AC 2008-1082: THE ACADEMIC JOB MARKET AS AN ARGUMENT FOR AND AGAINST INTERDISCIPLINARY ENGINEERING GRADUATE TRAINING

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The Academic Job Market as an Argument for and against Interdisciplinary Engineering Graduate Training

Abstract

Interdisciplinary approaches are often cited as the key to solving important technical research problems. This has been the motivation for interdisciplinary graduate programs such as those funded through IGERT at the U.S. National Science Foundation. However, interdisciplinary training is also cited as a career risk to students who might not be able to find faculty positions if not grounded in a traditional discipline. To explore the legitimacy of these beliefs related to interdisciplinary faculty openings, we analyzed 743 interdisciplinary academic job postings appearing in the *Chronicle of Higher Education* over a six-month period. We found that overall, less than 7% of all faculty postings are for interdisciplinary positions, but within engineering, 10.7% of the open positions are interdisciplinary (not statistically significant). A higher percentage of postings at senior rank are interdisciplinary than are at junior rank (18% vs. 6%). However, there were ten times as many postings for new assistant professors, and a full 83% of interdisciplinary postings are at the junior rank. Within individual institutions, there is a correlation between the number of engineering and science interdisciplinary positions, but not with humanities and social sciences. We compared these numbers to overall faculty openings and graduation rates from IGERT programs to show that, at least in theory, there are enough positions for graduate of interdisciplinary graduate programs. These results provide important quantitative data to refute claims of career risk as a disincentive for interdisciplinary graduate education.

I. Introduction

Interdisciplinary approaches are necessary for attacking the most critical technological and socio-technological challenges facing the nation and the world today[1-3]. Students and their training programs are recognized as central to increasing interdisciplinary research capacity. NSF's strategic plan states, "Future generations of the U.S. science and engineering workforce will need to collaborate across national boundaries and cultural backgrounds, as well as across disciplines"[3]. IGERT, NSF's $385 million investment in innovative graduate programs, "is intended to catalyze a cultural change in graduate education, for students, faculty, and institutions, by establishing innovative new models for graduate education and training in a fertile environment for collaborative research that transcends traditional disciplinary boundaries"[4].

However, interdisciplinary training is also considered a career risk to students who might not be able to find faculty positions if not grounded in a traditional discipline. These beliefs are such a part of the science and engineering culture that they are rarely documented in archived sources. The IGERT RFP hints at a need for students to remain grounded in traditional disciplines: "Students should gain the breadth of skills, strengths, and understanding to work in an interdisciplinary environment while being well grounded with depth of knowledge in a major field." Elsewhere in the RFP, this is described as "deep knowledge in chosen disciplines"[4]. While NSF and others recognize the need to prepare graduate students for careers in industry and

government[4,5], faculty positions are still regarded as prestigious placements for one's former graduate students.

The purpose of this analysis is to provide quantitative data to support or refute common beliefs related to interdisciplinary faculty openings. On a more personal level, as researchers studying interdisciplinary graduate education, we thought it important to have empirical data to address questions of the viability of interdisciplinary programs. The research questions used to guide this analysis were:

1. What percentage of all faculty openings is interdisciplinary?
2. Are there more interdisciplinary faculty openings at doctoral institutions than at other types of institutions?
3. Are there more interdisciplinary faculty openings in engineering than in science or humanities and social sciences?
4. Are there more interdisciplinary faculty openings at senior rank than at junior rank?
5. Does motivation for interdisciplinary hiring come from the institutional level? In other words, do institutions with many science and engineering interdisciplinary openings also have many social science and humanities interdisciplinary positions?

To address these, we built a database of academic job postings appearing on the *Chronicle of Higher Education's* web site (www.chronicle.com/jobs). This public web site advertises thousands of academic positions each month across a range of disciplines and institution types, categorized so that faculty positions could be easily extracted. Thus, the results of this analysis will be relevant to interdisciplinary faculty openings across disciplines and institution types, and of interest to a wide range of faculty, administrators and graduate students involved in interdisciplinary graduate education.

