

Deep Knowledge Integration Across Disciplines: The EMBeRS Method

Dr. Deana Pennington, University of Texas at El Paso

Dr. Kate Thompson, Griffith University

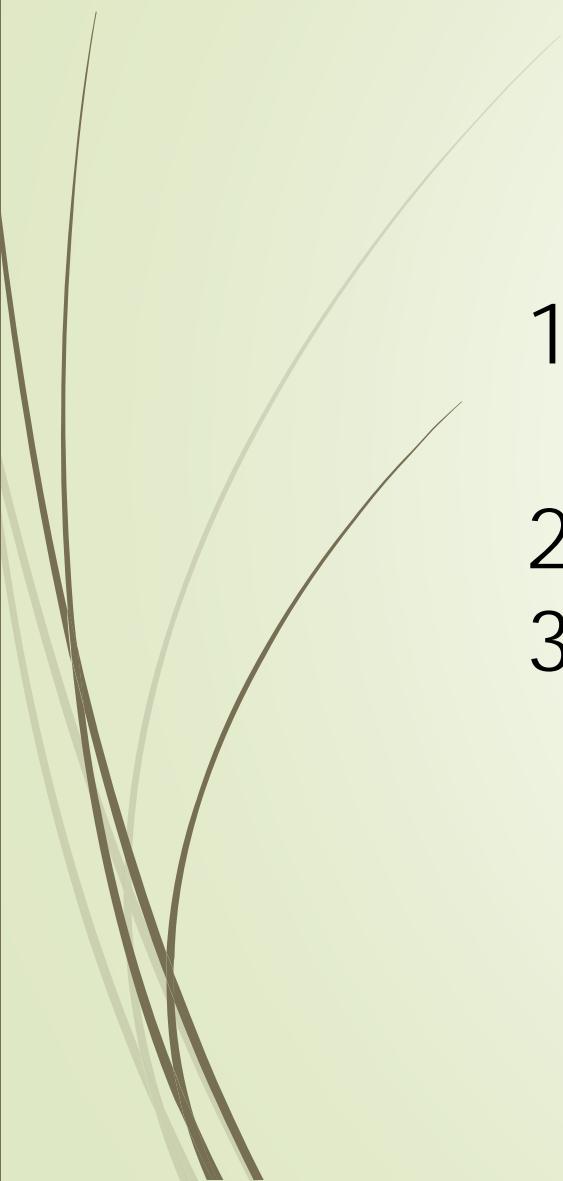
**Dr. Shirley Vincent, Vincent Evaluation Consulting, LLC*

Dr. David Gosselin, University of Nebraska at Lincoln

**Presenter*



AGENDA

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1. Need for interdisciplinary research in sustainability science
 2. Challenges of interdisciplinary research
 3. The EMBeRs method

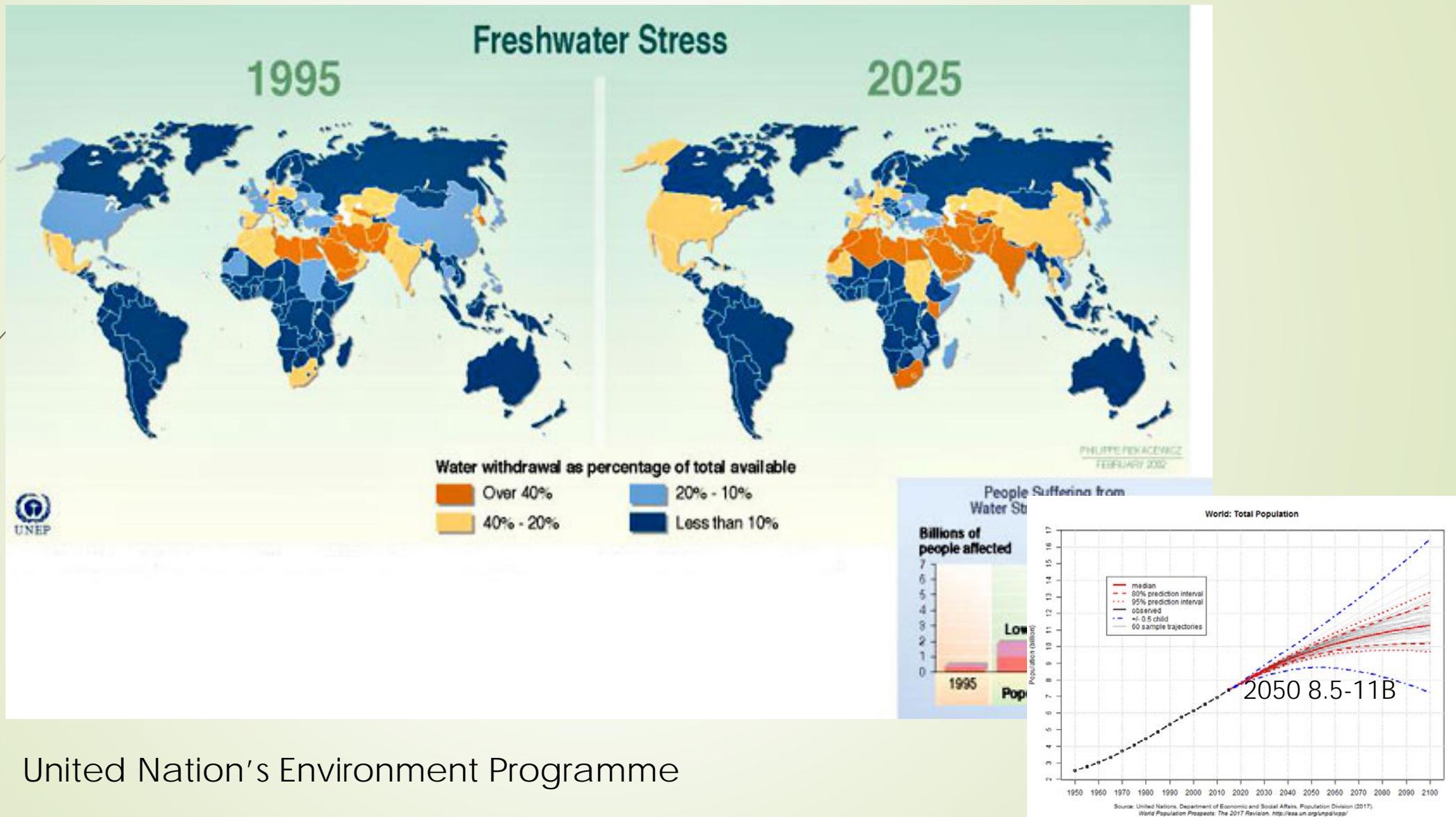
United Nation's 2015 Agreement 17 Sustainable Development Goals for 2030

