Rethinking STEM Graduate Education for Diverse Career Pathways at the Water-Energy Nexus

Syracuse University’s NSF Research Traineeship Program

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Background
Recent surveys show that only about half of PhD scientists find employment in academia; for engineering doctorate recipients, even fewer pursue academic positions.1 Studies of graduate student education find that employer expectations of graduate degree holders extend beyond advanced content knowledge: employers want graduates to develop skills in professional and work ethic, oral and written communication, teamwork, and problem solving. Despite this, professional training opportunities in graduate school may be limited or outside of the academic departments, thus requiring students to independently seek out opportunities. In the sciences, internship experiences have been seen by employers as essential for career preparation and professional skill development; however, less than 60% of graduate students have internship experience.2

Program Design
Graduates of the EMPower program are likely to pursue careers in four sectors: business, government, non-profits, or academia. Each career trajectory requires specialized professional skills. This program combines broad training across management, policy, communication, and law with in-depth training in a self-designed focus area most applicable to the trainee’s career objectives. Specific training opportunities are available to trainees throughout their graduate school careers: the arrows indicate which professional skills are supported by each training element.

Training Elements

<table>
<thead>
<tr>
<th>Water-Energy Seminar</th>
<th>Science Communication</th>
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<tr>
<td>Career Pathways Experience</td>
<td>Interdisciplinarity</td>
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<tr>
<td>Seed Grant Program</td>
<td>Advising, Mentoring</td>
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<tr>
<td>Field Courses</td>
<td>Prep non-academic experiences</td>
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<tr>
<td>Science Communication Class</td>
<td>Transferable Skills</td>
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<td>Research Productivity</td>
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Professional Skills

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<tr>
<th>Communication</th>
<th>Policy Study/Collaboration</th>
<th>Business &amp; Management</th>
<th>Entrepreneurship</th>
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Field Courses

Requests received for field courses were: 1) Energy Seminar (optional), 2) Field Experience Course (optional), 3) Water Seminar (optional).

Research Themes

The EMPower NRTI focuses on research at the interface of water and energy cycles. Research in this area is a priority nationally and is likely to produce graduates who will pursue careers in a range of sectors. Students in EMPower will develop advanced content knowledge on the formation, production, and effects of hydrocarbons and extends beyond the traditional departmental offerings.

Carrier Pathways Experience
Each trainee is required to participate in an off-campus experience aligned with their individual career goals. To date, four students have carried pathways: a visiting instructor at local college, a MAAS Max Media Fellow, an intern at an environmental consulting firm, and a GeoFORCE summer intern.

Professional Specialization Area (PSA)
Students take coursework outside of the STEM disciplines that are related to the student’s professional interests. PhD students are required to take 12 credit hours; MS students take 6.

Program of Study
The table below outlines the suggested program of study for students participating in EMPower. The exact program is determined individually for each student in consultation with EMPower’s leadership team and the student’s faculty advisor.

<table>
<thead>
<tr>
<th>Year</th>
<th>Water-Energy seminar (1-3 cr.)</th>
<th>Start PSA coursework</th>
<th>Science Communication Course</th>
<th>Field Experience Course (optional)</th>
<th>Complete PSA coursework</th>
<th>Water-Energy seminar (1-3 cr.)</th>
<th>Water-Career Pathway Experience</th>
<th>Water-energy seminar (optional)</th>
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Takeaways
An outside independent evaluation team is assessing the implementation and effectiveness of the program. EMPower has received valuable feedback from faculty, students, and the External Advisory Committee (EAC) that is guiding programming.

Successes:
1. EMPower’s EAC has identified skills that should be acquired as a graduate training program: high-level performance in the workplace. These skills include problem-solving flexibility, systems-thinking, communication skills, ability to interact with a range of stakeholders and colleagues, proficiency in foundational STEM classes, and aptitude in practical application of quantitative skills and tools.
2. Positive responses from students:
   - “Enjoying reading papers and then meeting the authors…also enjoy the opportunity to have lunch and interact with the visiting scientists.”
   - “This event [orientation] made me really excited about professional development—really hope we can integrate some of these classes into EMPower.”

3. Strong university support including (1) office and program space reservation and (2) additional funds to support students and EMPower activities.
4. High levels of faculty engagement
   - “I was able to connect my student across the different faculty when I go to their EMPower meetings; they show up, they talk, they contribute.” (from a faculty member)

Challenges:
1. Requirements may increase time to degree for trainees.
2. Building cross-disciplinary collaborations across the university.
3. Providing broad experiences for the trainees.
   - “With the biggest challenge for the program is and will continue to be having a broad enough experience for the students outside of their home discipline.” (from a faculty member)
4. Developing a pool of internship opportunities for students.
5. Recruiting new trainees to the program.

Acknowledgements
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References