

# Understanding the graduate school selection process from students' perspectives

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Students interested in graduate school may make application decisions, or choose a graduate school based on socio-economic factors, career interests, and their perceptions about graduate admissions/selection processes. To better understand students' graduate school decision-making, we conducted a Postgraduate Career Intentions Survey as part of the APS Bridge program — a program designed to increase the number of students from the traditionally marginalized ethnic/racial groups who earn physics PhDs. In this paper, we examine the responses to identify the main factors influencing students' graduate school decision making, especially in the case of students from traditionally marginalized race/ethnic groups in physics. Our study provides important information to departments interested in diversifying and improving support for the graduate cohort.

## I. INTRODUCTION

Physics remains one of the least diverse STEM disciplines at the undergraduate level, and with a disproportionate number of undergraduate students from traditionally marginalized race/ethnic groups not going to graduate school in physics, the lack of diversity is even more drastic at the graduate level [1,2]. In the period of 2010-2012, only about 6.4% of PhD's in physics were awarded to students from traditionally marginalized race/ethnic groups in physics— Hispanic Americans, African Americans, and American Indian/Alaskan Native identified students [1]. Nationwide many physics departments aim to improve this condition. Supporting this, research in the areas of graduate education about the admission practices, students recruitment, graduate retention, mentoring, and enculturation is ongoing.

In our prior work on graduate admissions, we surveyed physics departments nationwide to understand admissions practices from faculty perspectives [3,4]. We identified criteria perceived as most important (undergraduate physics/math GPA, recommendation letters) by physics faculty, and further reported that faculty often make admissions decisions by relying on several admission criteria [3]. Graduate Record Examination (GRE) scores are one such highly valued admission criteria, which has been shown to have serious negative impacts on the race/ethnicity diversity in admissions as it filters many aspiring graduates, including those from traditionally under-represented groups at the entry-level [5]. Nonetheless, we identified a significant fraction (more than one in three) of departments to be using GRE scores as a cutoff in admissions.

Moreover, we examined how (and if) race/ethnicity are accounted for in admissions processes, with many

departments reporting that it is not a consideration at all. One theme in this work was the reported dearth of students from traditionally marginalized racial/ethnic groups in application pools. Thus, we are failing to bring many students 'in the door' (not that our responsibilities as educators end there!). Furthermore, retention of graduate students, including those from traditionally marginalized racial/ethnic groups in physics is another universal issue [6]. The APS Bridge Program is vested in understanding practices that facilitate graduate students' successful enculturation in their departments such that students persist, graduate, and contribute to the physics community [7].

Overall, we take the position that the problem of low graduate diversity should be addressed from multiple dimensions and perspectives. A critical perspective is that of students applying to graduate programs or (are considering it); their decisions have direct impacts on graduate diversity. Understanding graduate diversity is incomplete without a primary understanding of students' interests and perceived barriers to graduate school. With this in mind, we deployed a survey — the Post Graduate Career Intentions (PGCI) to physics majors to gather information on students' perceptions about graduate education and admissions.

## II. RESEARCH QUESTIONS

In this paper, we focus on survey responses about graduate school selection processes [Q11] to understand the main factors influencing students in their graduate school selection/application. For this purpose, we select only those PGCI respondents that exhibited interests in applying to graduate school (n=802). Further, we narrow our focus on students who self-identify as Hispanic Americans, African Americans, and/or American Indian/Alaskan Native race/ethnic groups; and compare their collective responses

with the group who did not identify with one of these race/ethnicities. The research questions of this study are

- What are the main factors influencing students' graduate school decision making?
- How do traditionally marginalized race/ethnic groups weigh the importance of graduate school decision criteria in comparison to non-marginalized groups?

### III. SURVEY DEPLOYMENT AND DATA COLLECTION

The PGCi survey involves 27 multi-part questions. The initial version was developed by the authors in summer 2016. The APS Bridge Program team and faculty/colleagues at the STEM Transformation Institute, FIU provided a continuous feedback, and it was incorporated in the pilot version.

The construct and content validity tests of the pilot survey were assessed by testing on 14 undergraduate physics majors at FIU. Students' feedback was collected through a focus group meeting, and suggestions were incorporated to develop the final survey.

The final survey was made available online on the APS website, accessible via a secure link. We deployed the survey in conjunction with the American Institute of Physics (AIP) annual data collection of upper-division physics majors. Students responding to the short AIP survey were asked to subsequently take the PGCi survey from December 2016 until February 2017. Regular email reminders were sent to non-respondents to increase survey participation rate.