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."



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

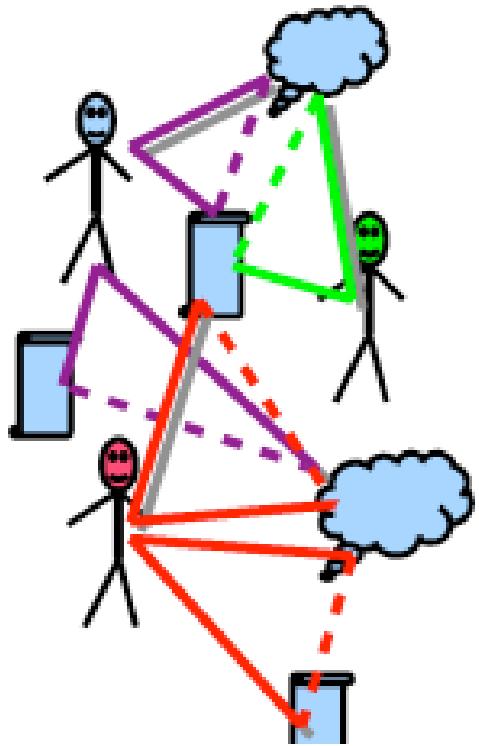
Depletion of Freshwater Resources



United Nation's Environment Programme

- 
1. Need for interdisciplinary research
 2. Challenges of interdisciplinary research
 3. The EMBeRS method