II. Method

A. Data Sources

Two related databases were populated using faculty job postings appearing on the *Chronicle of Higher Education's* web site (www.chronicle.com/jobs) from June 1 to November 30, 2007:

1. All faculty job postings (n = 2695) for the month of November, 2007, which included the most postings of any month in the 6-month sampling period.
2. Interdisciplinary faculty job postings (n = 743). For the first 30 days, every position description was read to identify key words that described interdisciplinary positions. It was determined that a keyword search for "discipline" and "disciplinary" would identify all relevant postings (using variations on "interdisciplinary," "multidisciplinary" and "cross-disciplinary"). This type of search was used in subsequent months.

For each position, the title, full description, contact information, rank, institution, and disciplinary categorization (selected by posting institution) were included in the database.

B. Data Analysis

Quantitative variables for the postings were coded as described in the following paragraphs.

Institutional type categorizations were based upon year 2000 Carnegie Foundation classifications, which are archived on a *Chronicle of Higher Education* site (http://chronicle.com/stats/carnegie/). For this analysis, doctoral institutions (doctoral intensive and doctoral extensive) were combined and compared to all other categories (combined). This variable was treated as categorical.

Discipline of the posting as engineering, sciences (including physical, biological and medical/health), social sciences and humanities, or an interdisciplinary combination of two or more of the above was based upon the text of the posting. This variable was treated as categorical.

The language used in the postings prevented categorization by tenured and untenured positions. Many positions, for example, specified "tenure-track assistant or associate professor." Rank of the position as open rank, tenure-track assistant or associate ("junior rank"), tenure-track associate or full ("senior rank"), or unspecified rank was based on statements in the body of the posting. This variable was treated as categorical.

Postings in the one-month sample were also identified as interdisciplinary or disciplinary (e.g., not interdisciplinary), based on whether their descriptions included variations of "interdisciplinary," "multidisciplinary," and "cross-disciplinary" as described above. This variable was treated as categorical.

Research questions 1, 2, and 3 were addressed using the postings from the one-month sample and Chi squared tests. Independent variables were institutional type, discipline, and rank. The dependent variable in each case was interdisciplinary or disciplinary nature of the posting.

The interdisciplinary positions from the six month sample were used to generate a data set in which each row corresponded to a specific institution. For each institution, we tallied the number of interdisciplinary positions in engineering, physical and biological sciences, social sciences and humanities (treated as scales). A Pearson correlation analysis was run between disciplinary groupings.

III. Results

A. All Positions (One Month Sample)

This section includes descriptive statistics and tests comparing interdisciplinary positions to other positions. Overall, a small percentage of recently posted faculty positions are interdisciplinary. Of 2695 faculty openings, only 184 or 6.8% were interdisciplinary.

1. Institutional Type

Table 1 lists the number of interdisciplinary positions at doctoral and other types of institutions. Over the one-month sampling period, there were more positions at master's and other institutions than at doctoral institutions (103 vs. 81), but the percentage of positions which were

interdisciplinary was slightly higher for doctoral institutions (7.9% vs. 6.2%). Chi squared analysis reveals that this difference is not statistically significant. Therefore, we conclude that interdisciplinary faculty openings are equally distributed between doctoral and other types of institutions.

Table 1. Faculty Openings by Institutional Type and Interdisciplinarity.

	Interdisciplinary	Disciplinary	Total
Doctoral Institutions	81	942	1023
Other Institutions	103	1569	1672
Total	184	2511	2695

2. Discipline

Table 2 lists the number of interdisciplinary positions in engineering, sciences, and social sciences and humanities. At 10.7%, the percentage of engineering positions that were interdisciplinary is notably higher than the percentages for other disciplinary groupings (6.0% and 6.3%); however, Chi squared analysis reveals this difference is not statistically significant. Therefore, we conclude that there is only a slightly higher percentage of interdisciplinary faculty openings in engineering than in science or humanities and social sciences, but that this difference is not statistically significant.

Table 2. Faculty Openings by Discipline and Interdisciplinarity.

	Interdisciplinary	Disciplinary	Total
Engineering	12	100	112
Sciences	47	740	787
Social Sciences and Humanities	111	1644	1755

3. Rank

Table 3 lists the number of interdisciplinary positions for each rank. The percentage of interdisciplinary positions was higher at the senior rank than at junior rank (18.4% vs. 6.0%). However, there were ten times as many openings at the junior rank, and three times as many interdisciplinary openings at the junior rank than at the senior rank (115 vs. 35). Chi squared analysis comparing only the specified ranks reveals this difference is indeed statistically significant. Therefore, we conclude that there are more interdisciplinary faculty openings at the junior rank than at senior rank.

