IGE: Applying Creative Inquiry to Enhance Imaginative and Collaborative Capacity in STEM

Nate Nibbelink, Mark Callahan, Elizabeth King, Kathryn Roulston, Brian Haas

UNIVERSITY OF GEORGIA

Center for Integrative Conservation Research

UGA Arts Collaborative

Summary

Advanced scientific training is insufficient to position future leaders to solve the complex problems we face. They must also think creatively, collaborate across disciplines, and work effectively with people having different perspectives, knowledge, and values.

Creativity training can stimulate both scientific creativity and skills for interdisciplinary collaboration. To date, its benefits for STEM graduate education are largely anecdotal, but clearly merit research.

We bring together diverse STEM and arts graduate students in a six-stage program that uses training methods from the arts to build students' imaginative and collaborative capacities. We are evaluating a range of students' experiences and perceived effects of the creativity-based training, including effects on their abilities to:

- **frame problems in new ways and**
- **solve complex problems in diverse teams**

If this mode of training generates desired outcomes, widespread adoption of these methods will contribute to equipping STEM graduates with communication and collaboration skills, and ultimately increase creative and innovative solutions to complex global environmental challenges.

"To develop a complete mind: Study the science of art, study the art of science. Learn how to see."

-Leonardo da Vinci

Many minds and hands

Our team contributes to environmental problem-solving through applied research, craft, and/or training using diverse skills and approaches.

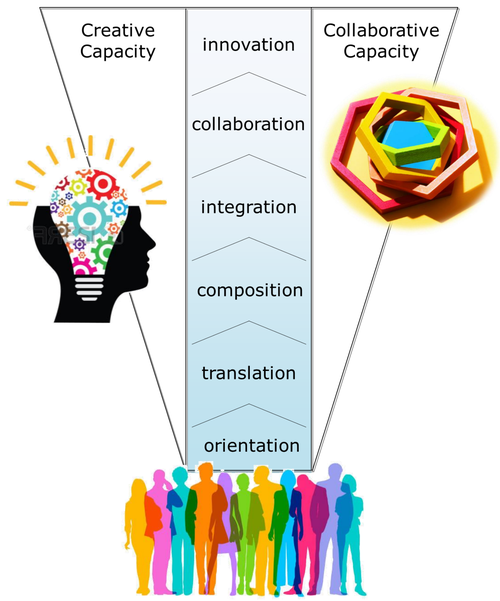
Mark Callahan - Visual Art, Media Art, ArtX
Christine Cuomo - Feminist Philosophy, Ethics
Laurie Fowler - Water Conservation, Law
Rebecca Gose - Dance, Choreography
Brian Haas - Neuro- and Behavioral Science
Jenna Jambeck - Environmental Engineering
Elizabeth King - Socio-Ecological Systems
Michael Marshall - Photography, Science and Art
Nathan Nibbelink - Spatial Ecology, Env Management
Kathryn Roulston - Education, Qualitative Assessment

Approach

The training program is embedded in a section of an orientation course that all 1st year graduate students at UGA must take. We actively recruit STEM and Arts program students, and accept all others who enroll.

One arts and one STEM faculty member instruct/facilitate a series of six workshop modules designed to build both imaginative and collaborative capacity. The campus watershed serves as a ***boundary object*** – *a concept that is understood by disparate groups, but in unique ways.*

In the activities, students learn to translate their unique perspectives to each other in novel ways, and integrate what they learn from one another to discover new problem framings and solutions.



Workshop Modules use pedagogy and forms of expression from the Arts to build student skills and confidence to communicate, collaborate, and innovate in science.

1. ORIENTATION: learning new ways to identify and share one's disciplinary viewpoints.
2. TRANSLATION: creating analogies and metaphors from scientific concepts.
3. COMPOSITION: applying creativity to discover new contexts and relationships in scientific data
4. INTEGRATION: using embodied cognition and creative expression to comprehend multiple perspectives
5. COLLABORATION: using creative group work to forge connections and develop collaborative frameworks for insight
6. INNOVATION: applying all previous skills in teamwork to improve complex problem-framing

"… that arts may help the sciences might well meet with skepticism in practice. However, the evidence is overwhelming that such seemingly irrelevant activities should not be seen as procrastination, but rather as effective ways to boost scientific productivity."

