

Transforming Physics Graduate Education: From Equitable Admissions to Student Success

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University of Georgia



**Georgia Physics and Astronomy
Education Research**

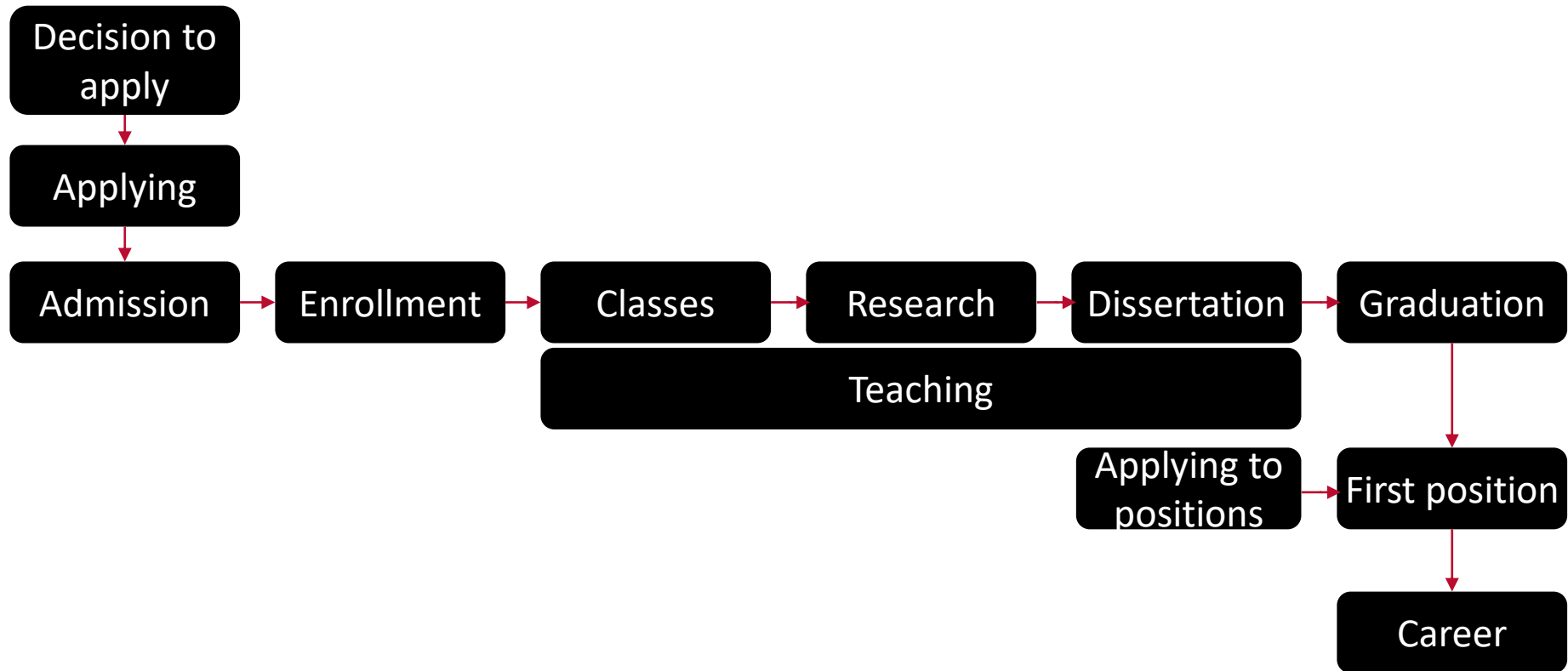
Franklin College of Arts and Sciences

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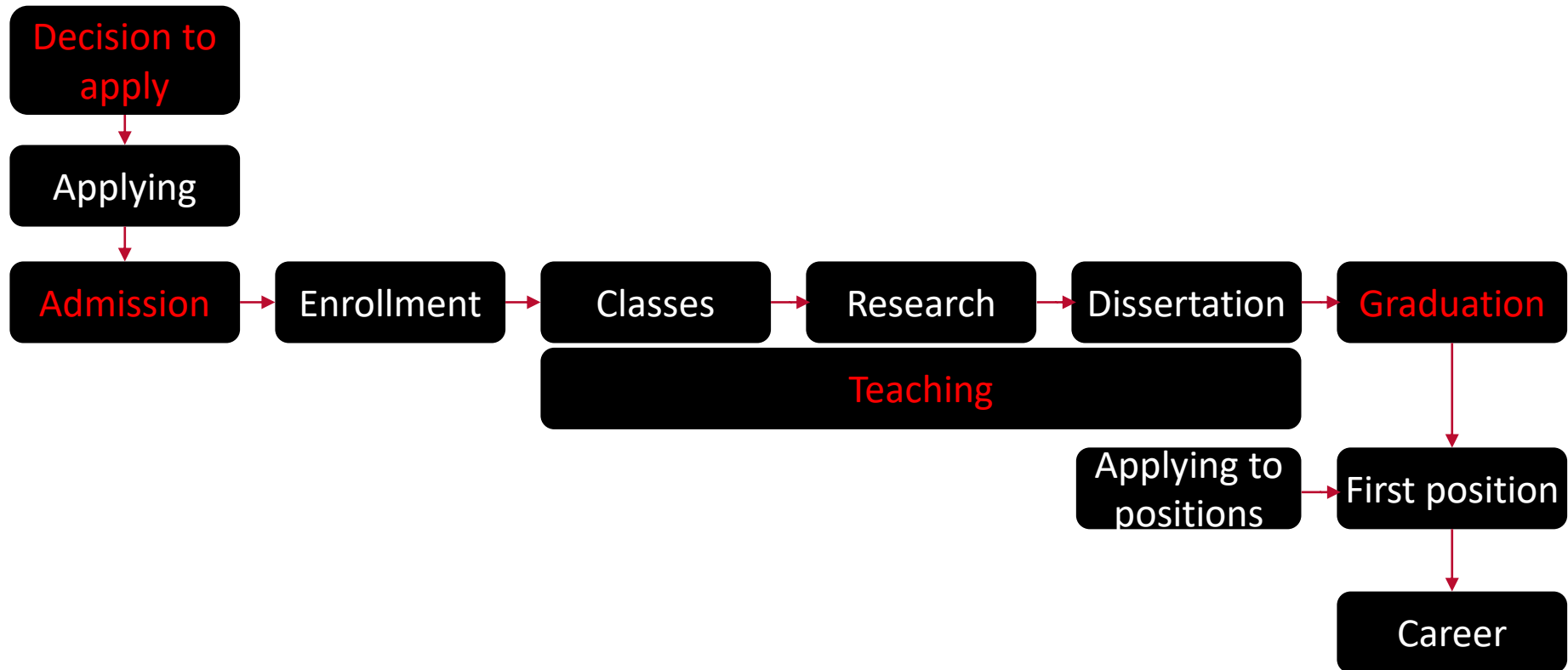
Research supported by the Michigan State University College of Natural Sciences, Lappan-Phillips Foundation, and the University of Michigan's Center for Academic Innovation.



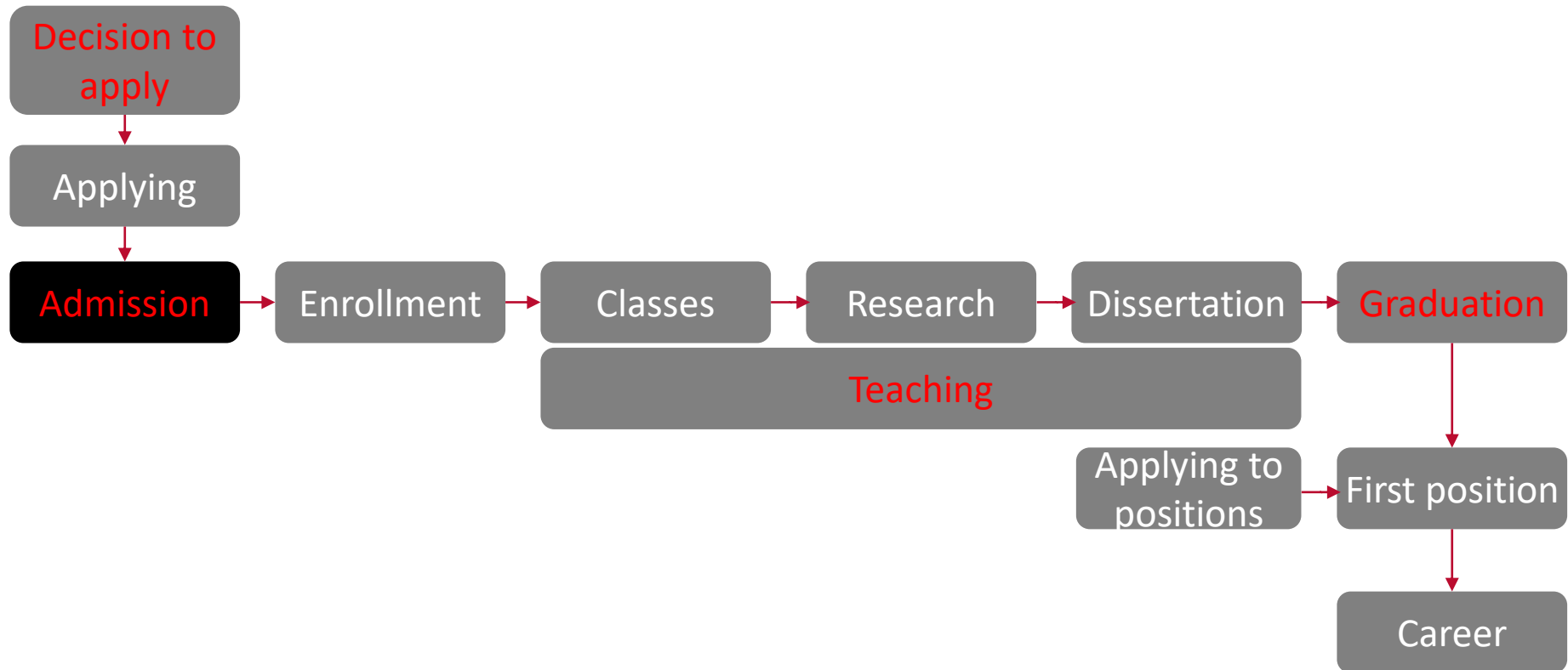
Rough process of graduate education



Rough process of graduate education

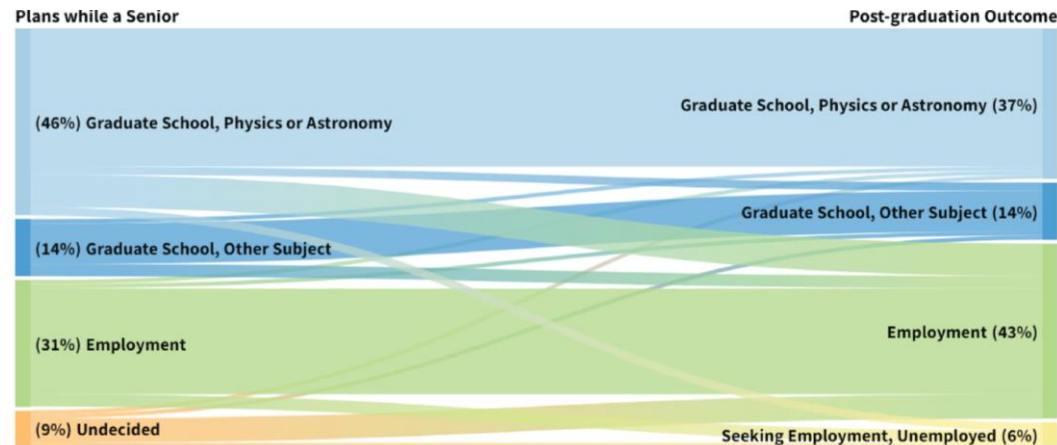


Rough process of graduate education



Graduate school is a popular choice for physics majors

Post-Graduation Plans versus Actual Outcomes for Physics and Astronomy Seniors, Class of 2021