It is also important to note that the overall distribution across ranks is similar for the interdisciplinary and disciplinary positions. Interdisciplinary positions were 63% junior level, 19% senior level, 7% open rank, and 12% unspecified. Disciplinary positions were 72% junior level, 6% senior level, 8% open rank, and 14% unspecified.

Table 3. Faculty Openings by Rank and Interdisciplinarity.

	Interdisciplinary	Disciplinary	Total
Junior (assist/assoc)	115	1808	1923
Senior (assoc/full)	35	155	190
Open Rank	12	200	212
Unspecified	22	348	370

B. Interdisciplinary Positions (Six Month Sample)

The 743 interdisciplinary faculty openings were posted by 367 different U.S. and Canadian institutions. The most at any one institution was 13 at Arizona State University. University of California Berkeley, Michigan State University, and College of New Jersey each posted 12. The most engineering postings by any one institution was two, by Arizona State University, College of New Jersey, Rochester Institute of Technology, and University of Georgia. The small numbers posted by individual institutions highlight the limitations of this data, collected over a relatively small time scale.

A Pearson correlation analysis across disciplinary categories to determine the location of motivation for interdisciplinary hiring as institution level or at the college/department level. Correlations were identified between engineering positions and science ($r = .254$, $p = .000$**) and between engineering and positions crossing multiple disciplinary categories (.159, .002**). There were no correlations between social science/humanities positions and any other category. We interpret this to mean that at a given institution, interdisciplinary hiring is not well-coordinated across the entire range of disciplines. However, when engineering hires interdisciplinary faculty, the sciences are also likely to do the same.

IV. Summary and Future Work

To better understand the job market for graduates of interdisciplinary graduate programs, we analyzed 743 interdisciplinary academic job postings appearing in the *Chronicle of Higher Education* over a six-month period, and 2695 other positions in a one-month period. We found that overall, less than 7% of all faculty postings are for interdisciplinary positions, but within engineering, 10.7% of the open positions are interdisciplinary. This difference was not statistically significant. A higher percentage of postings at the tenured level are interdisciplinary than are at the untenured level (18% vs. 6%). However, there were ten times as many postings for new assistant professors; a full 83% of interdisciplinary postings are at the junior rank. Within individual institutions, there is a correlation between the number of engineering and science interdisciplinary positions, but not with humanities and social sciences.

One important comparison for these results is graduation rates for new PhDs in interdisciplinary graduate programs. Data from NSF IGERT can be used to estimate these graduation rates. One evaluation[6] focused on 52 of the 57 IGERT sites funded in the program's first three years (1998-2000). Within each program, they identified the two largest departments out of as many as ten involved in each IGERT site. In total, they collected data from 361 students in three cohorts. A simple estimation based on these numbers would suggest that approximately 120 students

graduate from IGERT programs annually. An alternative calculation can be made from the current RFP for the NSF IGERT program[4]. Each site is awarded around $2 million, which can support approximately 20 students. Over the five years of the grant, this averages to four graduates per year. Twenty sites are funded each year. This calculation yields only 80 IGERT graduates per year.

Over the six-month sampling period, there were 468 junior rank interdisciplinary faculty openings, and another 176 of unspecified rank. Though the IGERT program includes social sciences, a more conservative figure would be the 165 positions in engineering and the sciences. Assuming that most interdisciplinary PhDs come from IGERT programs, we can conclude that there are more than enough faculty openings for those graduates pursuing a career in academia. It is important to note that many graduates of these programs choose a career in industry or government instead.

These analyses raise important new questions about the job market for graduates of interdisciplinary PhD programs. In future work, the text of the postings could be analyzed for motivations behind interdisciplinary hiring and classified by technology areas. Institutions could be surveyed in a few months about whether the positions were filled and whether the pool was competitive. Placement data collected and reported by IGERT sites could be compared to job market analysis. Finally, a longer-term sample of job postings would serve as a richer data set for both quantitative and qualitative analyses.

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