Deep Knowledge Integration Across Disciplines: The EMBeRS Method

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AGENDA

1. Need for interdisciplinary research in sustainability science
2. Challenges of interdisciplinary research
3. The EMBeRs method
United Nation’s 2015 Agreement 17 Sustainable Development Goals for 2030

1. No poverty
2. Zero hunger
3. Good health
4. Quality education
5. Gender equality
6. Clean water
7. Affordable and clean energy
8. Decent work and economic growth
9. Industry, innovation and infrastructure
10. Reduced inequalities
11. Sustainable cities and communities
12. Responsible consumption and production
13. Climate action
14. Life below water
15. Life on land
16. Peace, justice and strong institutions
17. Partnerships for the goals

UN World Commission on Environment and Development: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”
Depletion of Freshwater Resources

United Nation’s Environment Programme
Challenges of Interdisciplinary Research

National Academy of Sciences (2015) Enhancing the Effectiveness of Team Science

1. High diversity
2. Deep knowledge integration
3. Goal misalignment
4. Task interdependence
5. Permeable boundaries
6. Large size
7. Geographic dispersion
REALITY: Scientists & Engineers Collaborating

Study computation
“First you must convert your data to RDF and then we can use automated reasoning…”

Study nature
“The phenology and productivity of a C3 grass…"

Study people
…I study phenomenology, hermeneutics and structuration theory”
Practical lessons learned

No structure
Ad hoc dialogue
No progress

Firm structure
Research presentations
No understanding

How NOT to do this
Question of interest: How can we more effectively engage across disciplines to overcome the challenges of deep knowledge integration?

Approach: Apply theories from cognitive and social sciences:
- Transformative learning
- Experiential learning
- Model-based reasoning
- Boundary objects
The EMBeRS Method

- Lightly structured, participatory process
- Explore the problem space from different perspectives
- Emphasis on informal teaching and learning
- Co-create visual representations of the problem ("boundary negotiating objects")
- Recognize that shared vision emerges through time
EMBeRS Workshops

- Summer workshop for PhD students
- 2016, 2017 - 10 days each
- 13 students each workshop
- Recruited from large, interdisciplinary NSF projects related to water
- Different disciplines, different institutions
**Data Collection**

**Environmental education expert**  
*(Dr. Shirley Vincent)*
- Surveys, interviews with students

**Learning research team**  
*(Dr. Kate Thompson)*
- Photos, videotape, audio recording
- Documents produced during workshop
Evaluation outcomes

- Transdisciplinary Orientation scores increased 10%
- Confident in their ability to effectively participate in and lead interdisciplinary teams, and teach transdisciplinary research skills to others
- Developed competencies and understanding in 16 specific areas

Pennington et al. (submitted)
Learning research team

- Thematic analysis of student reflections:
  - Shifted concept of groups as needing to be goal oriented to productive, and from discussing conflict to trust and culture.

- Retrospective pre/post evaluation surveys:
  - Improvement in the value placed on self-awareness of their role in a group

- Analysis of the guided reflections at the end of each day:
  - Value of informal interactions in building trust and a supportive culture in groups

- Textual analysis of student writing:
  - Variety of approaches to interdisciplinary writing can impact on the final product submitted

- Linguistic analysis of the groups’ final output:
  - Two groups did produce an interdisciplinary research proposal

- Further research is examining the development of boundary negotiating objects
Long-term outcomes & transfer

Students consistently remark that they are finding the methods and tools they gained from the EMBeRS workshop extremely useful in a wide variety of ways:

- Within a variety of **research groups**
- To structure **collaborations** between research colleagues and project stakeholders
- To structure **dissertation design**
- Designed and led an **engineering class** period
- Led a **seminar** within a research group that was attended by a Center Director from Swaziland - **who then hosted** a two day workshop at the Center
- As a talking point with **job interviewers**
Preparing the next generation of sustainability scientists

Alexander K. Killion, Kelley Sterle, Emily N. Bondank, Jillian R. Drabik, Abhinandan Beri, Sara Alian, Kristen A. Goodrich, Marcia Hale, Rachel A. Myer, Quang Phung, Aaron M. Shew, and Anastasia W. Thayer.

ABSTRACT: Graduate programs emerging in unique complex socio-environmental systems. Constructing across disciplines and synthesize the social and natural inter- and transdisciplinary research acknowledge the this training is not available in all graduate programs opportunities. We present perspectives from a group of research in universities across the United States who training workshop to learn and develop socio-environmental autoethnographic study to share pre- and postworkshop opportuniestures reveal that students, regardless that include: (1) lack of exposure to epistemological perspectives in his/her research, and (2) variable levels barriers and advance integrative research, students advocate that both internal and sustainability scientists.

EMBeRS: An Approach for Igniting Participatory Learning and Synthesis

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Conclusions

- Interdisciplinary research is extremely challenging.
- There is a decade of research on science teams coming out of the cognitive, organizational, and social sciences that can help.
- There are many decades of research on learning that can also help.
- Transfer of these theories into meaningful approaches and activities “in the wild” is its own research challenge that must be undertaken by people in their own context.
- Training the next generation to do this more effectively is imperative if sustainability goals are to be reached.
Employing Model-Based Reasoning in Socio-Environmental Synthesis

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Lighting the fire of interdisciplinary synergy