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“Career-Smart STEM Curricula:” Access to Global Learning and Professional Development in the STEM Disciplines

February 18, 2014, 5:00-6:15PM

About the Panelists:

Gayle Elliott is Associate Professor of Professional Practice and Experiential Learning at the University of Cincinnati. She directs the University’s International Co-op Program (ICP). Since joining the Division of Professional Practice in 1993, Elliott advanced co-op programs for engineering and applied sciences. She earned M.S. and B.S. degrees from University of Cincinnati. Elliott has authored publications on engineering education, professional development and globalization. Elliott is an active member of NAFSA, ASEE, and WACE. Institutional website: www.uc.edu/propractice/uccoop

Tony Munro manages the University of Waterloo’s international undergraduate recruitment team using student-centric and data-driven enrollment management strategies. Prior to this position, Munro spent over fifteen years as a Co-op Coordinator in Waterloo’s co-operative education program, the world’s largest. He advised a broad spectrum of employers from around the world to recruit and successfully onboard students while simultaneously preparing and supporting students to ensure their effective transition to the workplace and success on the job. Institutional website: www.uwaterloo.ca/co-operative-education

Nina Lemmens is the Director of the New York Office of the German Academic Exchange Service (DAAD). Previously, she served as Director of Internationalization and Communication at the DAAD headquarters in Bonn, Germany, and held directorship over the Asia-Pacific Department and the London Office. Lemmens holds a doctorate in art history from the University of Bonn. She worked as a freelance journalist for ten years and held an administrative position at the German Parliament. Institutional website: www.daad.org

About the Chair:

Katja Kurz is University Relations Officer at Cultural Vistas. Kurz focuses on access to international education and professional development programs for STEM and underrepresented students. She has previously held research positions at Columbia University in NY and Johannes Gutenberg University in Mainz, Germany. Kurz has published on human rights advocacy and intercultural communication. She holds a doctorate in English from the Johannes Gutenberg University of Mainz and an M.A. from Clark University in Worcester, MA. Institutional website: www.culturalvistas.org

I. Understanding STEM Student Barriers to Global Education

Common Reasons for STEM Student Immobility:

- Finances and funding
 - Example: Loss of several weeks of domestic co-op experience for foreign language instruction, lower salaries in international co-op (~ 1/3 of U.S. co-op salaries)
- Language requirements & lack of language training
- Unwillingness to leave domestic co-op employer
- Domestic summer research opportunities
- Rigid and dense curriculum requires advance planning
- Visibility of resources on campus
- Faculty investment in international opportunities
- Credit transfer

Data on STEM Student Mobility (IIE, 2013):

FIELDS OF STUDY OF U.S. STUDY ABROAD STUDENTS, 2001/02 - 2011/12 (in %)											
Field of Study	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Social Sciences	21.9	21.3	22.6	22.6	21.7	21.4	21.5	20.7	22.3	22.9	22.4
Business & Management	17.6	17.7	17.5	17.5	17.7	19.1	20.2	19.5	20.8	20.5	20.5
Humanities	13.8	13.3	13.3	13.3	14.2	13.2	13.3	12.3	12.1	11.3	10.8
Physical or Life Sciences	7.6	7.1	7.1	7.1	6.9	7.3	7.2	7.3	7.5	7.9	8.6
Health Professions	3.0	3.1	3.4	3.4	3.8	4.1	4.5	4.5	4.7	5.3	5.7
Engineering	2.9	2.9	2.9	2.9	2.9	3.1	3.1	3.2	3.9	3.5	3.9
Math or Computer Sc.	2.2	2.4	1.7	1.7	1.5	1.5	1.6	1.6	1.5	1.8	1.7
Total	160,920	174,629	191,321	205,983	223,534	241,791	262,416	260,327	270,604	273,996	283,332

(Institute of International Education. (2013). "Fields of Study of U.S. Study Abroad Students, 2001/02-2011/12." *Open Doors Report on International Educational Exchange*. Retrieved from www.iie.org/opendoors)

Global Comparisons – Economic Impact of STEM Student Immobility (NSF, 2014):