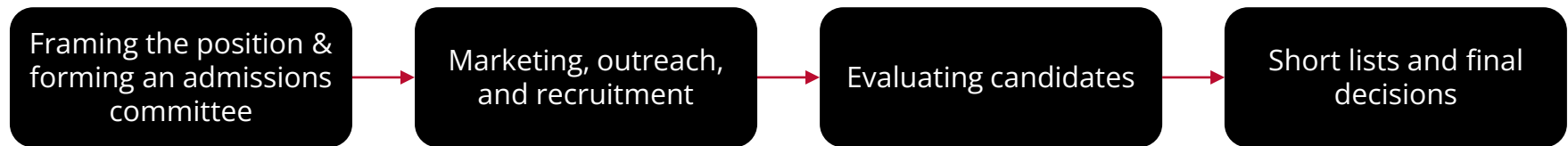


The figure includes only physics and astronomy seniors who graduated in the class of 2021.



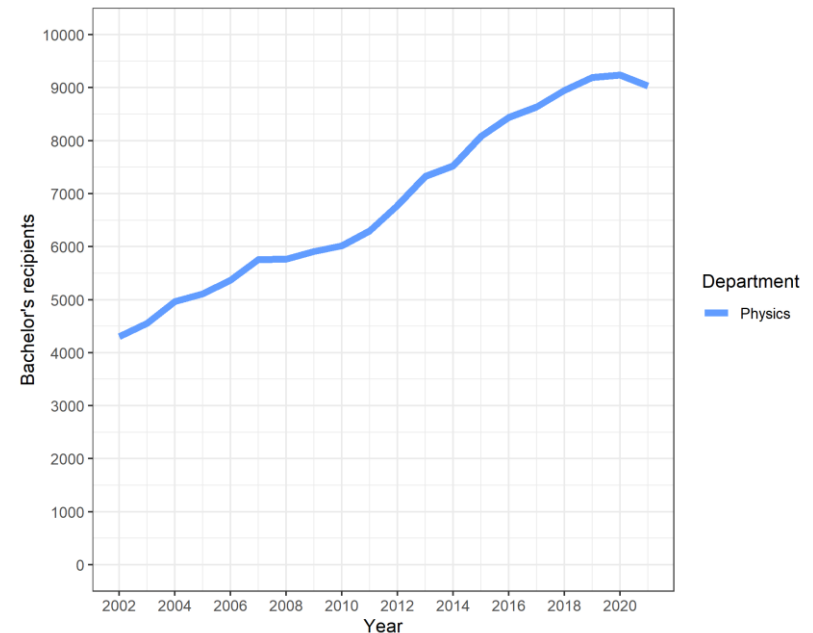
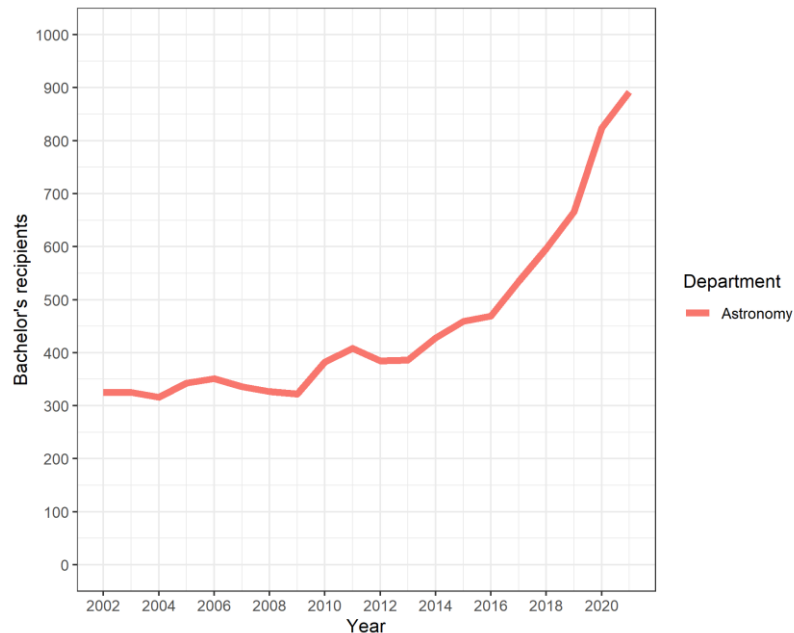
aip.org/statistics

The Graduate Admissions Process



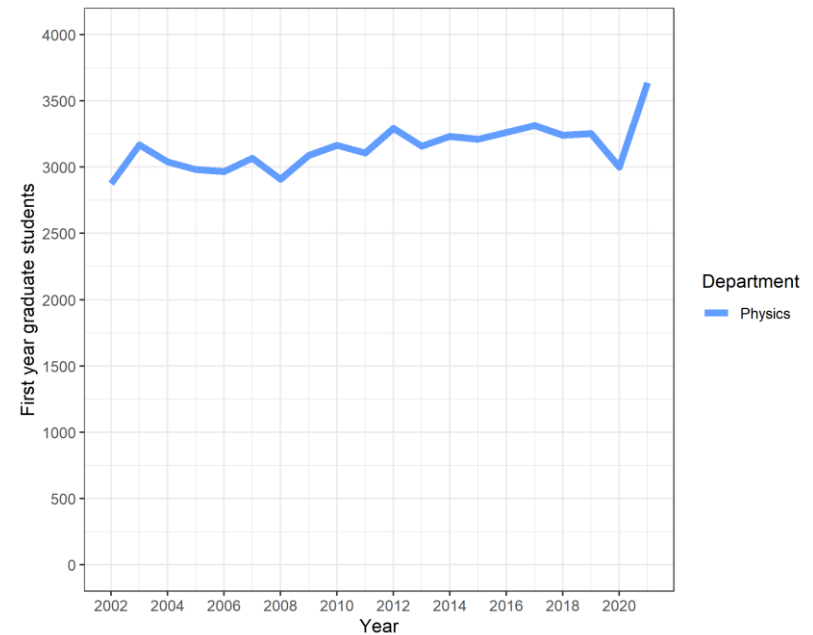
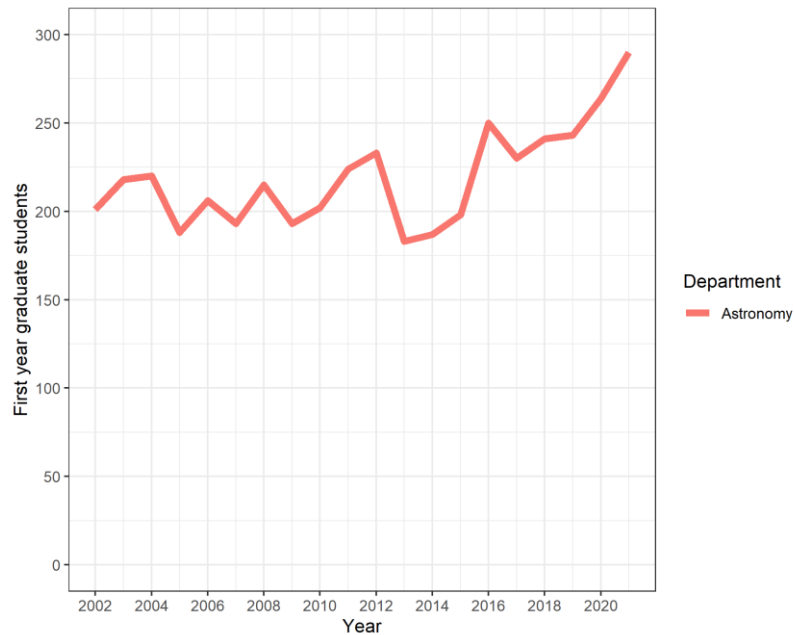
Adapted from O'Meara et al. 2020

Larger context: Number of Astronomy and Physics undergraduate degrees awarded are increasing.



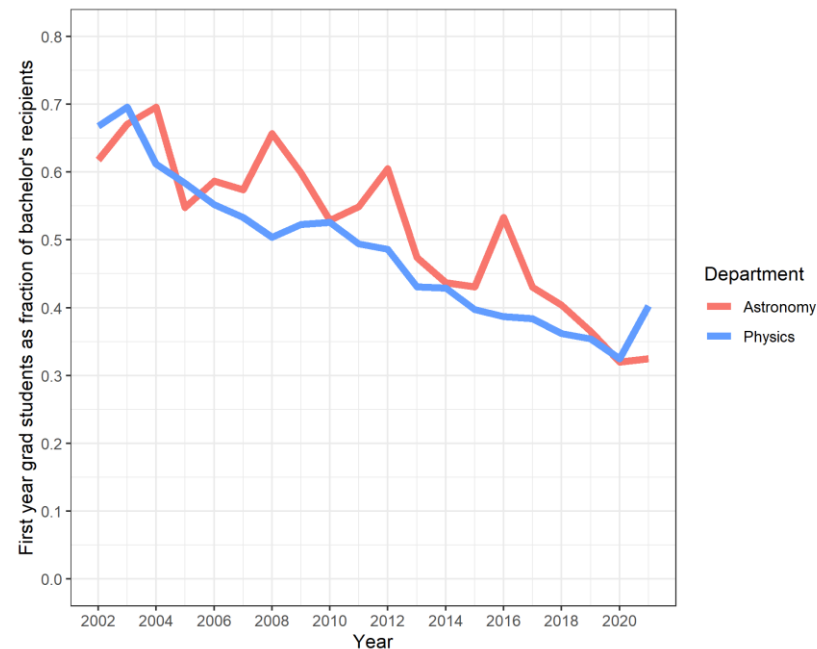
AIP rosters of physics and astronomy departments (2001-2021)

Larger context: Spots in graduate programs have seen slower growth.