A total of 1031 students responded to the PGCi. The response rate is approximately 14% (calculated from the initial list of 7000 email addresses available to AIP, though it is not possible pre-check the validity of all these addresses, so the "true" response rate is somewhat higher). A total of 12% of respondents self-identified as Hispanic, Latino, or Spanish origin, and 4% identified as Black or African American race/ethnicity (note that respondents were able to identify any and all of their racial/ethnic identities, so these groups are not mutually exclusive).

Furthermore, in our data, approximately 79% (n=816 of 1031 respondents) exhibited some level of interest in applying to graduate school. Within this sample, 802 were identified as juniors and seniors; and were chosen for the analysis reported in this paper.

Within this sample of interest, the proportion of students from historically marginalized race/ethnic groups is approximately 17% (N=137).

### IV. DATA ANALYSIS

We analyzed students' responses to a question [Q11] ranking 13 factors on their importance to choosing which school to apply to. These factors are:

- a. University/program reputation or competitiveness
- b. Availability of research opportunities that I'm interested in
- c. Availability/Amount of assistantships or scholarships
- d. Cost of living
- e. Not requiring physics GRE scores or not having a minimum score
- f. Location of university
- g. Recommendation from family or friends
- h. Recommendation from professors or teachers
- i. The university holds an open house/campus invitation for prospective students
- j. Having peers who are the same gender as myself
- k. Having peers who are the same race/ethnicity as myself
- l. Having a Ph.D. advisor of the same gender as myself
- m. Having a Ph.D. advisor of the same race/ethnicity as myself

Each factor was ranked separately on a Likert scale of 0 to 4. The analysis was performed using R [8]. Mean and associated standard errors for each factor was calculated for historically marginalized racial/ethnic groups (combining students who identified as Hispanic, Latino, or Spanish origin, Black or African American, or Native Americans or Alaskan Native), and for non-marginalized racial/ethnic groups (Asian, White, Middle Eastern or North African, Native Hawaiian or Other Pacific Islander, and Other race(s)/ethnicities not listed). Non-respondents to the race/ethnicity question were eliminated from this study. An overall missing-ness for this survey question was recorded as less than 2%.

The mean response along with associated standard error of each factor (listed above) for both the groups are summarized in Figure 1. The mean response for all questions for traditionally marginalized and non-marginalized racial/ethnic groups are  $1.68 \pm 0.10$  and  $1.38 \pm 0.04$ , respectively. The two top most important factors for both groups are identical, and are shown in Table I.

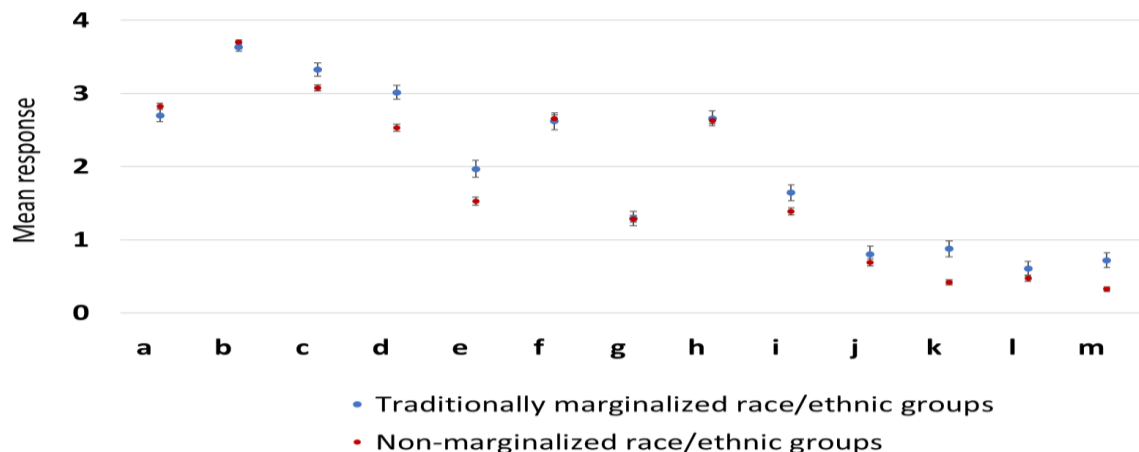


Figure 1 Mean importance assigned to each factor in graduate school application process

