. Most of it
    - e. All of it
  9. How much of the information tested on the oral exam is not taught in the specialty courses?
    - a. None
    - b. Only some
    - c. About half
    - d. Most of it
    - e. All of it
  10. How does the depth of knowledge required for the oral exam relate to what is taught in the specialty courses?
    - a. The oral exam requires deeper knowledge than the courses
    - b. The oral exam requires knowledge at the same level as the courses
    - c. The courses require deeper knowledge than the exam
    - d. The oral exam and the courses are sufficiently different that one cannot make a fair comparison between them

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11. Does your division's faculty have an agreed upon scope for the oral exams? If so, how do students receive this information in your division?
  - a. No
  - b. Yes (write in answer)
12. Does your division's faculty have an agreed upon grading rubric for the oral exams? If so, how do students receive this information in your division?
  - a. No
  - b. Yes (write in answer)
13. How often do the faculty in your division meet to discuss what topics should be covered on the oral exams? (free response box)
14. How does your division prepare new faculty for administering the oral exams? (free response box)
15. In the past, preparing for the oral qualifying exam has made graduate students in my research group (choose from: strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, strongly agree)
  - a. More informed about our specific line of research
  - b. Better at carrying out technical aspects of our research
  - c. Better at developing creative, novel research proposals
  - d. More independent of researchers
  - e. Better at giving technical talks and presentations
  - f. Better able to communicate with scientists at conferences my group attends
  - g. Better able to communicate with scientists outside my group but in my division at MIT
  - h. Better at teaching physics
16. Graduate students currently perform work in the following research areas. Which of these areas should we offer an oral exam in?
  - a. Applied physics and devices
  - b. Artificial intelligence and physics
  - c. Astrophysics (general)
  - d. Astrophysics (instrumentation)
  - e. Astrophysics (planetary science)
  - f. Atomic and molecular physics
  - g. Biological physics
  - h. Biomedical physics
  - i. Condensed matter experiment
  - j. Condensed matter theory
  - k. Cosmology and gravity
  - l. Interdisciplinary and/or individualized exam
  - m. Materials science and engineering
  - n. Mathematical physics / applied mathematics

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- o. Nuclear and particle experiment (collider physics)
  - p. Nuclear and particle experiment (general)
  - q. Nuclear theory
  - r. Optics and photonics
  - s. Particle phenomenology
  - t. Plasma physics
  - u. Quantum field theory
  - v. Quantum information experiment
  - w. Quantum information theory
  - x. String theory, holography, and quantum gravity
  - y. Other(s) [write in]
17. Do you have any ideas for improving the exam or other comments you'd like to share?

### Appendix B: Student survey questions

1. In which division of physics did (will) you take the oral exam?
  - a. Astrophysics
  - b. Atomic, molecular, and optical physics
  - c. Biophysics
  - d. Condensed matter experiment
  - e. Condensed matter theory
  - f. Nuclear and particle experiment
  - g. Nuclear and particle theory
  - h. Plasma physics
  - i. Quantum information
2. Do you work for a faculty member home-based in the Physics Department?
  - a. Yes
  - b. No
3. The most important aspects the oral qualifying exam SHOULD ideally measure are (select up to 5):
  - a. Proficiency in the required specialty coursework
  - b. Breadth of understanding of a whole field
  - c. Memorization of a canon of important facts about a field
  - d. Depth of knowledge surrounding one's specific area of research
  - e. Important modern developments in their research area
  - f. Important historical developments in their research area
  - g. Technical knowledge about experiments
  - h. Ability to perform calculations
  - i. Ability to think on their feet
  - j. Ability to give a presentation about physics
  - k. Ability to discuss their own research
  - l. Ability to perform under pressure
  - m. Creativity/originality
  - n. Progress on research so far
  - o. Potential for future success in research
  - p. Other (write in)
4. Graduate students currently perform work in the following research areas. Which of these areas should we offer an oral exam in?
  - a. Applied physics and devices
  - b. Artificial intelligence and physics
  - c. Astrophysics (general)
  - d. Astrophysics (instrumentation)
  - e. Astrophysics (planetary science)