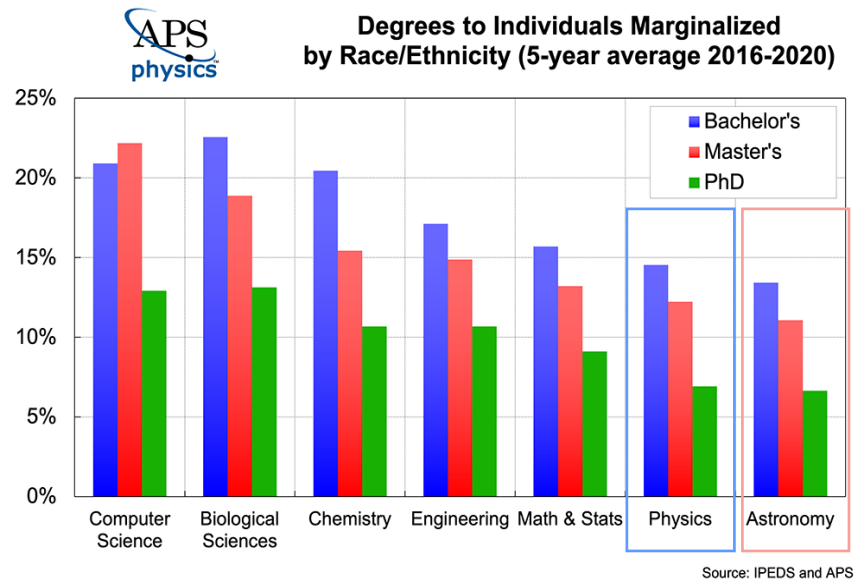
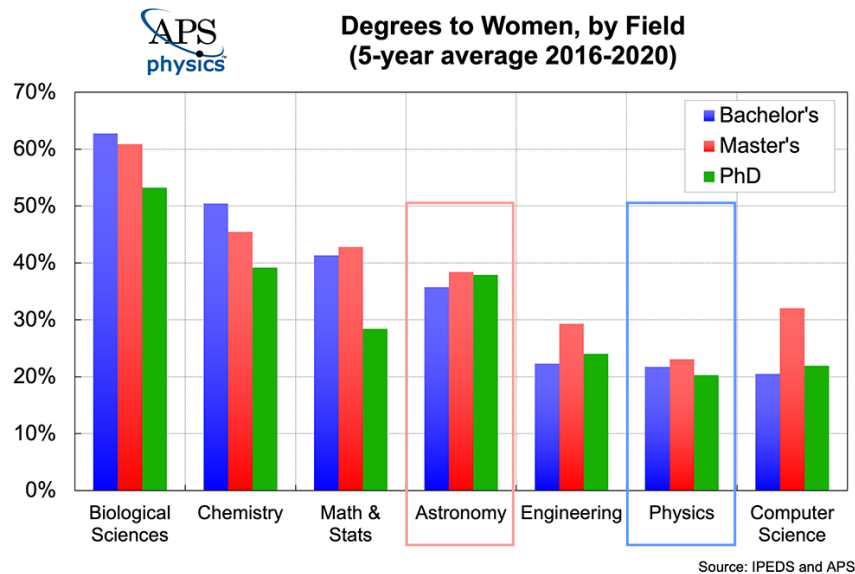
AIP rosters of physics and astronomy departments (2001-2021)

Larger context: The number of available spots per bachelor's graduate is decreasing.



Young, Hayward, and Bell 2023

Larger context: Physics (and astronomy) lag behind other STEM fields in terms of representation



What's inequitable with the way we've
always done it?

The typical admissions package

GRE scores

GPA

Personal statement

Research statement

Letters of
recommendation



The typical admissions package

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Personal statement

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The typical admissions package

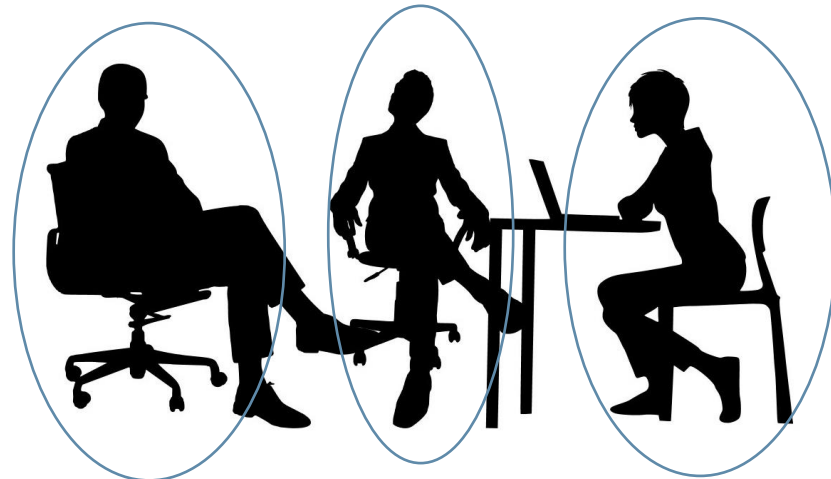
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Chari and Potvin, 2019

Potvin et al. 2017



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Chari and Potvin, 2019
Potvin et al. 2017

Posselt, 2016



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Chari and Potvin, 2019
Potvin et al. 2017

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Data

GRE scores

GPA

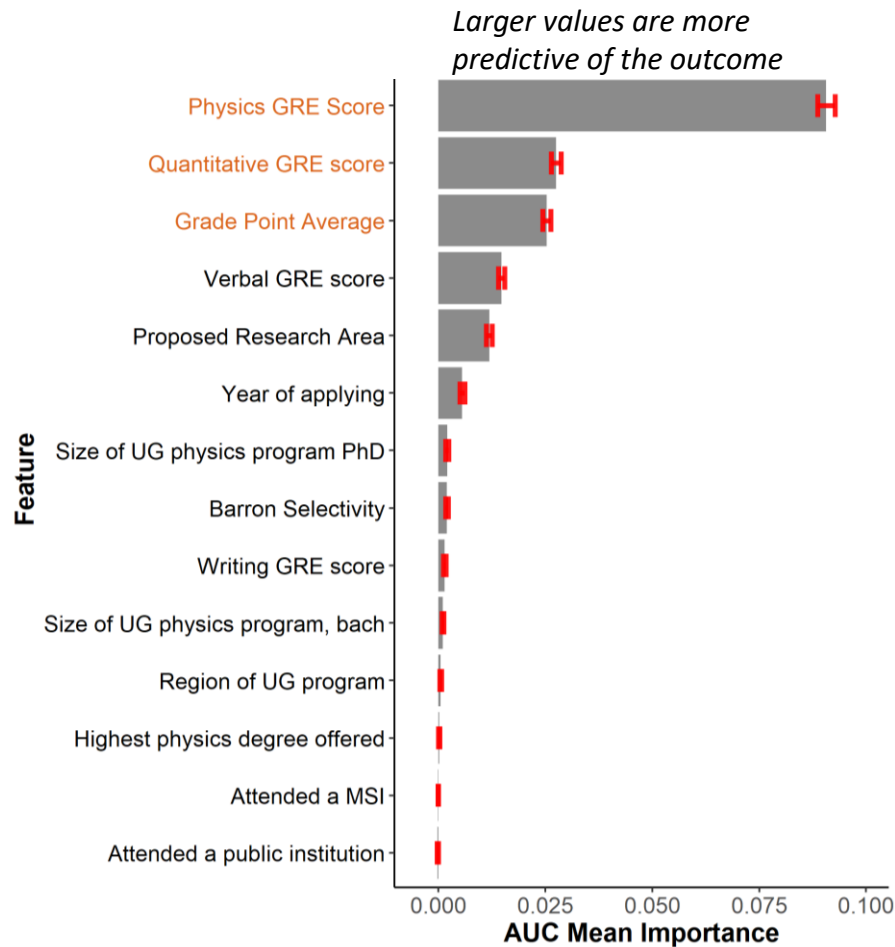
Undergrad school

N=512 domestic
applicants



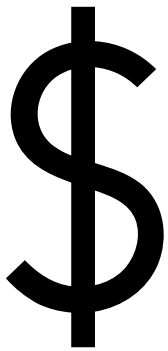
Michigan State University
2014-2017

Test scores & GPA are most predictive of admission



Young et al 2023

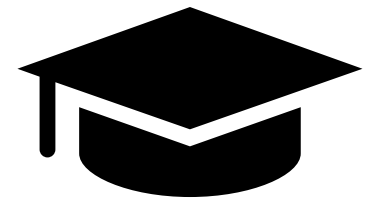
Why the Physics GRE is inequitable



Cost




Score discrepancies



Limited predictive
ability

Miller et al. 2019, Owens et al. 2020



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About the GRE® Subject Tests

General Test

Subject Tests

- About the Tests
 - Test Content and Structure
 - ScoreSelect Option
 - Test Fairness and Validity
 - Fees
 - Bulletin and Forms
 - Tools for Success
- Registration, Test Centers and Dates
- Prepare for a Test
- On Test Day
- Scores
- Frequently Asked Questions

What Are the Subject Tests?

The GRE® Subject Tests are achievement tests that measure your knowledge of a particular field of study.

Show what you know about a specific subject and graduate schools will take notice. The Subject Tests can help you stand out from other applicants by emphasizing your knowledge and skill level in a specific area.

Each Subject Test is intended for students who have an undergraduate major or extensive background in one of these six disciplines:

The GRE® Biology Test and the GRE® Literature in English Test will be discontinued after the April 2021 administration. Scores on both tests will continue to be reportable for five years per [GRE® score reporting policy](#).


- [Biology](#)
- [Chemistry](#)
- [Literature in English](#)
- [Mathematics](#)
- [Physics](#)
- [Psychology](#)

Note: The GRE Biochemistry, Cell and Molecular Biology Test was discontinued in December 2016. Scores will continue to be reportable per [GRE score reporting policy](#).