- U.S. accounted for 30% of 2011 global total R&D (down from 37% in 2001)
- EU accounted for 22% of total global R&D in 2001 (down from 26%)
- China, India, Japan, Malaysia, Singapore, South Korea and Taiwan represented 34% of global R&D total in 2011 (up from 25% in 2001)
 - China (15%) and Japan (10%) were the largest R&D performers
 - China experienced overall real growth of 18% annually (since 2001)
- U.S. awarded 33% of all bachelor's degrees in science and engineering in 2010, compared to 60% in Japan and 50% in China

- U.S. awarded 5% of all bachelor's degrees in engineering in 2010, compared to 18% in Asia and 31% in China specifically
- The number of science and engineering first university degrees awarded in China, Taiwan, Turkey, Germany and Poland doubled between 2000 and 2010
 - Science and engineering first degrees in the U.S., Australia, Italy, U.K., Canada and South Korea increased between 23-56% only
 - Science and engineering first degrees in France, Japan and Spain declined by 4-14%

(National Science Foundation. (2014). "Research and Development: National Trends and International Comparison" and "Higher Education in Science and Engineering." *Science and Engineering Indicators 2014*. Retrieved from www.nsf.org/statistics)

Undergraduate Demographics in Engineering and Applied Sciences (University of Cincinnati):

- Gender:
 - 85% male
 - 15% female
- Residency:
 - 88% from within Ohio
 - 12% from outside Ohio and international
- Ethnicity:
 - 85% Caucasian
 - 3% African American
 - 2.5% Asian
 - 2% Hispanic
 - 7.5% other or mixed

Facts about STEM Student Mobility – Case Study Germany (DAAD):

- STEM students are not as mobile as students in other fields (2012/13)
 - Share of Science and Math students at German HEIs in: 18 %
 - Share of Science and Math students/all mobile students from Germany: 10 %
 - Share of Engineering students at German HEIs: 19,2 %
 - Share of Engineering students/all mobile students from Germany: 10 %
- STEM students do not regard international experience as relevant for their career as much as other students
- Many STEM students think they will learn less relevant skills/content at international universities than at German HEIs
- Only 20% STEM students state that it is „usual“ to study abroad in their field
- German students in mathematics fear language barrier
- Fewer STEM students have international experience once they enter university

II. Solutions for Making Global Education & Professional Learning the Core of STEM Curricula

A. The Faculty Perspective: Developing Strategic Partnerships and Professional Practice

Deciding on an Appropriate Model:

- Identify your constraints
 - Rigid engineering curriculum
 - Will you require language instruction?
 - If not, limited to English-speaking opportunities
 - International programs are demanding, time-consuming and expensive – will your university commit resources?
 - Long-term commitment is necessary
- Identify your strengths
 - Existing co-op or internship program
 - Expected support from local co-op employers
 - Strong internal support at highest level
- Choose a model that fits within your constraints and utilizes your strengths
 - If no current co-op or internship program, how will it fit?
 - Will students earn credit?
 - Will jobs be paid or unpaid?
 - Numerous organizations exist for unpaid jobs
- Strive for shared program ownership in development stage
- Use students to promote later
 - Connect with student organizations on campus & alumni networks

Keys to Employer Participation (for International Work Experiences):

- Offer something of value
 - language skills enable students to communicate, be more productive
 - Previous discipline-related experience enables students to assume higher levels of responsibility
- Make logistics easy – have a smooth process for required documents abroad
- Identify stakeholders who are “champions”
 - ICP alums
 - Manager of a co-op student in the United States
- International co-op gives engineers a competitive advantage on the job market
 - Ability to work effectively in international teams, even in the U.S.
 - Leadership development in cross-cultural setting, advancements in technology shaped by cultural values of regional stakeholders
 - Cross-border solutions for cross-border challenges (e.g. energy sustainability)

B. Best Practices for Engaging STEM Students in Education Abroad: University of Cincinnati International Co-op Program (ICP)

Co-op History:

- Herman Schneider (Dean of the College of Engineering) invented co-op in 1906
- 28 Engineering students
- UC now has 5,500+ co-op placements annually and 1500 employers
- International option created for honors students (≥ 3.0 GPA) in 1991
- All students can co-op worldwide

Division of Professional Practice (Co-op):

- Centralized academic unit manages the Co-op Program
- 40 faculty and staff
- 40+ majors
- Co-ops employed across the USA and 20 countries worldwide

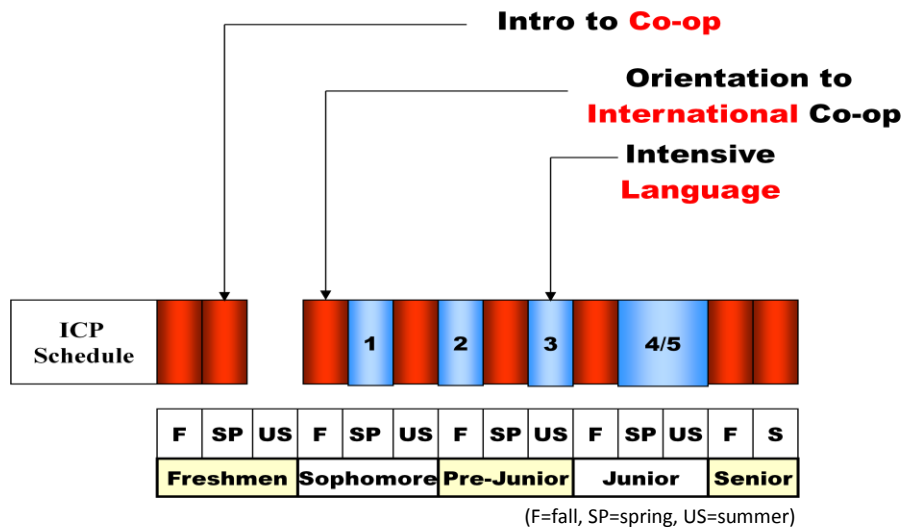
Co-op Program Structure:

- Centralized academic unit manages the Co-op Program
- 40 faculty and staff
- 40+ majors
- Four co-op colleges:
 - Engineering and Applied Sciences
 - Design, Architecture, Art and Planning
 - Business
 - Education
- Co-ops employed across the USA and 20 countries worldwide

ICP Course Structure and Requirements:

- Orientation to International Co-op
- Choice of one ICP elective
- Language-culture course series
 - Six-week summer intensive
 - Three credit hours fall semester
 - Two-week spring intensive
- Mandatory weekly blog postings overseas
- Reflection meeting on return
- Promotion of experience to others

ICP Schedule Overview:



Students Learning Achievements Abroad:

- Over 250 hours of language/culture instruction
- One year of discipline-related (co-op) work experience
- Understanding of new culture
- Ability to appreciate cultural differences
- Result: Success living and working abroad

Annual Participation Rates – ICP:

- Engineering Graduates: 525
- ICP:
 - German: 15-24 students
 - Japanese: 6-8 students
 - Spanish: < 1 students
 - French: 1 students
- 4-6% of Engineering students

Annual Participation Rates – Other International Options:

- International Experience outside the ICP (~400)
- Travel Semester (~100)
- Experiential Explorations Program (EEP):
 - Singapore Experience (~25 annually)
 - Study Abroad (~60 annually)
 - Unpaid Research or internship (~15 US and international)
- Not all students are in Engineering

French Program Example:

- First exchange with another school
- Year-long program combining study abroad with co-op
- UC places UTC students with employers in the US and UTC places UC students with employers in France
- Students pay tuition at their home school



New International Initiatives:

- Two-week study tours to Japan and Europe
- World Association for Cooperative Education (WACE) Pilot Work Exchange Program
- Shanghai Jiao Tong (SJTU) University – 2+3 Dual Degree Program
- UC-Chongqing University Joint Co-op Institute in China
- Job development activities with co-op employers for international placements

C. The Administrator’s Perspective: Intercultural Skills Training and Co-Op Career Planning

The Case for Career Planning in Co-op:

- Co-operative education = experiential learning
 - Developed by professionals who recognized gap between academic preparation and practical application
- Co-operative education is arguably the most effective method of linking undergraduate studies with career launch through the integration of academic learning and work experience
 - progressive career-related experience
 - application of learning and experience to both classroom and workplace
 - enhanced integration of learning through professional development course (WatPD)
 - embedding lifelong learning
 - creating cognitive dissonance
- Employers have consistently indicated that when hiring, they evaluate potential new hires on transferable skills ahead of technical or industry-specific knowledge
- Students are becoming more focused on “outcomes” as they evaluate prospective universities and programs of study
- Universities, in response, are examining how their curriculum meets the “outcomes” and expectations of these students
- As more students (especially STEM students) link university education to career goals, the emphasis is shifting to matching academic programs to career outcomes

D. Models for Co-op Education: University of Waterloo's Co-operative Education Program

Developing a Global Strategy:

- Internationalization is a stated pillar in Waterloo's most recent strategic plan (released in 2013)
 - common to many universities as demographics change and reputation become increasingly important
- Waterloo has identified diversity as a key learning outcome for all undergraduate programs
 - integration into curriculum wherever possible
 - graduates must be able to function and thrive in workplace that is increasingly multicultural and international (regardless of physical location)

Co-operative Education Structure:

- 6500-7000 students per term on work term
- 80% in Canada, 10% in USA, 10% in rest of world
- academic and work terms integrated to promote career- focused and applied learning
- students complete professional development courses online while on work terms using work experience as basis for course engagement

	FALL	WINTER	SPRING/SUMMER
YEAR 1	1A	1B	WT1
YEAR 2	2A	WT2	2B
YEAR 3	WT3	3A	WT4
YEAR 4	3B	WT5	4A
YEAR 5	WT6	4B	

(A=semester 1, B=semester 2, WT=work term)

Professional Development Program (WatPD) – Objectives:

- To enhance the overall work-integrated learning experience of co-op students by providing engaging and relevant online courses to improve students' employability and workplace productivity
- To promote the integration of what is learned at work with what is learned during academic terms through critical reflection
- To enable peer learning and foster a sense of community among co-op students

Professional Development Program (WatPD) – Structure:

- Courses completed while on work term (with exception of PD1)
- Time commitment: 20-25 hours per 4-month term

Professional Development Program (WatPD) – Schedule:

<u>Required Courses:</u>	<u>Elective Courses:</u>
PD1: Co-op Fundamentals	PD3: Communication
PD 2: Critical Reflection and Report Writing	PD4: Teamwork
PD20: Engineering Workplace Skills I: Developing Reasoned Conclusions	PD5: Project Management
PD21: Engineering Workplace Skills II: Developing Effective Plans	PD6: Problem Solving
	PD7: Conflict Resolution
	PD8: Intercultural Skills
	PD9: Ethical Decision Making
	PD22: Professionalism and Ethics in Engineering Practice

Intercultural Skills Training (PD8) – Learning Goals:

- Analyze their own cultural characteristics and explain how they might affect their working styles
- Explain key differences across cultures with respect to time, space hierarchy, risk-taking, the role of the individual, and analyze their impact on the workplace
- Identify key cultural differences in verbal and non-verbal communication
- Apply intercultural models and tools to analyze cross-cultural interactions in professional settings
- Feel more confident in managing cultural differences in multicultural and international work settings

Intercultural Skills Training (PD8) – Course Format:

- 10 units
- Workload: 20-25 hours
- Hybrid online course completed while on work term

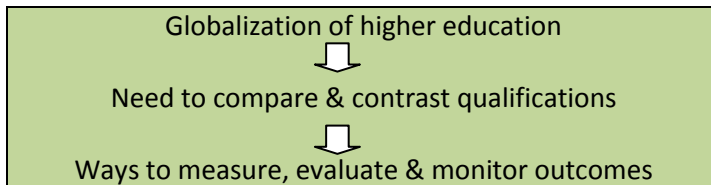
Intercultural Skills Training (PD8) – Course Examples:

- What is Cultural Intelligence (CQ)
- Impact of Culture on Thinking & Behaviour
- Values Across Cultures
- Cultural Differences in Verbal Communication
- Cultural Differences in Non-Verbal Communication
- Applying Cultural Concepts
- Relationships with Supervisors and Colleagues
- Cross-Cultural Teamwork
- Cultural Differences in Attitudes Towards Work
- Increasing Your Cultural Intelligence (CQ)

Intercultural Skills Training & Career Planning:

- Publically-funded universities in Ontario have established expectations of performance by graduates of Bachelors programs
- UDLEs: undergraduate degree-level expectations
 - ✓ Depth and breadth of knowledge
 - ✓ Knowledge of methodologies

- ✓ Application of knowledge
- ✓ Communication skills
- ✓ Awareness of limits of knowledge
- ✓ Autonomy and professional capacity
- ✓ Experiential learning (University of Waterloo)
- ✓ Diversity (University of Waterloo)



E. The Provider's Perspective: Creating Partnerships for STEM Programming

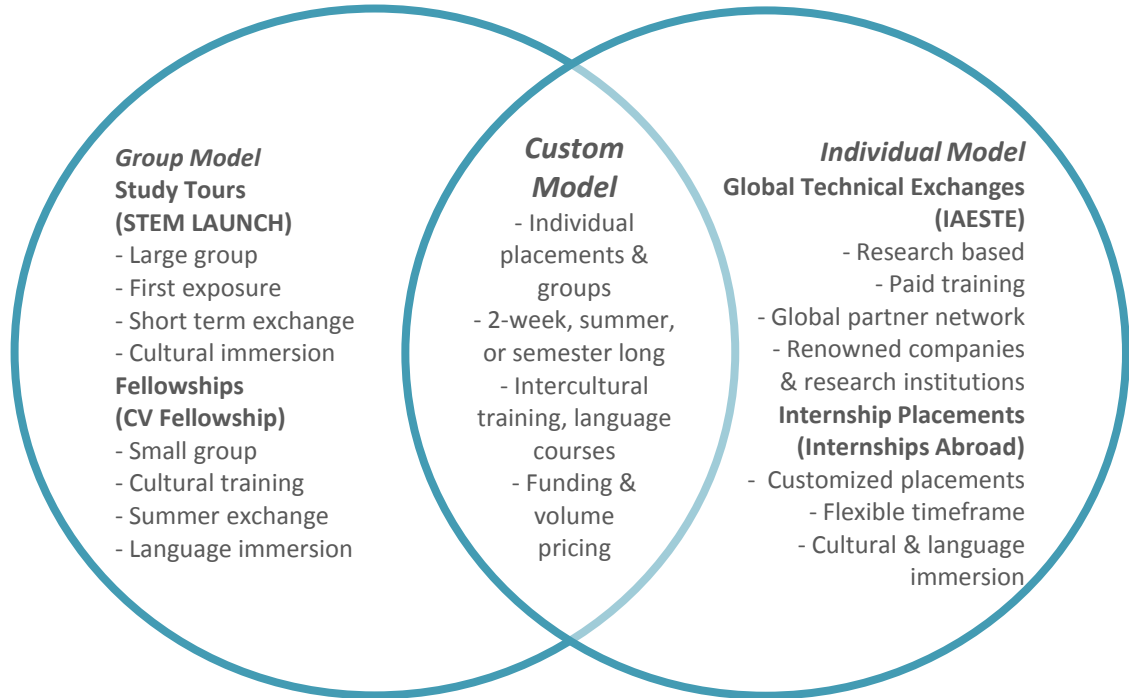
Partnership Building and Quality Assessment:

- Identifying partners with similar educational mission and compatible institutional structure
- Evaluating institutional strengths and weaknesses (home institution, potential overseas partners, program providers)
- Creating and revisiting strategic plans (2, 5, 10 years)
- Establishing trusted relationships with international host companies
- Building reliable partner and support network in host countries
- Clear definition of goals and open communication of program expectations (partners, companies, students)
- Honest and ongoing assessment of a student's skill set:
 - Academic background & research profile
 - Relevant practical experiences
 - Career goals
 - Language level
 - Personality type
 - Potential for intercultural learning
- Regular check-ins to assess progress of internship & intercultural experience (student, employer, partners)
- Final evaluation of internships (students, employers)

