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DOES IT MATTER WHERE I GO TO COLLEGE? EFFECTS OF PHYSICS DEPARTMENTS ON STUDENT OUTCOMES

HIGHLIGHTS

- Does the type of department make any difference in the post-graduation lives of physics bachelors? This report compares outcomes for physics bachelors from large and small departments, defined by number of bachelor's degrees awarded. It also looks at differences in physics bachelors' outcomes between departments that grant PhDs in physics and those that award only a bachelor's degree in physics.
- Physics bachelors from large departments are more likely to attend graduate or professional school with the intention of earning a degree in any field than physics bachelors from smaller departments (**Figure 3**).
- Graduates of large departments rate their physics and math preparation for a career more highly than graduates of smaller departments (**Figure 4**). Graduates from departments that offer only bachelor's degrees in physics rate their career communication and teamwork preparation more highly than graduates of departments that offer PhDs in physics (**Figure 5**).
- Physics bachelors are more satisfied with the department climate when they graduate from departments that do not offer graduate degrees in physics (**Figure 6**).
- Many very important outcomes are *not* affected by size and type of department, including salary, working in a science or technology job, and length of time spent looking for work (**Table 1**).
- Physics departments whose bachelors were very satisfied with the department's climate in the early 1990s had higher numbers of graduates per FTE faculty member in the mid- to late-1990s (**Figure 7**). This occurred in spite of the overall decline in the number of physics bachelors during the 1990s.

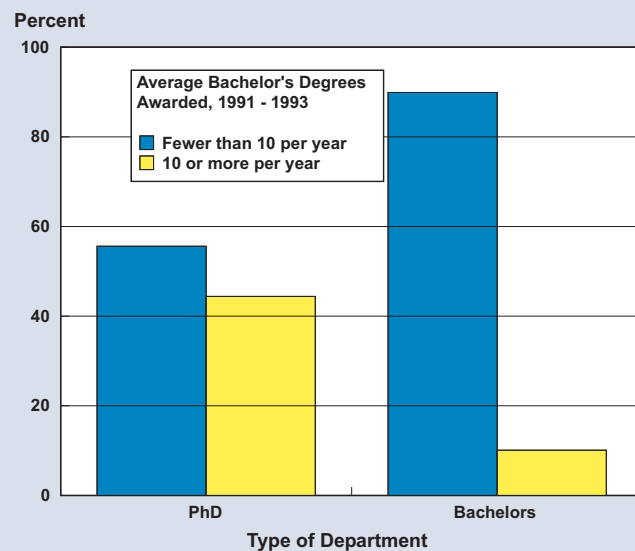
The decision about which college to attend can be daunting. College bound high school students may pore over catalogs, make visits to multiple campuses, and negotiate the intricacies of financial aid. There are a variety of choices, and the most basic of choices involves what type of school to attend. Should it be a well-funded research university with faculty members who have done respected research in their fields? Or would the smaller, more personal interaction characteristic of a liberal arts college be preferable? In the end, at graduation, will it make any difference to employers or to graduate schools?

This report attempts to answer these questions for physics majors. In 1998-99, the Statistical Research Center of the American Institute of Physics collected data from approximately 1200 people who received bachelor's degrees in physics between 1991-93. The graduates completed a sixteen-page questionnaire on which they recorded their career and educational histories and evaluated their undergraduate educational experiences. We chose the potential respondents by randomly selecting approximately 150 physics departments from the population of all degree-granting physics departments in the US. The list was stratified by size and type of department. Selected departments were contacted and asked to provide us with a list of all their bachelor's degree recipients between 1991-93. We had about 2400 potential respondents whose mail was not returned to us by the post office. Of these, about 1200 physics graduates from 131 departments replied to a lengthy questionnaire. We wish to thank each department that provided us with names and addresses of their graduates. Our thanks also go to each of the graduates who responded. Without their efforts, this study would not have been possible.