Who Takes Them?

Prospective graduate school applicants take the Subject Tests. Applicants come from varying educational and cultural backgrounds and the GRE Subject Tests provide a common measure for comparing candidates' qualifications.

GRE Subject Test scores are used by admissions or fellowship panels to supplement your undergraduate records, recommendation letters and other qualifications for graduate-level study. Some Subject Tests yield subscores that can indicate the strengths



Ready to take a GRE® Subject Test?

[Register Now](#)

Send Only Your Best Scores

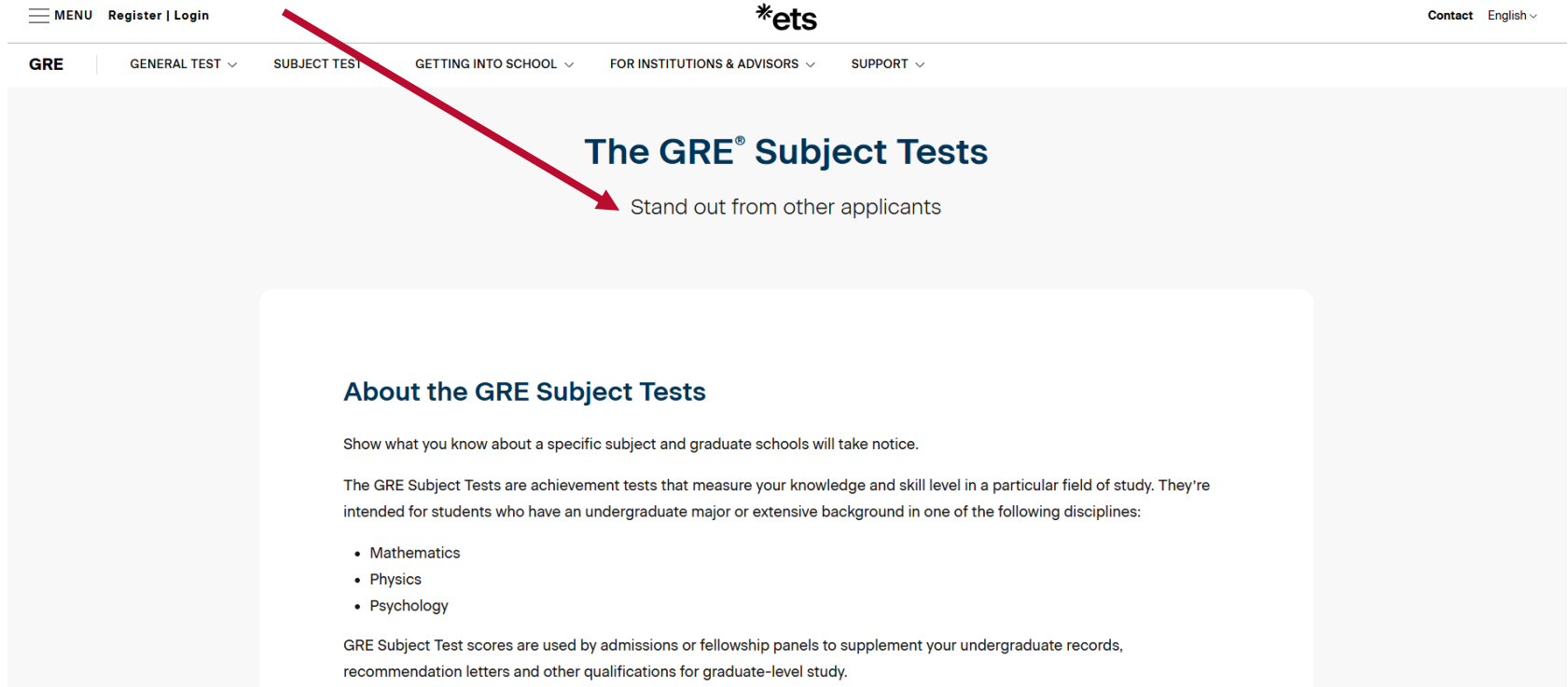
Approach test day with more confidence, knowing you can send the scores that show your personal best — only with the ScoreSelect® option.

Official Test Prep from ETS

Nobody knows our tests better than we do. We offer free practice tests and tips to help you prepare for your GRE Subject Test. Check them out today.

Historical GRE Subjects Test Page (~2021)

<https://www.ets.org/gre/subject/about> Langin 2019



MENU Register | Login

*ets

Contact English ▾

GRE GENERAL TEST ▾ SUBJECT TEST GETTING INTO SCHOOL ▾ FOR INSTITUTIONS & ADVISORS ▾ SUPPORT ▾

The GRE® Subject Tests

Stand out from other applicants

About the GRE Subject Tests

Show what you know about a specific subject and graduate schools will take notice.

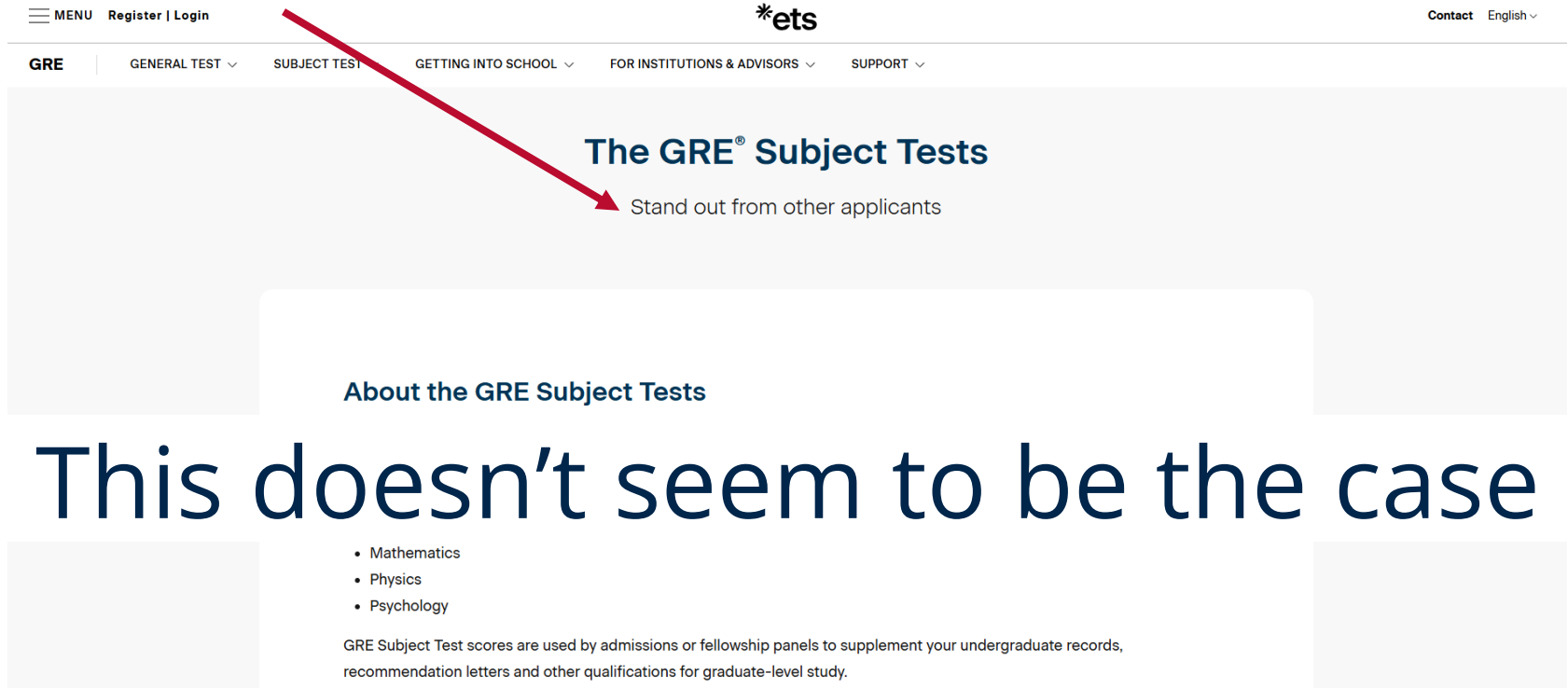
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- Mathematics
- Physics
- Psychology

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GRE Subject Tests page (last week)

