STEM Education Abroad: The Global Laboratory

Nikki Kernaghan
“U.S. scientists and engineers must be able to operate in teams comprised of partners from different nations and cultural backgrounds if they are to confront the many challenges in this increasingly global society”

Dr. Arden L. Bement, Jr., Former Director of NSF
Background

- Need to develop globally competent scientists and engineers
  - Compete internationally
  - Develop collaborative solutions to global problems
- 2011 – 2012 Open Doors Report

<table>
<thead>
<tr>
<th></th>
<th>Nationally</th>
<th>UF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td>8.6%</td>
<td>7.0%</td>
</tr>
<tr>
<td>Engineering</td>
<td>3.9%</td>
<td>5.1%</td>
</tr>
<tr>
<td>Math &amp; Computer Science</td>
<td>1.7</td>
<td>0.5%</td>
</tr>
<tr>
<td>Undergraduate</td>
<td>86%</td>
<td>72%</td>
</tr>
<tr>
<td>Graduate</td>
<td>14%</td>
<td>28%</td>
</tr>
</tbody>
</table>
Background

• Few science and engineering-related study abroad programs

• Limited research on participation of science and engineering students in international programs

• No pre-existing protocols or instruments to assess outcomes for science and engineering study abroad
Overview

• Program Formats
  • Field Schools
  • International Research Projects
  • Study Tours

• Evaluation and Outcomes

• Recommendations

• Discussion
AMW3 - 2006-2010

Adaptive Management of Water, Wetlands, and Watersheds: An interdisciplinary doctoral program that provides students with technical, interdisciplinary, and adaptive management skills.

- Florida Everglades – 3 weeks
- Botswana & southern Africa - 6 weeks
International Research

GK-12 SPICE - 2009

• Theme: ecosystem health and sustainability
• Students in all departments of science and engineering
• International supplement
• Four week research projects in South Africa
• Outreach to local primary and secondary schools
International Research

I-Cubed – 2010 - 2012

Provides professional development opportunities to graduate students in STEM and SBE disciplines

• Interdisciplinary and international research awards to teams of students in Peru, Colombia, Haiti, Costa Rica, Nicaragua
Study Tours

South Eastern Alliance for Graduate Education and the Professoriate (SEAGEP)

• Comprehensive professional development program to increase minority representation among STEM faculty

• University of Florida, University of South Carolina, Clemson University
Study Tours

Course Objectives

• Develop an understanding of the differences in STEM education and research cultures between the U.S. and the host country

• Network with students, faculty, researchers and government agencies abroad

• Engage in discussions on four research topics in the host countries

• Learn about the history, culture and traditions of the host country
Outcomes - Study Tours

**SEAGEP - 2011**

*10-14 days study tours for under-represented STEM graduate students*

<table>
<thead>
<tr>
<th>Country</th>
<th>Program Dates</th>
<th>Focus</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chile</td>
<td>Mar 4 – Mar 14</td>
<td>Energy</td>
<td>11</td>
</tr>
<tr>
<td>China</td>
<td>May 6 – May 18</td>
<td>Engineering</td>
<td>15</td>
</tr>
<tr>
<td>South Africa</td>
<td>Jun 10 – Jun 22</td>
<td>Ecology &amp; Conservation</td>
<td>10</td>
</tr>
<tr>
<td>Brazil</td>
<td>Jul 23 – Aug 3</td>
<td>Agriculture &amp; Natural Resources</td>
<td>10</td>
</tr>
</tbody>
</table>
Program Example

**China: Focus on Engineering**
- Organized in country activities with UF Beijing Center
- Visited prestigious universities (Tsinghua, Beijing University of Science and Technology) and key labs
- Included factory visits – Tianjin industrial park
- Cultural activities – Great Wall, Summer Palace
Evaluating Learning

Research Programs

Evaluation Tools
- Individual interviews
- Focus groups
- Long-term outcomes tracking

Outcomes
- Research reports
- Dissertation/thesis content
- Conference presentations
- Manuscript publication
- Future research collaborations & funding
Outcomes – Field School

AMW3 IGERT

• 11 students conducted Ph.D. research in Africa
• 3 students conducted Ph.D. research in Everglades
• 22 PhD’s graduated to date
Outcomes - Research

SPICE GK-12

• 3 manuscripts for publication
• 3 dissertation chapters
• 4 international conference presentations
• Sister-schools project/supply drive
• New Peace Corps volunteer in Guyana
• Participation in other international opportunities
  • Fulbright
  • Post-docs
Outcomes – Study Tour

Evaluation Tools
- Participant surveys (pre-post)
  - STEM Outcomes Survey
  - Intercultural Development Inventory
- Course syllabi and itineraries
- Longer-term outcomes tracking

Outcomes
- Academic learning outcomes
- Personal learning outcomes
- Intercultural competence outcomes
- Future research collaborations & funding
Methodology

Assessment Tools
• Academic learning and personal growth assessment tool
• Intercultural Development Inventory
• Program observations
• Participants’ reflections
• Focus groups

Data Collection
• SEAGEP Participants completed pre and post-trip assessments
• Comparison group completed each assessment once
STEM Assessment Tool

- 29 items with 5-point Likert scale
- 14 academic learning items
- 15 personal growth items
- 9 demographic items
- Good reliability for all scales and subscales

Section 1 - Academic Outcomes

Please respond to the following statements related to academic learning

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I believe that I can learn new knowledge from scientists/engineers in other countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am aware of scientific/engineering research opportunities in other countries</td>
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<td></td>
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Results

Academic Learning

• Quantitative
  – no significant differences for Professional Identity sub-construct
  – Science communication and socio-cultural role of STEM were both significantly different

• Qualitative: students commented on
  – Itinerary and site visits
  – Level of research and technology
  – Networking and future research connections
Results

Personal Growth
• Quantitative: all sub-constructs were significantly different
• Qualitative: few comments on personal growth

Intercultural Development
• Quantitative: no significant differences
• Qualitative: most student comments on knowledge and understanding of other cultures
**Results**

**Life and Physical Science vs Engineering**

- No significant differences between gain scores for any of the 3 targeted outcomes

**Destinations**

- No significant differences between academic learning and personal growth gain scores
- Significant differences in gain scores on the IDI
  - China = significant positive increases in IDI scores
  - S. Africa & Brazil = no significant differences in IDI scores
Recommendations

Professional relevance

- Alignment with student and advisor expectations
- Include faculty and graduate students in design of program
- Provide more networking opportunities in students’ fields of study
- Schedule visits to maximize research collaboration opportunities
- Provide relevant course credit
- Provide evidence of outcomes
Recommendations

Professional relevance

• Increase opportunities to visit leading research facilities and meet key faculty

• Build on the strength of existing in country partnerships

• Work with faculty who have extensive in country research experience
Recommendations

Science Communication
• Include research presentations
• Provide technical translations
• Post-trip presentations

Intercultural Communication
• Provide extensive pre-departure training in intercultural communication
• Increase time for individual exploration
• Service-learning or community-based projects
Recommendations

Personal Growth

• Pre-trip orientations on global awareness
• Meetings within disciplines for career impact
• Follow-up activities for career relevance
• Reflection activities to develop awareness of impacts on personal confidence
Discussion

• What are your institutions doing in graduate STEM Education Abroad?

• How are you assessing student outcomes?

• What are the greatest challenges?