This report is the third in a series based on the data collected from the respondents. The first report addressed the situation of those respondents who did not obtain additional degrees after their physics bachelor's degrees (Ivie and Stowe, 2002). The second report covered the career and educational experiences of physics bachelors who went on to obtain master's degrees in a variety of fields (Ivie and Stowe, 2003).

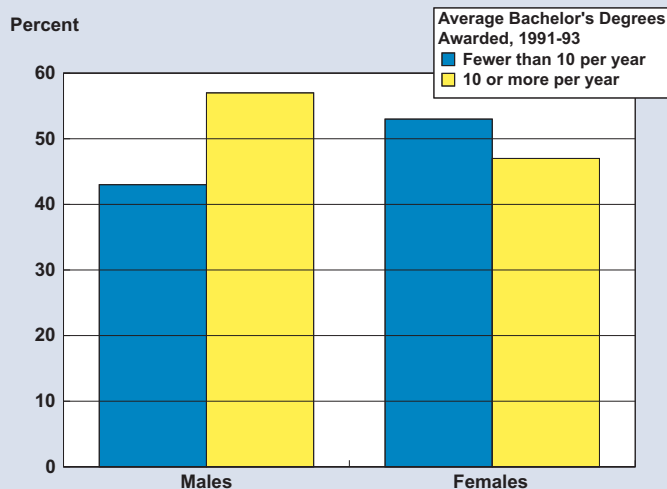
In this report, we group physics departments into broad categories to try to determine if the type of department makes any difference in the post-graduation experiences of physics bachelors. We discuss the differences between departments that only grant bachelor's degrees in physics and departments that grant PhDs in physics. We also discuss the effects of the number of bachelor's degree recipients. Do those from smaller programs evaluate their undergraduate experiences differently than those from larger programs? Do physics bachelors from bigger schools or from well-known research departments have any edge in the job market? Finally, we discuss how departmental efforts to improve the climate for undergraduates affect number of graduates. Do departments that are more student-centered have more graduates than those that are less student-centered?

Figure 1. Average Number of Physics Bachelor's Degrees Awarded, 1991 - 1993, by Type of Department



Source: American Institute of Physics, Statistical Research Center: 1998-99 Bachelors Plus Five Study and 1991-93 Enrollments and Degrees Report. Data are significant at $\alpha \leq .05$.

Figure 2: Males and Females Receiving Physics Degrees from Large and Small Departments



Source: American Institute of Physics, Statistical Research Center: 1998-99 *Bachelors Plus Five Study* and 1991-93 *Enrollments and Degrees Report*. Data are significant at $\alpha \leq .05$.

RELATIONSHIP BETWEEN TYPE OF DEPARTMENT AND NUMBER OF STUDENTS

In general, departments that grant PhDs in physics also produce larger numbers of bachelor's degree recipients. Departments that do not grant graduate degrees tend to be smaller, although many PhD departments also have a small number of students. In this study, there are respondents from 79 departments that grant bachelor's degrees as their highest physics degree, and from 36 departments that grant PhDs in physics. As shown in **Figure 1**, only 10% of bachelors departments represented in this study averaged more than 10 bachelor's degrees per year in 1991-93. In contrast, 44% of departments that grant PhDs averaged more than 10 bachelor's degrees per year during this time period.

In the following charts, we distinguish between outcomes that are affected by type of department (departments that grant only bachelor's degrees compared to those that grant PhDs) and outcomes that are affected by size of department (average number of

bachelor's degrees awarded annually). We distinguish between departments that averaged ten or more physics bachelors per year during 1991-93, and those that averaged fewer than ten. Although the results are not given in this report, we use both variables (type and size) in multivariate models to determine if department size affects the outcome independent of any effects of type of department. So when we report that an outcome is affected by type of department, the effect occurs even controlling for number of graduates from that department, and vice versa.