Challenges of Interdisciplinary Research



Process of developing a
shared research vision

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

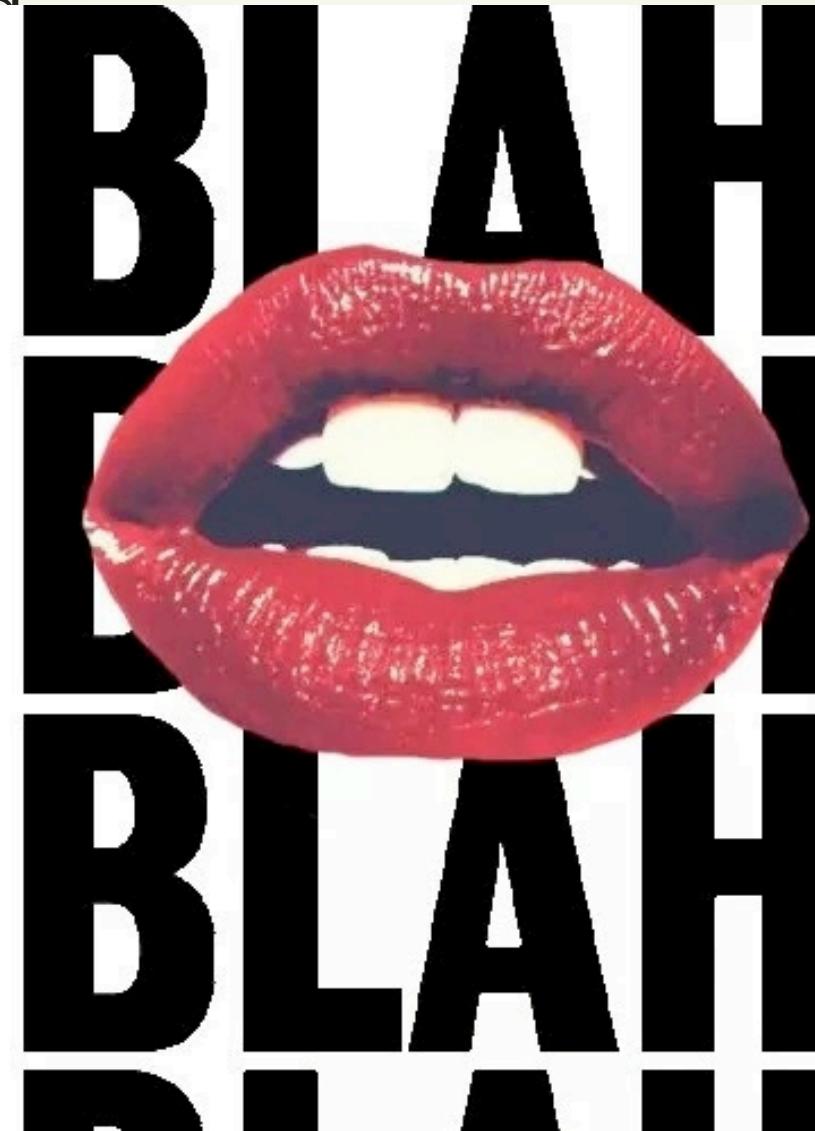


Focus here

REALITY: Scientists & Engineers Collaborating



Study computation
"First you must convert your data to RDF and then we can use automated reasoning..."



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Practical lessons learned

No structure
Ad hoc dialogue
No progress

Firm structure
Research presentations
No understanding



How NOT to do this

1. Need for interdisciplinary research
2. Challenges of interdisciplinary research
3. The EMBeRS method



Employing Model-Based Reasoning in Socio-Environmental Synthesis

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**

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Killion, A. K., K. Sterle, E. Bondank, J. Drabik, A. Bera, S. Alian, K. Goodrich, M. Hale, R. A. Myer, Q. Phung, A. M. Shew, and A. W. Thayer. 2018. Preparing the next generation of sustainability scientists. *Ecology and Society* 23(4):39. <https://doi.org/10.5751/ES-10395-230439>



Insight, part of a Special Feature on [Integration of Social and Natural Dimensions of Sustainability](#)

Preparing the next generation of sustainability scientists

[Alexander K. Killion^{1,2}](#), [Kelley Sterle³](#), [Emily N. Bondank⁴](#), [Jillian R. Drabik⁵](#), [Abhinandan Bera⁶](#), [Sara Aliah⁷](#), [Kristen A. Goodrich⁸](#), [Marcia Hale^{9,10}](#), [Rachel A. Myer¹¹](#), [Quang Phung¹²](#), [Aaron M. Shew¹³](#) and [Anastasia W. Thayer¹⁴](#)

ABSTRACT. Graduate programs emerging in universities are addressing complex socio-environmental systems. Constructing research training programs across disciplines and synthesize the social and natural dimensions of sustainability. Inter- and transdisciplinary research acknowledge the complexity of these systems and the need for training that addresses this complexity. However, this training is not available in all graduate programs that offer sustainability related opportunities. We present perspectives from a group of students who participated in a two-day research training workshop to learn and develop socio-environmental research skills. This autoethnographic study to share pre- and postworkshop experiences and outcomes. Results reveal that students, regardless of their discipline, identified three challenges that include: (1) lack of exposure to epistemological frameworks that support the integration of social and natural dimensions of sustainability in his/her research, and (3) variable levels of support for research training. To address these barriers and advance integrative research, students recommended the development of research training programs. Students advocate that both internal and external stakeholders support the development of research training programs that prepare the next generation of sustainability scientists.

iEMSSs International Congress on Environmental Modelling and Software



9th International Congress on Environmental Modelling and Software
Fort Collins, Colorado, USA, Mazdak Arabi, Olaf David, Jack Carlson, Daniel P. Ames (Eds.)
<https://scholarsarchive.byu.edu/iemssconference/2018/>

EMBeRS: An Approach for Igniting Participatory Learning and Synthesis

[Deana Pennington¹](#), [Emily Bondank²](#), [Jennifer Clifton¹](#), [Alexander Killion³](#), [Katalina Salas¹](#), [Aaron Shew⁴](#), [Kelley Sterle⁵](#) and [Bradley Wilson⁴](#)

¹University of Texas at El Paso, ddpennington@utep.edu, jclifton@utep.edu, ksalas2@miners.utep.edu; ²Arizona State University, ebondank@asu.edu; ³Boise State University, alexanderkillion@u.boisestate.edu; ⁴University of Arkansas, amshev@email.uark.edu, bsw006@email.uark.edu; ⁵University of Nevada, sterlek@unce.unr.edu

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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"Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation."



Lighting the fire of
interdisciplinary
synergy

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