The Case for Short-Term Programs:

- "Breaking the ice" towards international experience
- Increasing awareness of graduate and post-graduate opportunities in STEM
- Exploring global research and career pathways
- Increasing motivation to learn another language
- Increasing international exposure for faculty members
- Group identity and "safe space": increasing underrepresented students' access to global mobility

- Opportunity for faculty to build reciprocal relationships abroad
- Encouraging the development international mentors (industry)
- Cultural immersion and service learning
- Short-term programs paving the way for further programming



F. The Funder’s Perspective: Funding STEM Global Education Initiatives

Statistics on International STEM Students in Germany:

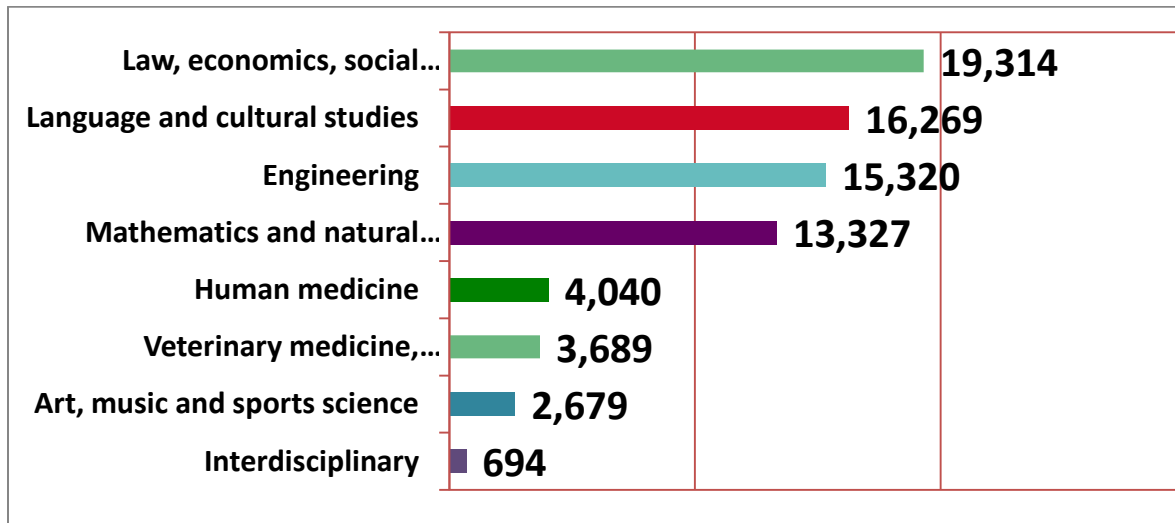
- 79 % of international Engineering students enrolled at German higher education institutions expect their careers to benefit from studying in Germany
- Mechanical Engineering and Process Engineering are the most popular fields of study for international STEM students in Germany
- Germany’s STEM student body is increasingly international:
 - 23 % of all Engineering students in Germany come from abroad
 - 15 % of all Science students in Germany come from abroad
- The top sending countries (STEM):
 - Overall: China and India
 - Cameroun is the third biggest sending country for Engineering students
 - Russia the third biggest sending country for Science and Mathematics

Areas of Study (International STEM Students in Germany):

2002/3	20012/13
1. Computer Science	1. Mechanical Engineering, Process Engineering
2. Electrical Engineering	2. Computer Science
3. Mechanical Engineering, Process Engineering	3. Electrical Engineering
4. Industrial Engineering	4. Biology
5. Biology	5. Civil Engineering

G. Funding International STEM Programs: The DAAD Model

DAAD Funding Recipients (2012):



(Not including EU programs)

Research Internships in Science and Engineering (RISE):