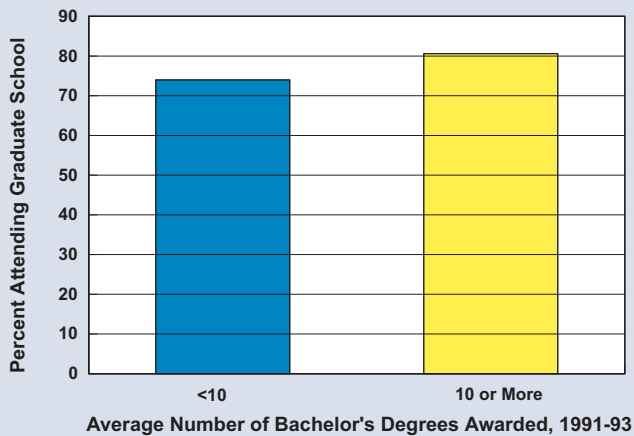
There is a gender difference in the types of institution physics bachelors attended. We find that women are more likely to have degrees from smaller physics departments (averaging fewer than ten bachelor's degrees per year from 1991-93) than men, who are more likely to graduate from larger departments (**Figure 2**). We do not have the data that would tell us, however, whether the smaller departments have higher retention rates for women, or if women are more likely to select smaller colleges before enrolling as freshmen. We do know that among the physics departments that have the highest percentages of female graduates, most are at smaller colleges and universities (Ivie and Stowe, 2000).

LIKELIHOOD OF ATTENDING GRADUATE OR PROFESSIONAL SCHOOL

Attending graduate or professional school is a common path for physics bachelors. In this study, only one-third of physics bachelors had not received any additional degrees five to eight years after attaining their bachelor's degrees. Even among physics bachelors with no additional degrees, most of them attended graduate or professional school but left without earning a degree (Ivie and Stowe, 2002).

The decision to attend graduate or professional school is a complex one and is affected by many factors, ranging from the job market to some very personal considerations. We find for this group that attending graduate or professional school with the intention of earning a degree is also affected by the size of the undergraduate program. Respondents who attended

Figure 3. Percent of Physics Bachelors Attending Graduate/Professional School, by Undergraduate Department Size



Source: American Institute of Physics, Statistical Research Center: *1998-99 Bachelors Plus Five Study* and *1991-93 Enrollments and Degrees Report*. Data are significant at $\alpha \leq .05$.

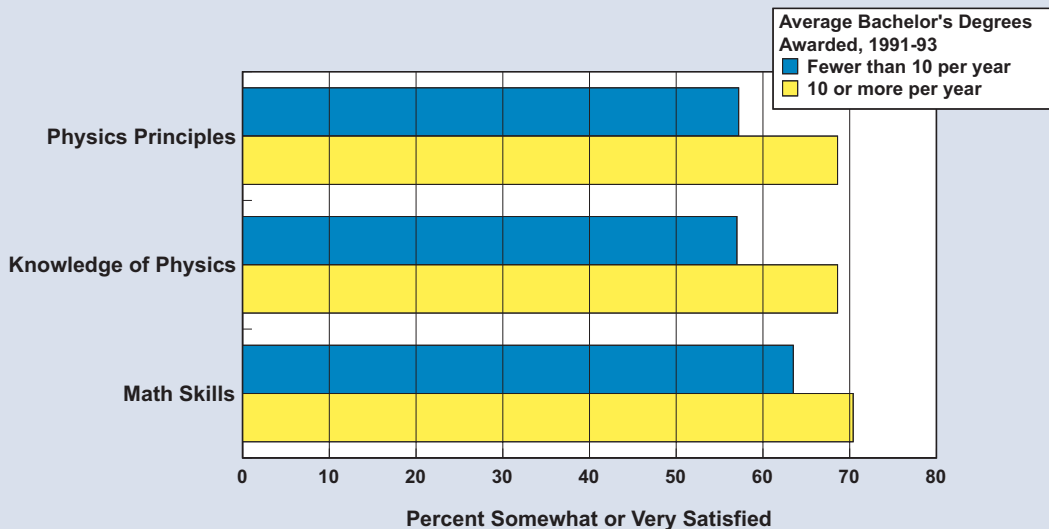
departments that averaged more than ten bachelor's degrees per year between 1991-93 are more likely to attend graduate or professional school than

respondents who attended smaller schools (**Figure 3**). Whether or not the department grants graduate degrees has no effect on the likelihood that their physics bachelors will attend graduate or professional school.