<https://www.ets.org/gre/subject/about> Langin 2019



MENU Register | Login

*ets

Contact English ▾

GRE GENERAL TEST ▾ SUBJECT TEST GETTING INTO SCHOOL ▾ FOR INSTITUTIONS & ADVISORS ▾ SUPPORT ▾

The GRE® Subject Tests

Stand out from other applicants

About the GRE Subject Tests

This doesn't seem to be the case

- Mathematics
- Physics
- Psychology

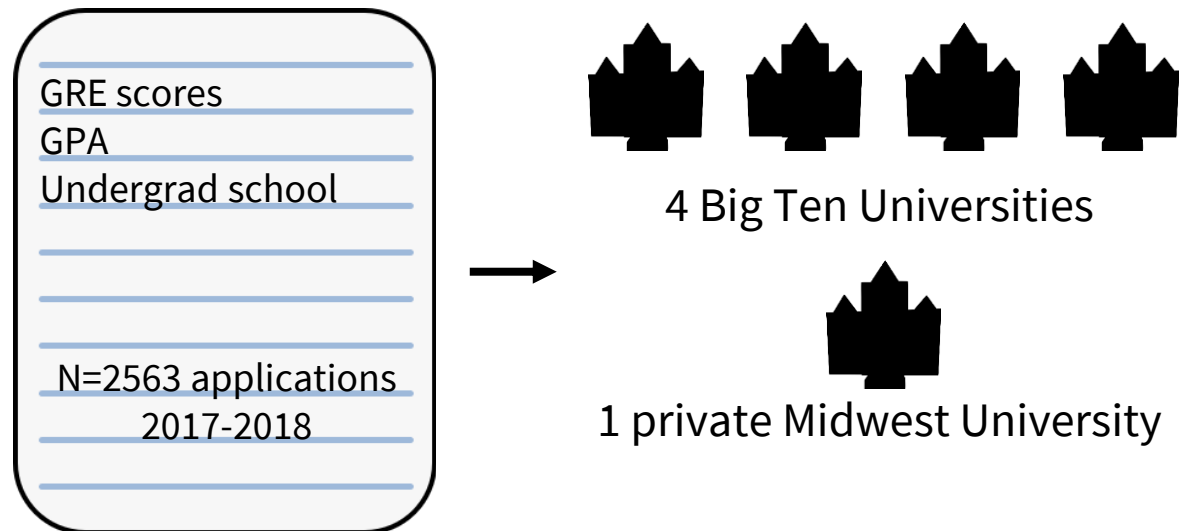
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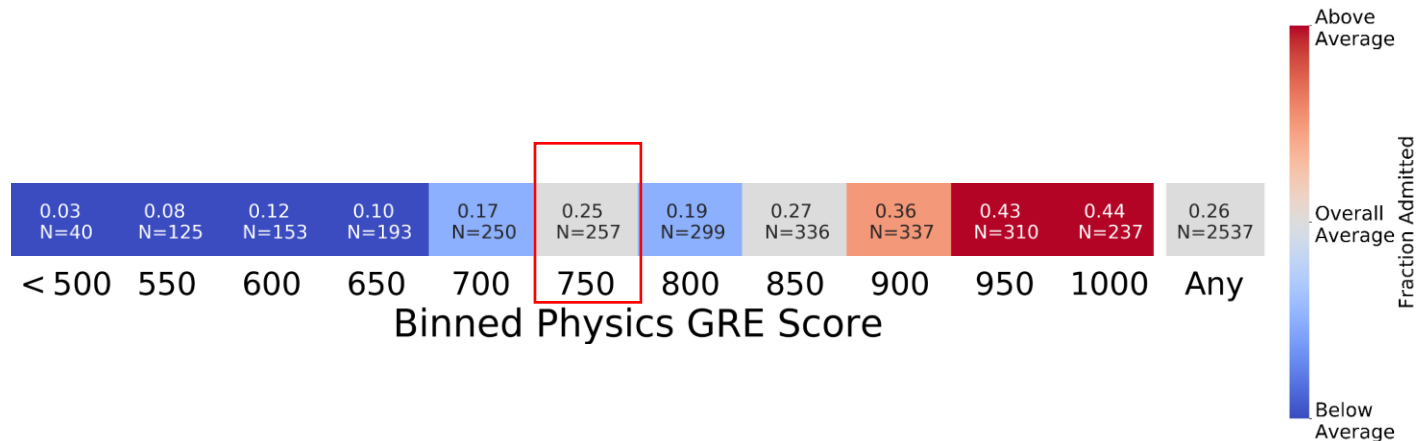
Young and Caballero 2021

← Nicholas Young →

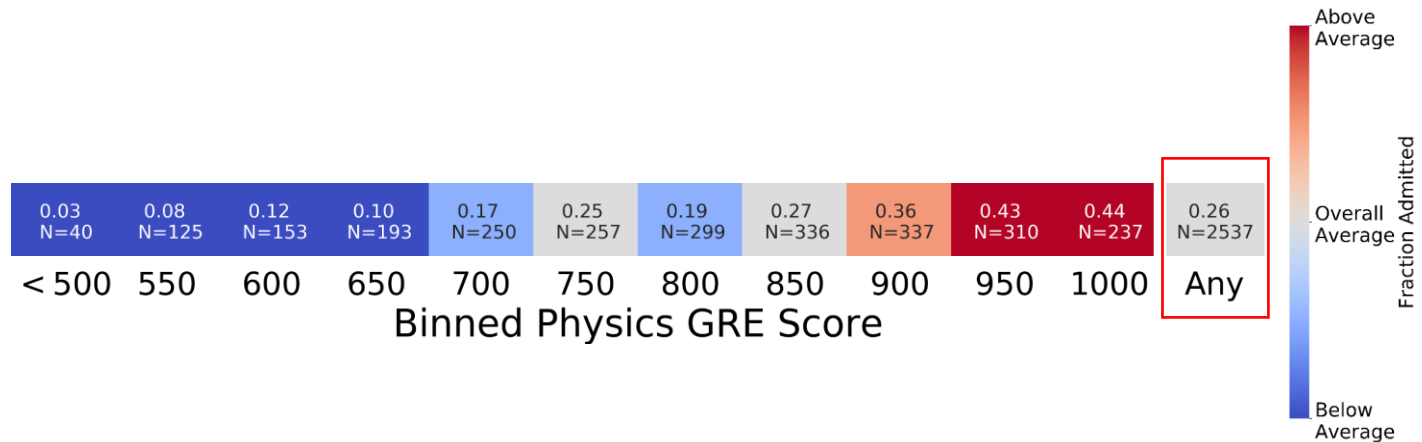
Data



Having a higher pGRE score helps...



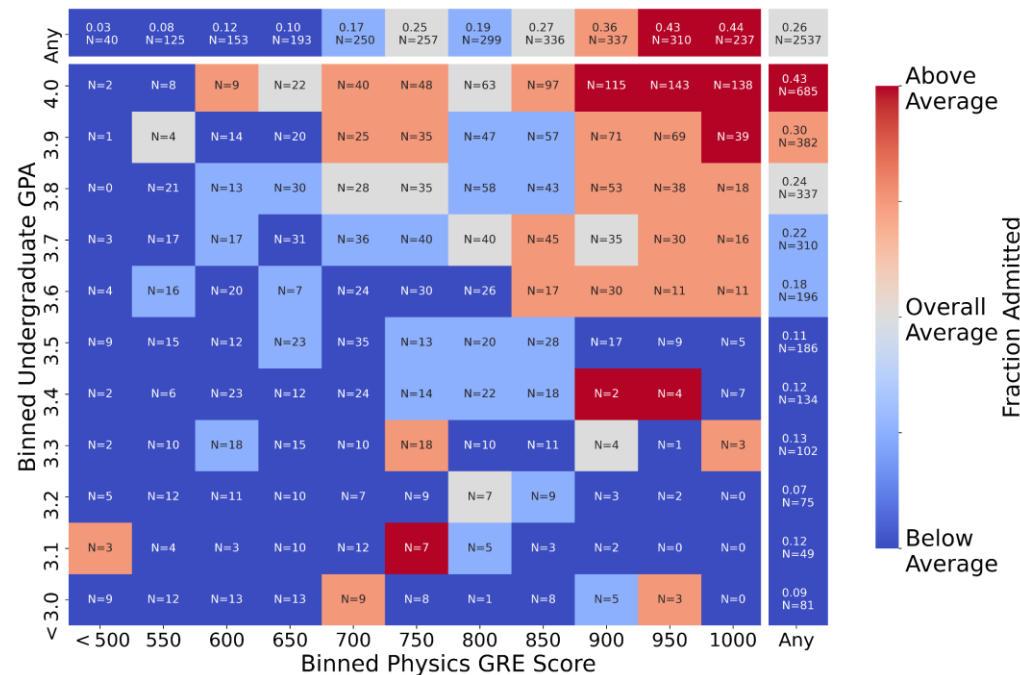
Having a higher pGRE score helps...



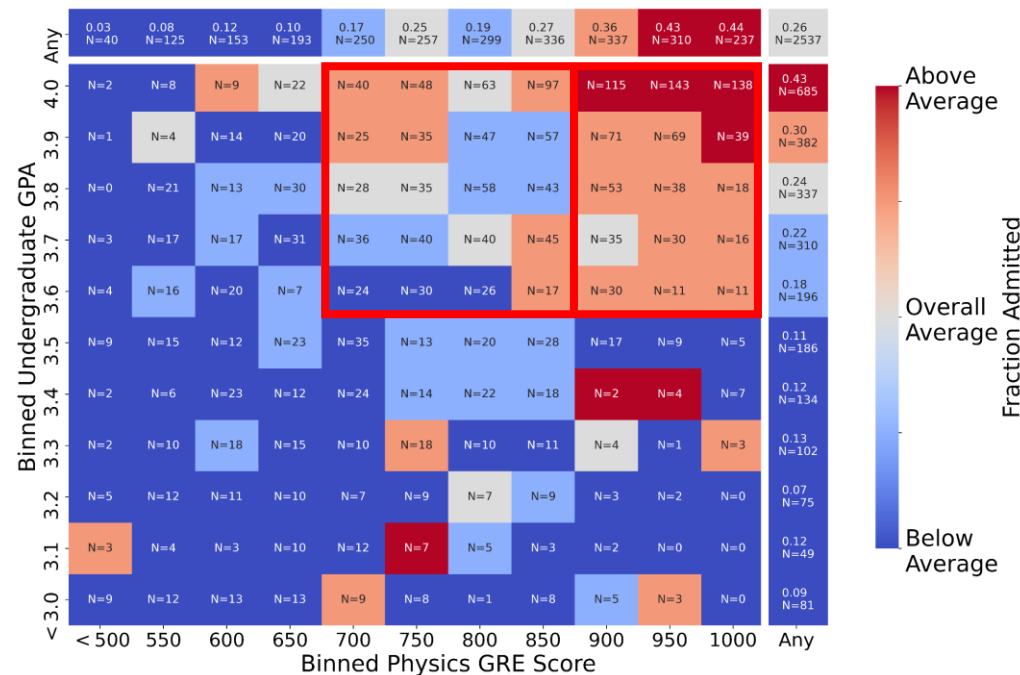
Q: Who needs to stand out?

A: Applicants with a low GPA.

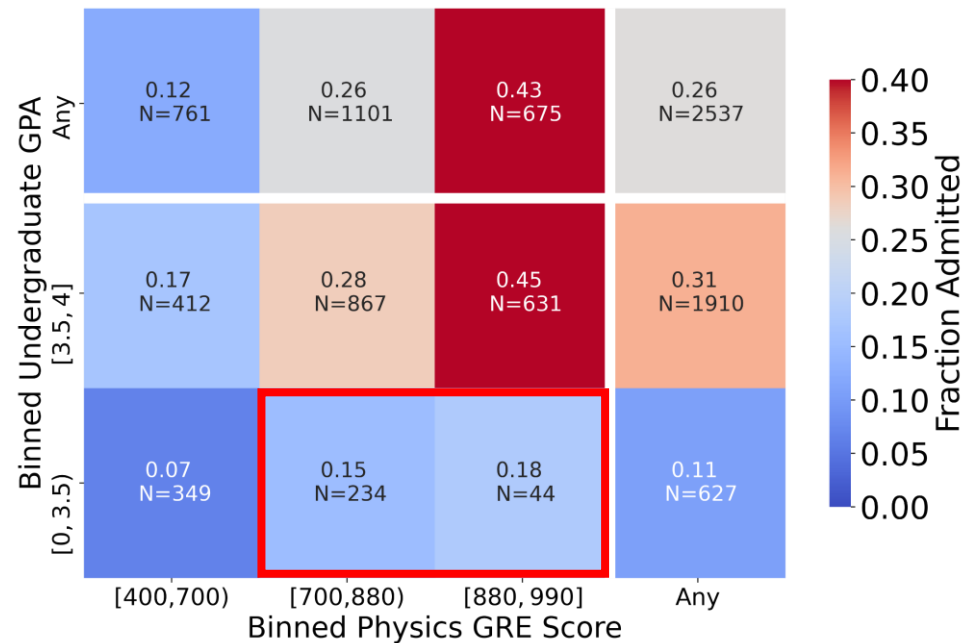
but doesn't help an applicant with a low GPA "stand out."