- 8-12 weeks in summer
- Web-based matching process
- Undergrads work directly with German doctoral students at top labs across country
- Knowledge of German is not required
- Scholarships and housing assistance provided
- 314 interns placed in 2013

RISE professional:

- For undergraduate DAAD alumni, recent graduates or graduate students

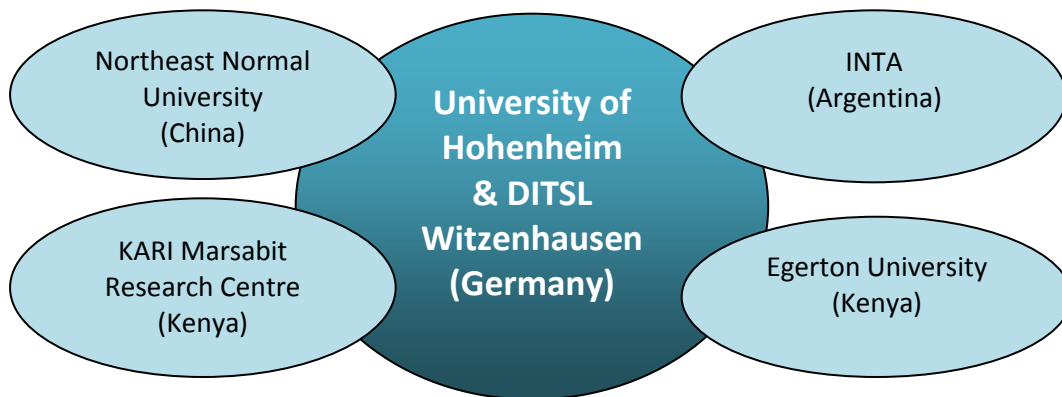
- 6-26 week summer placements in industry internships with leading German companies
- German requirements depend on the nature of the internship
- Scholarships and housing assistance are provided
- 2 week intensive language course for RISE and RISE *pro* participants with little or no German
- €250/monthly for graduates, €500/monthly for PhD students + €500/monthly from host company, health insurance and travel reimbursement

Bi-National Junior Research Groups Example – “Modern Applications of Biotechnology”:

- Research fields: All topics in the field of modern biotechnology
- Funding model: Individual scholarships
- Funding term: 6 to 24 months
- Financial sponsors: Federal Ministry of Education and Research (BMBF), Ministry of Education of the People's Republic of China (MoE)
- Implementing agencies: German Academic Exchange Service (DAAD), China Scholarship Council (CSC)

Multinational Research Groups Example – “International Networks on Climate Change”:

- Cross-continental network for sustainable adaption of grassland systems vulnerable to climate change (GrassNet)
- Study and Research Scholarships for foreigners and for Germans, Summer Schools, Workshops



Scholarships for Postgraduate Studies in Germany Example – “SPACES”:

- SPACES: Sciences Partnership for the Assessment of Complex Earth System Processes
- Corporate research projects in the fields of Ocean and Coast, Biosphere and Geosphere studies
- SPACES scholarships offer for young excellent postgraduates from Angola, Namibia and South Africa to study in selected M.Sc.-Courses at German universities

III. Conclusion: Lessons to Take Away

On STEM Career Planning and Intercultural Skills:

1. Transferable (or soft) skills should be a significant part of the STEM curriculum.
2. Integration of practical work experience into academic sequencing exposes STEM students to learning environments which build relevant practical skill sets.
3. Diversity and cultural intelligence should be integrated into the STEM curriculum and need to be highlighted as a stated program outcome.

On Strategic Partnership Building:

1. Developing international STEM opportunities that fit well into an institution's existing structure will be most sustainable.
2. Ensuring sufficient support and resources from the highest levels at the institution is crucial.
3. Participating students are the best advertisements for promotion of international experiences and should be included in outreach/recruiting.

On Funding Global STEM Initiatives:

1. STEM faculty need to encourage their students to go abroad, since they are very important advisors and role-models.
2. Funders should realize the value of international experiences leading to better job opportunities for their STEM students, whether international or domestic.
3. Customized programs are particularly important to increase STEM students' access to global experiences.

IV. Further Resources

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