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- f. Atomic and molecular physics
  - g. Biological physics
  - h. Biomedical physics
  - i. Condensed matter experiment
  - j. Condensed matter theory
  - k. Cosmology and gravity
  - l. Interdisciplinary and/or individualized exam
  - m. Materials science and engineering
  - n. Mathematical physics / applied mathematics
  - o. Nuclear and particle experiment (collider physics)
  - p. Nuclear and particle experiment (general)
  - q. Nuclear theory
  - r. Optics and photonics
  - s. Particle phenomenology
  - t. Plasma physics
  - u. Quantum field theory
  - v. Quantum information experiment
  - w. Quantum information theory
  - x. String theory, holography, and quantum gravity
  - y. Other(s) [write in]
5. Note that if you select no to [the following question] you will be redirected to the end of the survey. If you have comments you'd like to make, please leave them here. (Students who don't select no will have a second comment box at the end of the survey.)
- a. Comment box
6. Have you taken the oral exam yet?
- a. Yes
  - b. I am taking it for the first time this semester
  - c. No
7. At the moment, the aspects the oral qualifying exam actually measures the most are a student's (select up to 5):
- a. Proficiency in the required specialty coursework
  - b. Breadth of understanding of a whole field
  - c. Memorization of a canon of important facts about a field
  - d. Depth of knowledge surrounding one's specific area of research
  - e. Important modern developments in their research area
  - f. Important historical developments in their research area
  - g. Technical knowledge about experiments
  - h. Ability to perform calculations
  - i. Ability to think on their feet
  - j. Ability to give a presentation about physics

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- k. Ability to discuss their own research
  - l. Ability to perform under pressure
  - m. Creativity/originality
  - n. Progress on research so far
  - o. Potential for future success in research
  - p. Other (write in)
8. How long did you study for your oral exam(s), in total?
- a. The equivalent of 0-2 weeks, full-time
  - b. The equivalent of 2-4 weeks, full-time
  - c. The equivalent of 4-6 weeks, full-time
  - d. The equivalent of 6-8 weeks, full-time
  - e. The equivalent a full semester, full-time
  - f. Other (please specify)
9. Did your advisor relieve you of research duties while you were studying for the oral exam?
- a. Yes
  - b. Somewhat
  - c. No
10. Were you TA'ing the semester(s) you took the oral exam?
- a. Yes
  - b. Once out of two tries
  - c. No
11. Did you pass the oral exam on your first try?
- a. Yes
  - b. No
  - c. Have not taken the exam yet
  - d. Prefer not to specify
12. From 1-10, 1 being little added stress and 10 being your most stressful life event, how would you rate the stress of your oral exam experience? (integer increments)
13. How much of the information taught in required specialty courses is tested on the oral exam?
- a. None
  - b. Only some
  - c. About half
  - d. Most of it
  - e. All of it
14. How much of the information tested on the oral exam is not taught in the specialty courses?
- a. None
  - b. Only some

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- c. About half
  - d. Most of it
  - e. All of it
15. How does the depth of knowledge required for the oral exam relate to what is taught in the specialty courses?
- a. The oral exam requires deeper knowledge than the courses
  - b. The oral exam requires knowledge at the same level as the courses
  - c. The courses require deeper knowledge than the exam
  - d. The oral exam and the courses are sufficiently different that one cannot make a fair comparison between them
16. Prior to the oral exam, the department/division formally explained to me (strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree, strongly disagree)
- a. The scope of the exam
  - b. The purpose of the exam
  - c. The method for assessing student performance on the exam
17. How much helpful information did you receive about the scope, content, grading, and expectations from the following (very little information, some information, moderate amount of information, a lot of information, almost all the information I knew prior to the exam)
- a. Formal instructions from my division
  - b. The oral examiners
  - c. My research advisor
  - d. My academic advisor
  - e. Specialty course instructors
  - f. Other faculty in my division
  - g. Senior students in my division
  - h. Peers also studying for the exam
18. The exam committee... (strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree, strongly disagree)
- a. Recognized my hard work preparing for the exam
  - b. Was respectful at all times before, during, and after the exam
  - c. Wanted me to pass
  - d. Gave me useful feedback after the exam
19. Answer the following (strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree, strongly disagree)
- a. The scope of the exam depends on the committee members
  - b. The difficulty of the exam depends on the committee members
  - c. Students assessment criteria depend on the committee members
  - d. In principle, my division's procedures for conducting the oral exam are fair and consistent

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- e. In practice, my division's method of conducting the oral exam is fair and consistent
20. Preparing for the oral qualifying exam made me (strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, strongly agree)
- a. More informed about my specific line of research
  - b. Better at carrying out technical aspects of my research
  - c. Better at developing creative, novel research proposals
  - d. A more independent researcher
  - e. Better at giving technical talks and presentations
  - f. Better able to communicate with scientists at conferences my group attends
  - g. Better able to communicate with scientists outside my group but in my division at MIT
  - h. Better at teaching physics
21. Do you have any ideas for improving the exam or other comments you'd like to share?  
(Free response)