PREPARATION FOR A CAREER

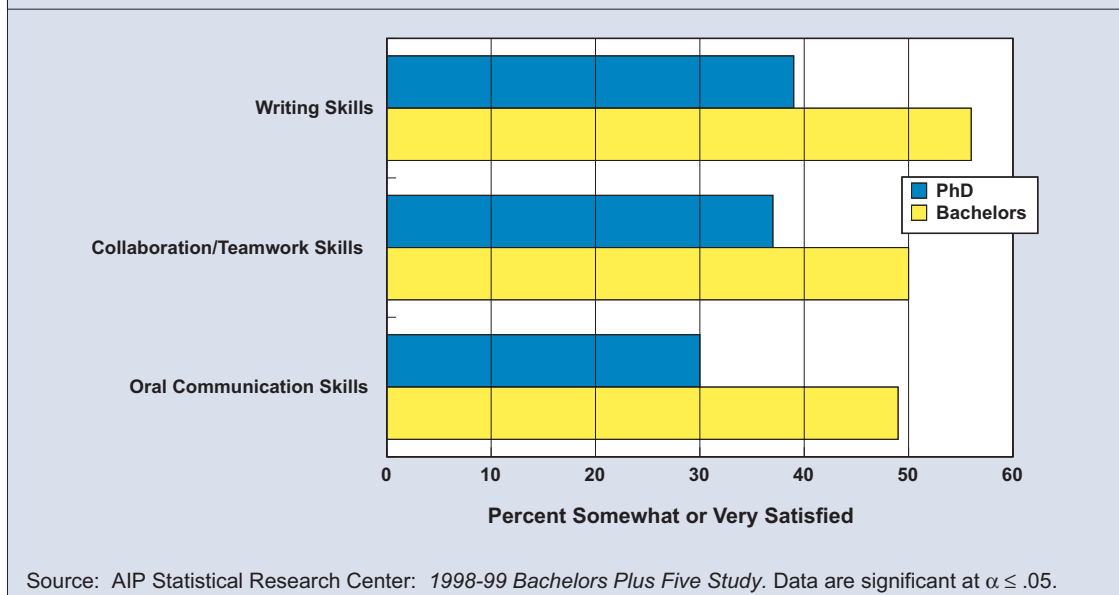
Although many physics bachelors attend graduate school, almost all eventually enter the workplace. Their experiences as undergraduates form the foundation for the careers they will eventually enter. We asked respondents to rate how well their physics undergraduate education prepared them for their careers. Most are positive, reporting that they had received very good preparation for a career. We find that some aspects of physics bachelors' satisfaction with their undergraduate preparation for a career depend on the size of the undergraduate program they attended. Other aspects depend on whether they attended a program that offers PhDs. Specifically, physics bachelors who attended larger departments rate their physics and math preparation more highly than those who attended smaller departments (**Figure 4**). Physics bachelors who attended departments that averaged ten or more physics bachelors per year during 1991-93 rate their preparation in the areas of

Figure 4. Percent Respondents Indicating High Satisfaction with Undergraduate Career Preparation, by 1991-93 Average Number of Bachelor's Degrees Awarded in their Department



Source: American Institute of Physics, Statistical Research Center: *1998-99 Bachelors Plus Five Study* and *1991-93 Enrollments and Degrees Report*. Data are significant at $\alpha \leq .05$ in multivariate models.

Figure 5. Percent Respondents Indicating High Satisfaction with Undergraduate Career Preparation, by Department Type



physics principles, knowledge of physics, and math skills more highly than students who attended smaller programs. This difference holds regardless of whether their departments offer graduate degrees in physics. Students from large departments, including those large departments that do not offer graduate degrees in physics, rate their physics and math preparation more highly.