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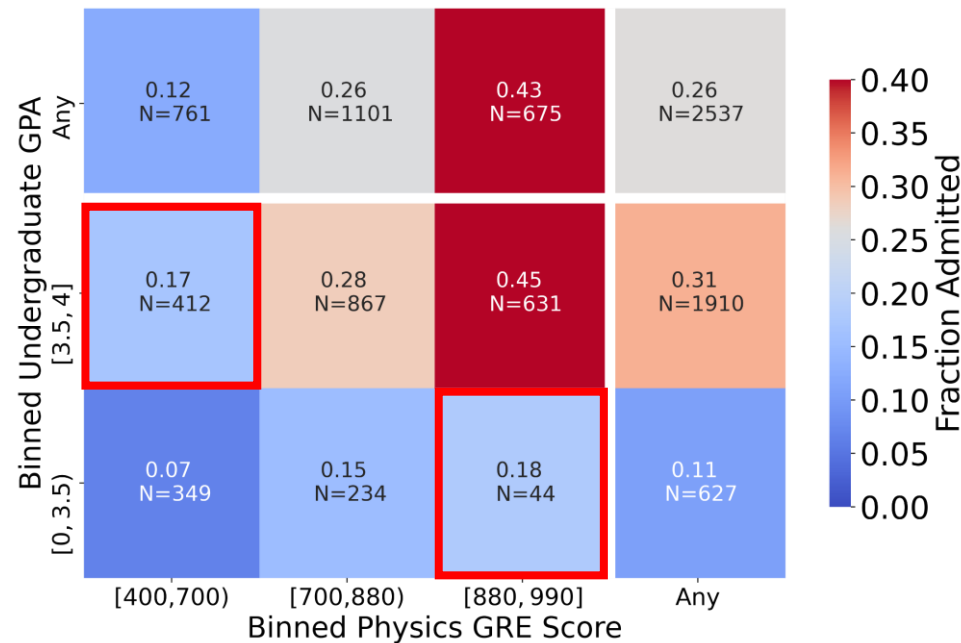
Having a high physics GRE score isn't much better than having an average score.



Miller et al. 2019

← Nicholas Young

Having a high GPA is just as good as a high physics GRE score.



Miller et al. 2019

← Nicholas Young →

Takeaway

In theory, the physics GRE could help applicants stand out.

Takeaway

In theory, the physics GRE could help applicants stand out.

In practice, it does not.

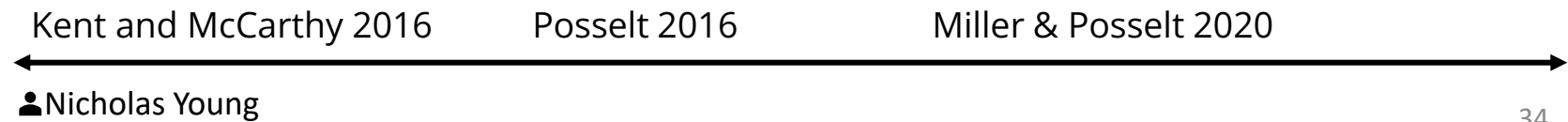
What would it look like to rethink graduate admissions and make it more equitable?

Young et al. 2022



 Nicholas Young

Rubric-based holistic review




Rubric-based holistic review



[Flickr](#), CC-BY-2.0

Miller 201 Barceló et al 2021 Woo et al 2020



 Nicholas Young

Academic Preparation (25%)	Physics Coursework
	Math Coursework
	Other Coursework
	Academic honors and/or recognitions

Non-Cognitive Competencies (25%)	Achievement Orientation
	Conscientiousness
	Initiative
	Persistence

Research (25%)	variety/duration
	quality of work
	technical skills
	dispositions

Fit with program (15%)	research
	faculty
	community
	diversity

GRE Scores (10%)	General GRE
	Physics GRE

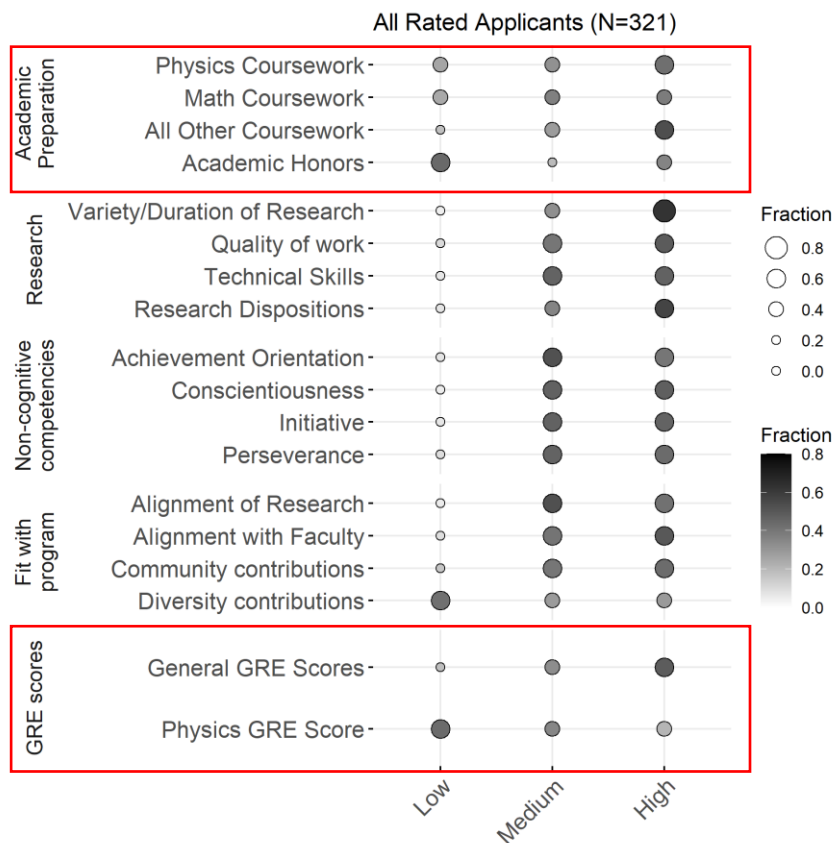
<https://igenetwork.org/>

Academic Preparation (25%)	Physics Coursework	Research (25%)	variety/duration
			quality of work
	Math Coursework		technical skills
	Other Coursework		dispositions
	Academic honors and/or recognitions	Fit with program (15%)	research
Non-Cognitive Competencies (20%)	Resilience/Adaptability		faculty
			community
	Conscientiousness		diversity
	Initiative	GRE Scores (10%)	General GRE
	Persistence		Physics GRE

