Background

- Pedagogical reform at a large scale is a slow process.
- We are interested in understanding routes to expediting this reform.
- Our approach considers what past educational experiences may influence current faculty practices.
  - This includes exposures and experiences as an undergraduate student, a graduate student, and faculty.
  - Institutions responsible for training future faculty might have an influence on how they teach.
- We are studying patterns in where current physics faculty received their undergraduate and graduate degrees.
  - This information can indicate both opportunities and barriers for large scale pedagogical reform.
- Previous research uncovered an imbalance in the production of faculty by doctoral universities.
- We follow up on this work and a prior model of pedagogical change in academia by examining the balance of faculty production by undergraduate universities.

Methods

- Data collection: Identify all institutions that granted a PhD in physics in 2018
- Faculty production: Identify tenure-track physics professors at each institution
- Search for BS and PhD university of each faculty
- Identify new universities and repeat process
- Six rounds total

Non-US institutions train a large number of faculty

- Around 40% of all TT faculty in physics had their first experiences with undergraduate classrooms occur in institutions outside of the US.
- We originally conceptualized a model of pedagogical influence and change that assumed a closed and insular system.
- However, this assumption is inappropriate given the large number of faculty who received their training outside the US.
- Understanding how the undergraduate and graduate experiences of this faculty integrate into their own teaching beliefs and practices will be an important step toward improving higher education.

Discussion and future directions

- Most faculty earn their degrees at the same set of elite institutions that are densely connected to one another and core central to all other universities.
  - The imbalance at the level of undergraduate degrees mirrors current and previous findings at the level of graduate degrees.
- Because experiences as a student influence future teaching decisions, this handful of universities that make up this core may be key to future pedagogical reform.
  - For example, requiring all students at universities that produce the majority of future faculty to graduate with a baseline knowledge of evidence-based pedagogy may expedite pedagogical reform.
- The large number of TT faculty whose undergraduate and graduate experiences come from non-US institutions illustrate this as an "open-system."
  - We are now interested in exploring:
    - How pedagogical experiences differ by where one went to school.
    - Whether and how instructors from different cultural backgrounds integrate past experiences into their US classroom.

Citations


Figure A: All faculty experience college classrooms from the perspective of their own undergraduate and graduate school experiences before they ever teach their own college courses. What these faculty experience during these periods of professionalization has implications for how they go on to teach. These experiences are shaped by where they earned their degrees and the professors and graduate student instructors that taught them (curved purple arrows). Not all universities train the same number of future professors. First, many universities do not have PhD programs, though they must hire faculty who came from other universities that do. Second, some universities may train more future faculty than others.

Figure B: Where physics faculty in the US earned their undergraduate degree

<table>
<thead>
<tr>
<th>Country</th>
<th>BS</th>
<th>PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moscow Institute of Physics and Technology</td>
<td>581 University of Wisconsin-Madison (44)</td>
<td></td>
</tr>
<tr>
<td>University of Illinois at Urbana-Champaign</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>University of Georgia</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>University of Michigan</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>

Figure C: Where physics faculty in the US earned their PhD

<table>
<thead>
<tr>
<th>Country</th>
<th>BS</th>
<th>PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Wisconsin-Madison</td>
<td>1,035</td>
<td></td>
</tr>
<tr>
<td>University of Michigan</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>University of California, Berkeley</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>University of Chicago</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>University of Pennsylvania</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>

Figure D: Primarily Undergraduate Institutions

Doctoral Institutions

Non-Doctoral Institutions

Figure E: Faculty production

Most of the 7,676 TT faculty in the US were trained by a small fraction of universities.

The PhD line shows what percent of faculty awarded what percent of these faculty their PhD degrees. The percent of universities is out of 594 US and foreign universities that granted a PhD to at least one TT faculty in the dataset. The Gini coefficient for PhDs is 0.76.

The BA/BS line shows what percent of universities awarded what percent of these faculty their undergraduate degrees. The percent of universities is out of 1,220 US and foreign universities that granted an undergraduate degree to at least one TT faculty in the dataset. The Gini coefficient for BA/BS is 0.66.

A Gini coefficient of 0 = perfect equality; 1 = complete inequality.

Dataset

<table>
<thead>
<tr>
<th>Faculty</th>
<th>BS</th>
<th>PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td>581 University departments</td>
<td>7,876</td>
<td>7,176</td>
</tr>
<tr>
<td>7,854</td>
<td>175</td>
<td>5631</td>
</tr>
<tr>
<td>2,602</td>
<td>2,602</td>
<td>1916</td>
</tr>
<tr>
<td>3,111</td>
<td>602</td>
<td>602</td>
</tr>
<tr>
<td>7,876</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>7,768</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

Figure F: Undergraduate → Faculty

PhD → Faculty

Block 1: 1114 Smaller and less elite US and foreign programs
Block 2: 32 Large elite US programs
Block 3: 60 Large less elite US programs
Block 4: 54 Most elite US programs
Block 5: 54 Small elite US programs and elite supply programs

Block 1: 12 Very large and elite US programs
Block 2: 58 Large elite US programs
Block 3: 121 Smaller less elite US programs
Block 4: 12 Most elite US programs
Block 5: 82 Small elite US programs and elite supply programs

The professionalization networks included many universities (Undergrad—Faculty: 1,266 PhD—Faculty: 1,035). Block modeling was used to reduce the complexity in these networks, uncover structural patterns, and highlight roles different universities play in the professionalization of faculty. Universities were clustered by structural equivalence using Euclidean distance. Even though this method clusters universities only using their shared connections in the network, the blocks that were formed included universities that shared many characteristics.

Figure G: Block # of Uni's

<table>
<thead>
<tr>
<th>Uni's Description</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>University of Wisconsin-Madison</td>
</tr>
<tr>
<td>University of Michigan</td>
</tr>
<tr>
<td>University of California, Berkeley</td>
</tr>
<tr>
<td>University of Chicago</td>
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<tr>
<td>University of Pennsylvania</td>
</tr>
<tr>
<td>University of Wisconsin-Madison (44)</td>
</tr>
</tbody>
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University networks

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