Other aspects of satisfaction with undergraduate preparation for a career depend on whether or not physics bachelors attended a department that offers graduate degrees in physics. In this case, physics bachelors who attended departments that do *not* offer graduate degrees are more satisfied with their career preparation in terms of writing skills, oral communication skills, and collaboration/teamwork skills (**Figure 5**). And this difference is true regardless of the size of the department. Students from large and small departments that do not offer graduate degrees felt better about their writing, speaking, and teamwork preparation than students who attended departments that grant PhDs in physics.

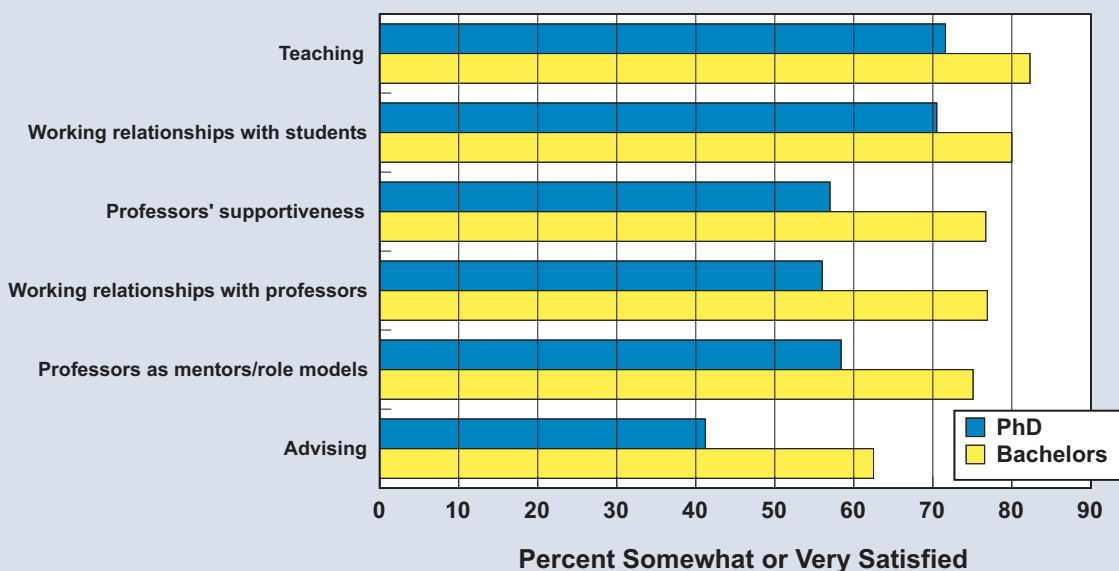
While the importance of physics and math skills on the job varies with the field of employment (Ivie and

Stowe 2002), almost all respondents say that collaborative skills and teamwork are extremely important on the job, regardless of their fields of employment (Ivie and Stowe 2002, 2003). And physics bachelors report that skills such as teamwork, collaboration, and communication are taught to their greater satisfaction by departments and universities whose focus is not on graduate education.

DEPARTMENT CLIMATE

The department's climate for undergraduates can be essential in attracting and retaining physics majors. A supportive climate can mean more students and more majors. A department's climate consists of many different factors, ranging from supportiveness of professors to interactions with other students. We asked physics bachelors to rate various aspects of the climates in their physics departments. These aspects included curriculum, teaching, professors as mentors or role models, advising, supportiveness of professors, working relationships with professors, and working relationships with other students. We find that physics bachelors who graduated from departments that do not offer graduate degrees rate the climate in their departments more favorably than those who graduated

Figure 6. Percent Respondents Indicating High Satisfaction with Facets of Undergraduate Education, by Department Type



Source: AIP Statistical Research Center: 1998-99 Bachelors Plus Five Study. Data are significant at $\alpha \leq .05$.

from departments that offer PhDs (Figure 6). This is true even at large departments that grant only undergraduate degrees. Satisfaction with department climate is not affected by size of department.