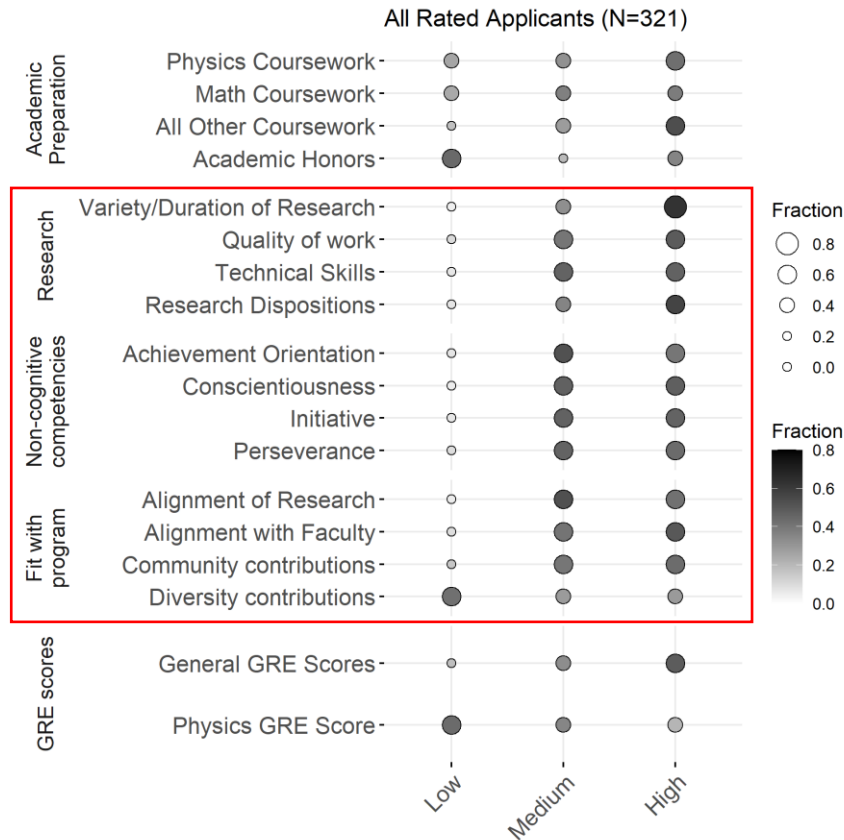
3 years

321 Rated Domestic Applicants

<https://igenetwork.org/>

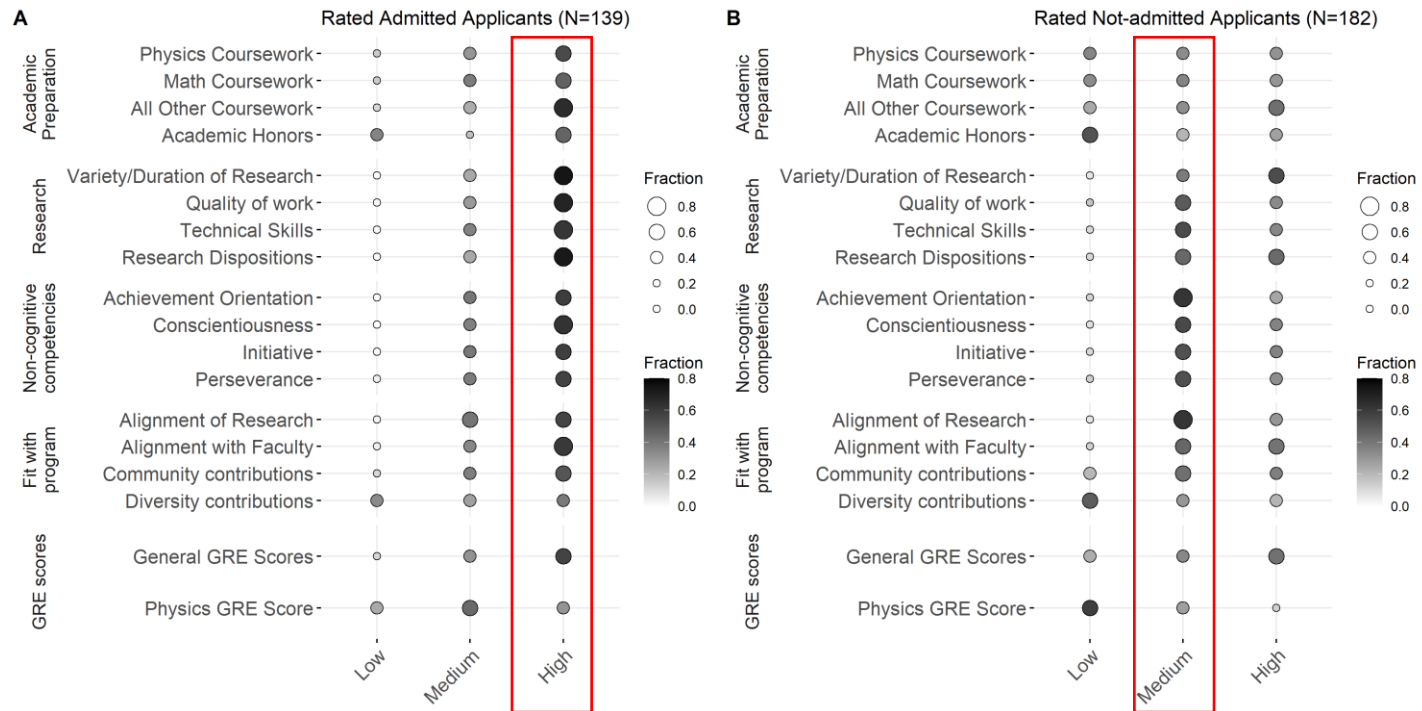


Applicants spread
between the rubric levels



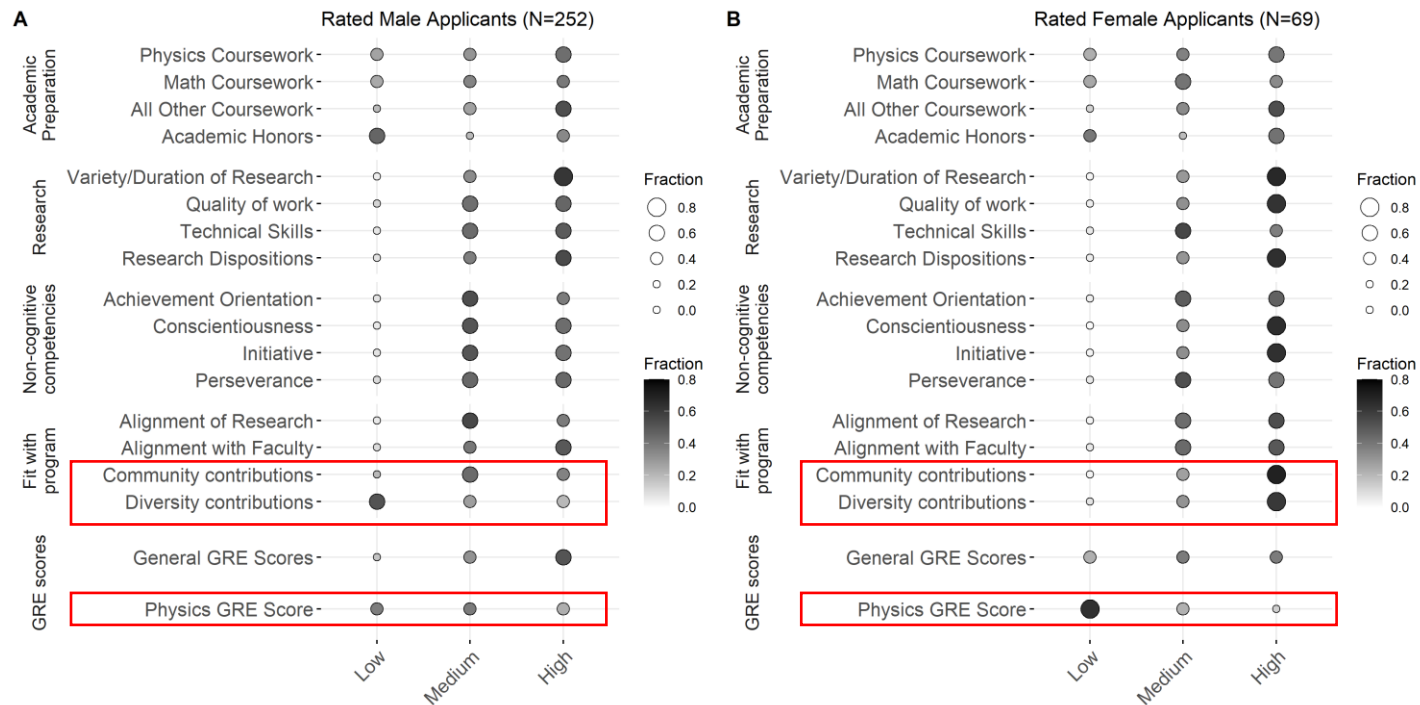
Applicants concentrated in the “medium” and “high” categories

Admitted applicants tend to score “high”... Rejected applicants tend to score “medium”

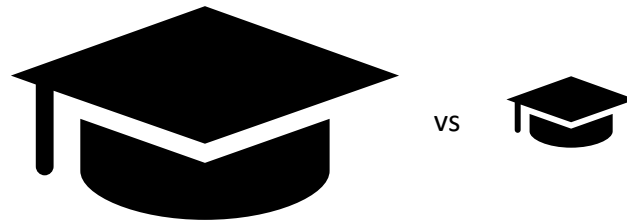


What about equity???

The only differences in ratings between males & females were on physics GRE scores and service/diversity work.



Miller et al. 2019, Guarino & Borden 2017



Test scores are the only consistent difference

Mikkelsen, Young, Caballero 2021

Takeaway

Rubric-based holistic review seems promising for achieving equity in graduate admissions.

But is really a different process?

The evidence suggests that rubric-based holistic admissions is a change from the traditional admissions process...

The evidence suggests that rubric-based holistic admissions is a change from the traditional admissions process...

but there's still some work to do to be confident in that conclusion.

Young et al. 2023



👤 Nicholas Young

Takeaways

- The traditional graduate admissions process in physics is test score and GPA heavy.

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- In practice, the physics GRE does not help applicants stand out.

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- The traditional graduate admissions process in physics is test score and GPA heavy.
- In practice, the physics GRE does not help applicants stand out.
- Rubric-based holistic review seems promising for achieving equity in graduate admissions.

Recommendations

- Discontinue the use of the physics GRE

Owens et al 2020



 Nicholas Young

Recommendations

- Discontinue the use of the physics GRE
- Rethink the admissions process in terms of what applicants are evaluated on, how they are evaluated, and who is doing the evaluating

View the Michigan State Rubric:

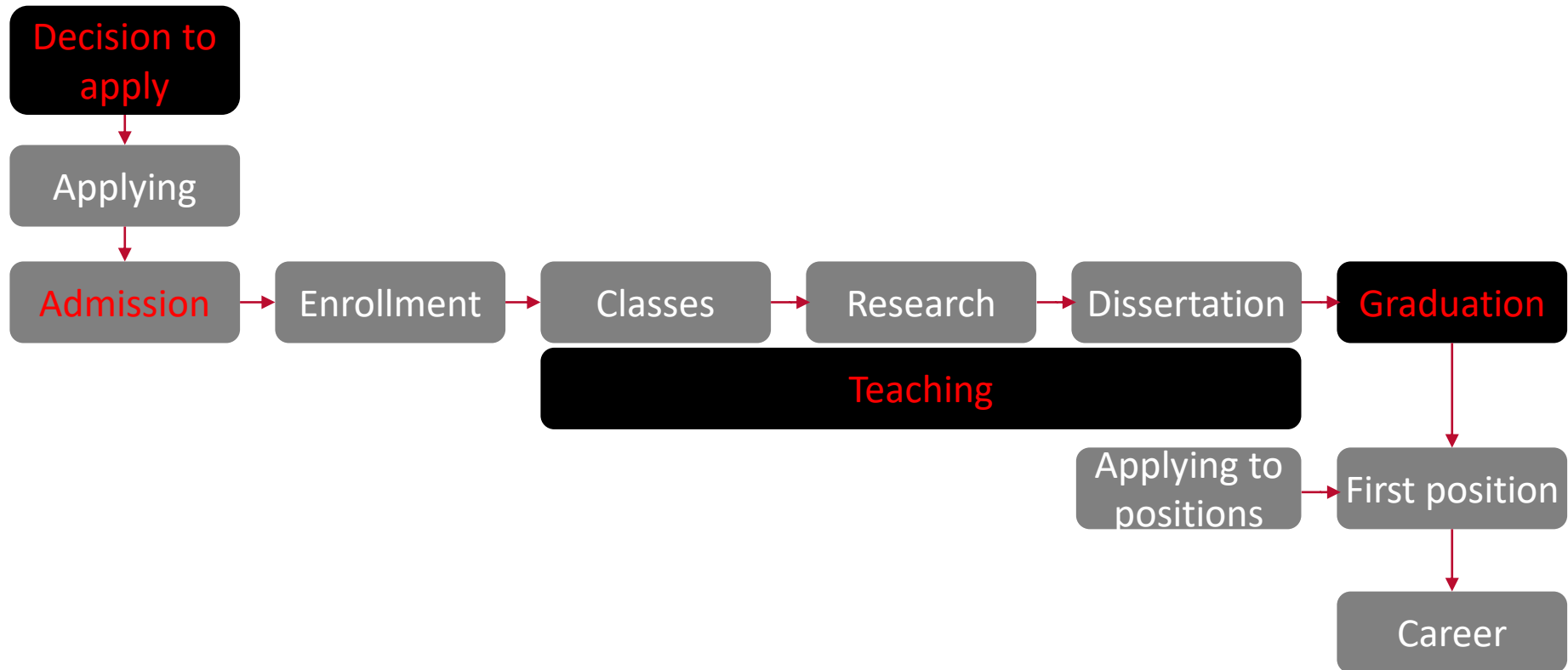
Rubric-based holistic review: A promising route to equitable graduate admissions in physics
(Young et al 2022)

Recommendations

- Discontinue the use of the physics GRE
- Rethink the admissions process in terms of what applicants are evaluated on, how they are evaluated, and who is doing the evaluating
- Engage in self-study and report on what is and is not working

Scherr et al 2017, Rudolph et al 2020

Rough process of graduate education




Decisions where to apply

What type of information is communicated to potential applicants via webpages?