TABLE I. Mean and standard error of the top 2 important criteria for the graduate school selection process

Factors important in choosing a graduate school for application	Mean $\pm$ standard error	
	Historically marginalized racial/ethnic groups in physics (N=137)	Non-marginalized racial/ethnic groups in physics (N=665)
Availability of research opportunity that I am interested in	3.64 $\pm$ 0.06	3.70 $\pm$ 0.03
Availability/Amount of scholarships or assistantships	3.33 $\pm$ 0.09***	3.08 $\pm$ 0.04

We also performed Wilcoxon Rank-sum tests between groups for each factor to look at the relative importance placed on each factor. A total of 5 out of 13 factors were determined as statistically significantly different (at the  $p < 0.001$  level). Moreover, the mean response of the traditionally marginalized racial/ethnic group is higher than the non-marginalized group in every case as shown in Table II.

The differences in mean provide some insights about which factors most influence students' graduate school choices.

TABLE II. Mean response and standard error of factors significantly different between the groups

Factors with a significant difference of $<0.001$ (indicated as ***).	Mean $\pm$ standard error	
	Historically marginalized racial/ethnic groups in physics (N=137)	Non-marginalized racial/ethnic groups in physics (N=665)
Availability/amount of assistantships or scholarships	3.33 $\pm$ 0.09***	3.08 $\pm$ 0.04
Cost of living	3.02 $\pm$ 0.10***	2.53 $\pm$ 0.05
Not requiring physics GRE scores or not having a minimum score	1.97 $\pm$ 0.12***	1.52 $\pm$ 0.06
Having peers who are the same race or ethnicity as myself	0.88 $\pm$ 0.11***	0.42 $\pm$ 0.04
Having a PhD advisor of the same race or ethnicity as myself	0.72 $\pm$ 0.10***	0.33 $\pm$ 0.03

## V. DISCUSSIONS

The most important factor in the graduate school selection is the availability of research opportunities as shown in Figure 1. This is not surprising considering students indicating a willingness to invest significant time, effort, and energy in graduate school may be expected to prioritize research opportunities during applications.

The second-most important factor is the availability or amount of scholarships or assistantships. Also, traditionally marginalized racial/ethnic groups rate this factor higher than non-marginalized students. This indicates the importance of making research/teaching assistantships available (and messaging this to students) so that for potential students, the financing of graduate education will not constrain their application decisions. The higher importance placed on “cost of living” by the traditionally marginalized students echoes this. Prior studies about the barriers to graduate school have indicated how financial concerns may discourage students from traditionally marginalized groups from applying to graduate school [9].

Although given lower importance overall, the factors (k) and (m) were rated significantly higher by traditionally marginalized racial/ethnic groups in our data, suggesting that efforts to improve diversity in the faculty ranks and in the graduate pool itself can have a multiplicative effect on future diversity. Prior studies have also shown a direct and positive impact of having peers and faculty of same race/ethnicity on the students’ adjustment to the newer academic environments and their academic achievements [10]. The physics departments would be well-advised to make efforts to increase the diversity in the faculty ranks.

## VI. CONCLUSIONS AND FUTURE IMPLICATIONS

The PGCI is the first-ever dedicated national survey on physics students’ perceptions of graduate admissions. The focus of this paper is on identifying the factors most influential on students’ graduate application decisions, particularly the factors that may differently impact traditionally marginalized students.

The availability of interesting research opportunities is of prime importance for students. Departments should make such information distinctly visible and accessible to potential applicants at every possible venue; for instance, informational websites could be directed to pages summarizing the various research opportunities at departments. Opportunities could also be articulated clearly through other recruiting venues (such as undergraduate research conferences).

The high importance placed on the availability of scholarships or assistantships should further inform faculty about admissions related mentoring. Undergraduate faculty can guide potential applicants by clearly explaining the graduate funding structure, and expectations, and even introduce possible avenues for departmental and external scholarships/assistantships (such as NSF Graduate Research Fellowships) especially to students from

traditionally marginalized groups. Given our finding, it appears likely that aspiring applicants from lower socio-economic backgrounds may choose not to even apply to graduate school in the absence of such information. The differential importance placed upon having peers and PhD advisors of same/race ethnicity amongst traditionally marginalized racial/ethnic groups suggests that greater diversity at the faculty level will serve to attract more students from traditionally marginalized racial/ethnic groups to graduate education.

## VII. ACKNOWLEDGEMENT

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