Although graduates from bachelors-granting departments are more satisfied, graduates from PhD-granting departments are still satisfied with the climates in their departments. For example, more than 70% of the bachelors from PhD-granting departments report that they are either very or somewhat satisfied with the teaching in the department. At bachelors-granting departments, satisfaction with teaching is over 80%.

The item with which students are least satisfied is advising, but we did not collect data that would enable us to say how the respondents felt their advising could be improved. We also asked about satisfaction with the curriculum. More than 80% of physics bachelors are satisfied with the curriculum in their departments, but there are no significant differences between PhD and bachelors-granting departments.

Table 1. Things That Are Not Affected by Type of Department or Size of Department

- Whether or not physics bachelors held a career path job
- Whether or not physics bachelors work in a STEM job
- Number of interviews for a first career path job
- Length of time spent looking for a first career path job
- Number of offers for a first career path job
- Perception that physics degree helped them get a first career path job
- Number of university resources used to find a first career path job
- Salary, when controlling for type of job, degree, years of experience, gender, and hiring bachelor's level employees

1998-99 Bachelors Plus Five Study

OUTCOMES THAT ARE NOT AFFECTED BY DEPARTMENT SIZE AND TYPE

Although type and size of department do affect whether or not students attend graduate school, how they rate their preparation for a career, and how they rate their department's climate, there are many things that are not affected by size and type of the department. These outcomes, reported in **Table 1**, are perhaps even more important to students than those that are affected by department size and type. Most notably, type and size of department do not affect whether or not physics bachelors get a career path job, which we defined as "a job that will help you in your future career or a job in the field in which you want to make your career." 88% of all those who are not currently students have held a career path job, and this is not related to type or size of department. Type and size of department also make no difference in whether or not physics bachelors' current jobs are in a STEM field (science, technology, engineering or math). In addition, type and size of department make no difference in number of job interviews, number of job offers, length of time spent looking for a job, number of university resources used to get a job, and perception that having a physics degree helped them get a job. Most importantly, type and size of department make no difference in the salaries earned by physics bachelors five to eight years after earning their degrees.

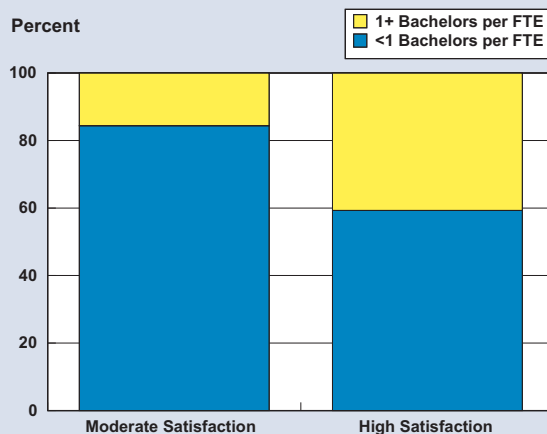
EFFECT OF STUDENT SATISFACTION ON DEGREES AWARDED

We developed a measure of satisfaction with departments' climates that includes all of the measures mentioned in the "Department Climate" section except satisfaction with the curriculum. First, we started with the 74 departments that have more than five respondents to this survey. We took each of these departments' averages on six measures of student satisfaction: teaching, professors as mentors/role models, advising, supportiveness of professors, and working relationships with both professors and other students. For each department, we then took the average of these six scores as our measure of student satisfaction with the overall climate. Thirty-six

percent of the departments have students who were highly satisfied (a score of 4 or higher on a five-point scale). About 60% have students who were "moderately satisfied" with the climate (scores of 3-3.99), and only two departments have average satisfaction scores of below three. Overall, these 74 departments tended to produce physics bachelors who were reasonably satisfied with the climate.