[Browse Programs](#) [Sort Programs By...](#) [The Magazine](#) [Grad School Resources](#) [Advertise](#) [About](#) [Contact us](#)



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Description of your department culture

Our faculty are dedicated to mentorship and personalized guidance and support throughout the program, as well as providing comprehensive and rigorous curriculum, advanced research skills, and specialized knowledge.

RIT is now among the Top 100 of National universities ranked by US News and World Report. We've added to our graduate programs portfolio (including the Physics PhD as well as many others), directed more money to graduate scholarship and have greatly increased experiential learning opportunities for graduate students including research and co-op positions. And we've added to our state-of-the-art facilities.

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Initial Categories (work-in-progress)

- Formal department events/opportunities (e.g. socials, seminars, annual events, student organizations)
- Research opportunities and rankings
- Diversity and inclusion

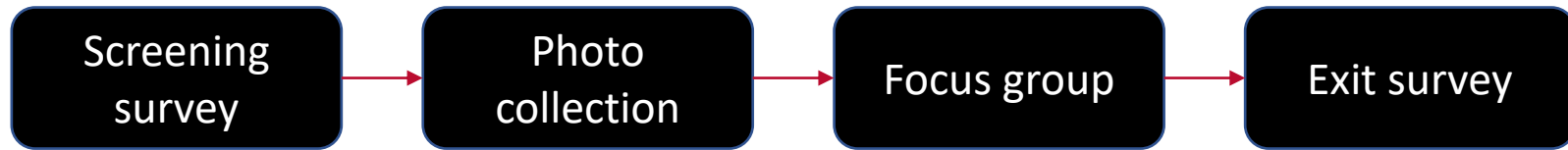
Teaching



Teaching

- What is the range of experiences physics and astronomy graduate students encounter in their role as graduate teaching assistants?

Photovoice methodology



Wang and Burris 1997

← Nicholas Young

Preliminary themes

- Lack of resources
- Externally and internally sources positives experiences
- Chaos
- Uncertainty/stress
- return on investment

Seiden et al *in prep*

Graduation

Graduation

- How does physics graduate school retention vary over previous two decades in the US?
- How does physics graduate school retention vary by type of program?

Estimating Retention

$$\begin{aligned} \# \text{ leaving (last year)} &= \text{total (last year)} \\ &+ \# \text{ first-years (this year)} \\ &- \text{total (this year)} \\ &- \# \text{ graduated (last year)} \end{aligned}$$

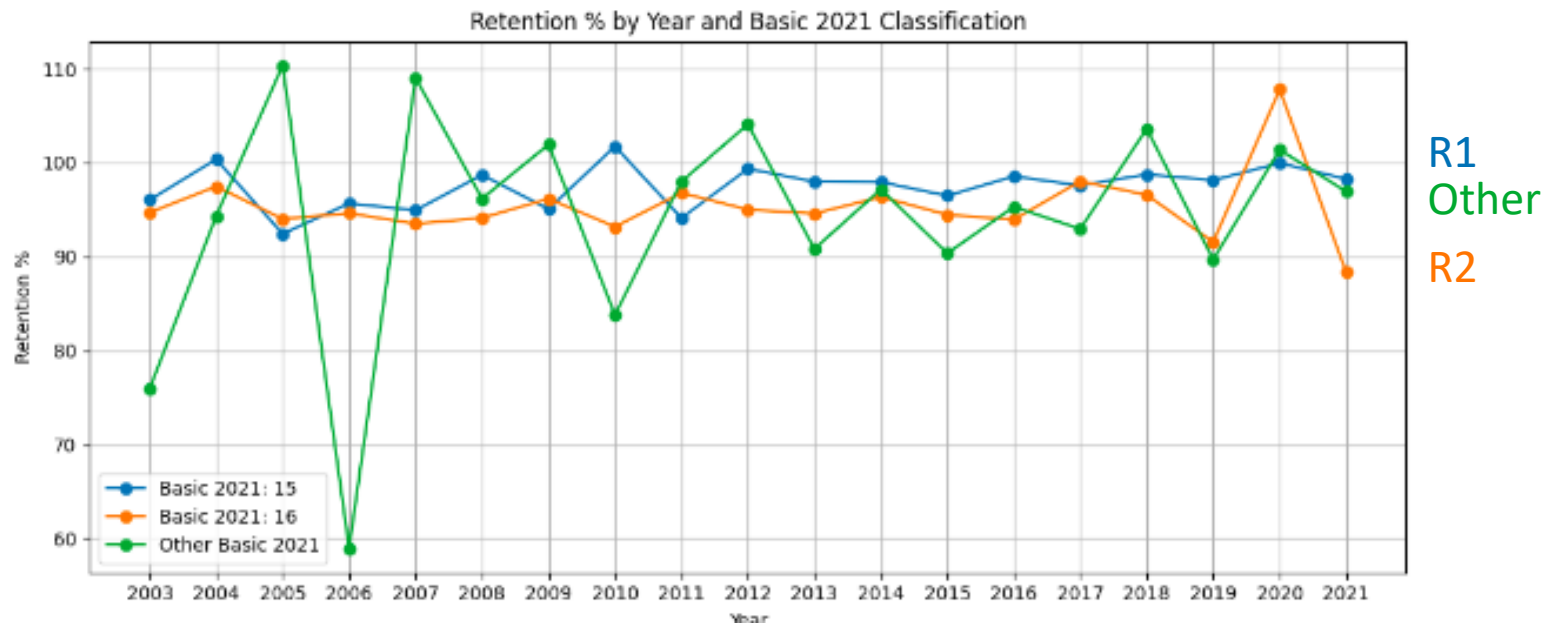
Bridges et al 2024

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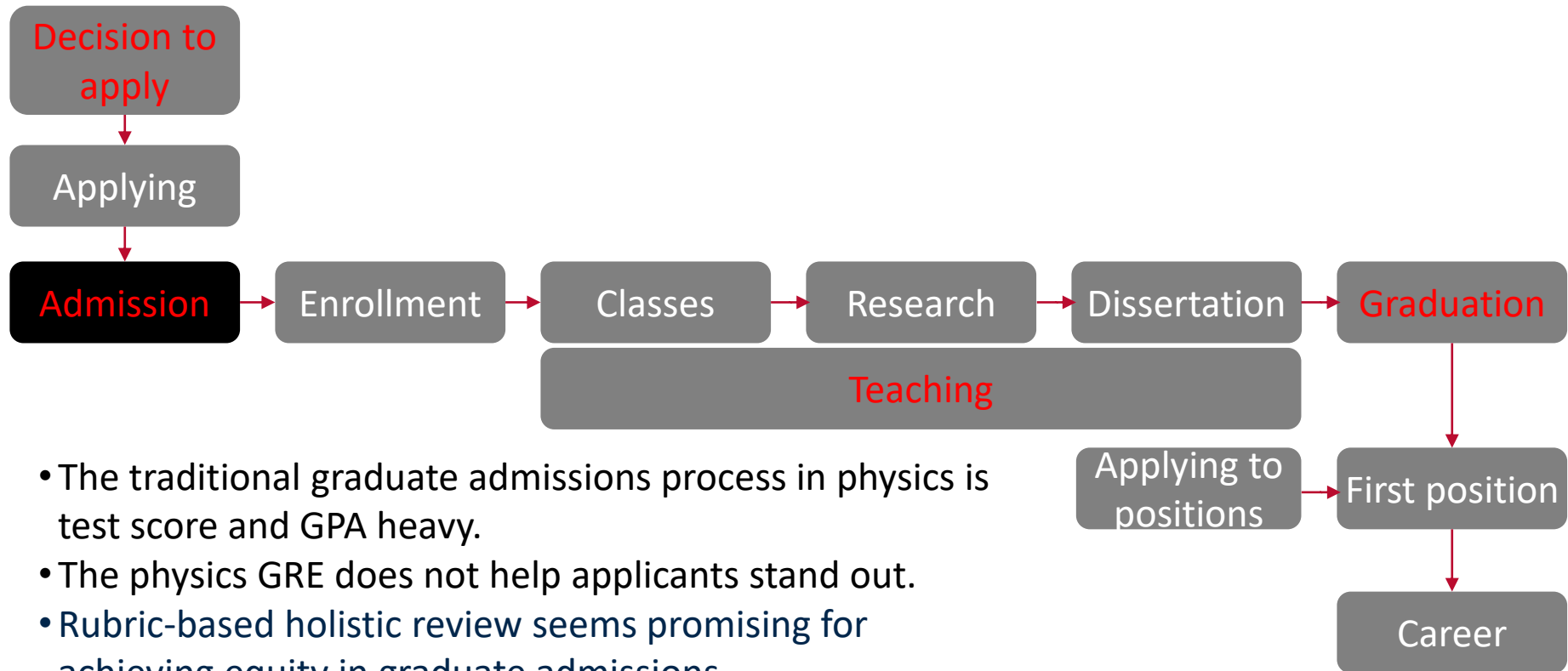
$$\text{Retention fraction} = 1 - \# \text{ leaving} / \text{total}$$

R1 universities have slightly better annual retention rates than R2 universities



Overton PERC poster 2024

Takeaways



- The traditional graduate admissions process in physics is test score and GPA heavy.
- The physics GRE does not help applicants stand out.
- Rubric-based holistic review seems promising for achieving equity in graduate admissions.

Takeaways

Decision to
apply

Applying

Admission

- Departments describe their grad programs in terms of social/professional offerings, research opportunities and rankings, and DEI
- Grad TAs report a range of positive and negative experiences
- Retention rates show differences based on institution type

Enrollment

Classes

Research

Dissertation

Graduation

Teaching

Applying to
positions

First position

Career

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Questions?

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