Because of the unique nature of our data, we were able to take these satisfaction scores from 1991-93 graduates and use them to predict how successful departments were at graduating physics bachelors *after* the early 1990s. We defined "successful" as having more than one bachelor's graduate per FTE faculty member during the period 1994-2001. About one fourth of the 74 departments had more than one bachelor's graduate per FTE faculty member during this time. What makes these successful departments different from the others? One answer is that their

Figure 7. 1994-2001 Mean Ratio of Bachelor's Degrees Awarded to Full-Time Equivalent (FTE) Physics Faculty, by Student Satisfaction with Undergraduate Physics Climate



Student Satisfaction is the mean response value of students' reported satisfaction with their undergraduate program's teaching; professors' mentoring/role modeling skills; advising; supportiveness of professors; and working relationships with both professors and other students.

Data are statistically significant at $\alpha \leq .05$

Source: AIP Statistical Research Center, 1994, 1996, 1998, 2000 Academic Workforce Report; 1994-2001 Enrollments and Degrees Report; and 1998-99 Bachelors Plus Five Study.

Table 2. Physics Programs with High Student Satisfaction and High Bachelor's Degree Production

Note: Schools listed are taken from the study sample of one department in five.

- Angelo State University
- Bowdoin College
- Carleton College
- East Central Oklahoma State University
- Goshen College
- Harvey Mudd College
- Hastings College
- Lawrence University
- Mount Holyoke College
- Murray State University
- College of Wooster

1998-99 Bachelors Plus Five Study

1991-93 graduates were more satisfied with the climate in their departments (**Figure 7**). Departments whose 1991-93 physics bachelors were only moderately satisfied with the climate were much more likely to have *less* than one bachelor's graduate per FTE faculty member during the period 1994-2001. And departments whose 1991-93 graduates were highly satisfied with the climate were much more likely to have *more* than one bachelor per FTE faculty member in 1994-2001. The departments whose 1991-93 graduates were highly satisfied and had more than one bachelor's graduate per FTE are listed in **Table 2**.

These finding mirror the results of Project SPIN-UP, which finds that thriving departments (which include those that have a higher than average number of bachelor's recipients) are "challenging, but supportive and encouraging" (Hilborn, Howes, and Krane, 2003). Thriving departments were described as including a "well-developed curriculum, advising and mentoring, ...and many opportunities for informal student-faculty interactions, enhanced by a strong sense of community

among the students and faculty." In other words, the thriving departments in SPIN-UP are very similar to the departments in our study who produced highly satisfied students. The departments with highly satisfied students subsequently produced a larger number of graduates per FTE faculty member. Our results, and those of the site visits in SPIN-UP, strongly support the conclusion that departments who take the time to develop a supportive climate for undergraduates will undoubtedly benefit by an increased number of physics bachelor's degree recipients.

CONCLUSION

Our original question was "does it matter where I go to college?" Does graduating from a physics department at a large research university make any difference in the careers of physics bachelors, or would a small liberal-arts college be better? For the most part, the answer is that it does not matter, at least not on an aggregate level. Graduating from a department with lots of physics majors or that grants PhDs in physics does not affect salary and does not affect whether physics bachelors work in science, engineering, or technology jobs. Type and size of department also do not affect whether or not physics bachelors hold career path jobs, how long they look for these jobs, how many offers they have, or other outcomes. On the other hand, going to a large department does make it more likely that physics bachelors will attend graduate or professional school with the intention of earning a degree in any field, although most do anyway, regardless of the size of their undergraduate program.

The main difference choice of college makes is in how physics bachelors evaluate their undergraduate experiences. We have seen that those from larger departments feel their physics and math preparation was better, while those from departments that do not grant graduate degrees feel their collaboration and communication skills were better served. We have also seen that those who graduated from bachelors-only physics departments rate their undergraduate department climates more highly than those who received bachelor's degrees from departments that grant PhDs in physics. The real

lesson for physics departments is that departments whose students were highly satisfied during the early 1990s were able to produce more physics bachelors per FTE faculty member during the mid- to late-1990s. This is even more significant when we consider that overall physics bachelors production declined during the 1990s. Departments that are more student-centered ultimately produce more physics bachelors.

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