Scheffer et al. (2015)

Evaluation

A. Effectiveness of Training

Quantitative, pre/post tests of cognitive flexibility.

- Divergent thinking: Alternative Uses test
- Convergent thinking: Remote Association

B. Value of Training

Qualitative, inductive & abductive approaches to assess training impact.

Evaluators use ethnographic observation and analysis of student activities, interviews, and materials to assess the ***most significant changes*** that students attribute to training, including:

- Effects on creativity and collaboration
- Plus ***broader range of values*** they gain from the training experience

Preliminary Findings

A. Effectiveness of Training

The 1st cohort (n=29) showed modest pre/post increases in divergent thinking.

However, a key limitation of these tests is ***language***. Both tests rely on word associations, and our cohorts – like many grand challenge scientists – are not all native English speakers.

B. Value of Training

We are making exciting and unexpected discoveries about the value of creativity-based training.

Generally, many students reported that:

- The class is a welcome and needed opportunity to have fun and reduce stress.
- Low-stakes learning was a celebrated relief.
- They rediscovered their enjoyment of creative activities (even Arts students!).
- They didn't realize people had such different ways to think about or tackle the same problem.
- They learned valuable give-and-take skills for communicating and collaborating with others.

ORIENTATION Module: Two student groups' rapid prototyping work. Given paper and pens, they were asked to interpret their own demographic and academic data, and formulate shared questions about their graduate career ahead.

Institutionalization

We will continue to offer the training through the current curricular model, as part of the required 1st year orientation course. Dozens of sections of that course are offered across campus. However, as more students hear about the positive reviews for our Arts & Environmental Problem Solving option, we expect its popularity will grow.

Our current plan is to offer the modules through the Graduate School's portfolio of professional development workshops and trainings as a way of supporting and scaling up successful efforts.

UGA's Center for Integrative Conservation Research and the UGA Arts Collaborative will continue to coordinate and offer the IGE workshops after NSF funding is complete.

COMPOSITION Module: In 3 15-minute rounds, students created individual collages of a photo set related to watersheds. Then they had to combine their collage with a neighbor, letting go of their commitments and opening up to new possibilities. Then two pairs had to combine theirs. Above is one product, in which they crumpled and cut letters out of pictures, in the end creating a dynamic, meaning-rich composition.

Dissemination

We will publish a web-based manual including the full curriculum, links to assessment results, lessons learned, and best practices.

However, we do not know how much of the significant changes are due to the activities, the facilitators, or their unique combination. Thus the effective design of web-based materials is a major challenge before us. We anticipate that it will require detailed training for facilitators as well as the exercises themselves. Thus we are considering offering training sessions as well as printed material.

We will use NSF's database of IGERT/ NRT programs and the Council of Graduate Schools to disseminate our model through and to established, receptive faculty and student populations. We also intend to publish the evaluations of the project.

Acknowledgements

Thanks to NSF reviewers and program officers for constructive feedback over multiple submissions. We appreciate Meredith Welch-Devine and the UGA Graduate School for being champions of interdisciplinarity and innovative ideas! This material is based upon work supported by the National Science Foundation under Grant No. 1856302. 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.

For further information

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This NSF-IGE award will bring diverse groups of graduate students together from STEM and arts disciplines to address local watershed issues using creativity-based training methods from the arts. We will investigate the impact of targeted creativity training on students' abilities to:

- ***frame problems in new ways, and***
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Approaches

One arts and one STEM faculty member will serve as instructors/facilitators in a series of six workshop modules designed to build creative and collaborative capacity in the context of local watershed issues.

1. *<u>Orientation</u>: cohort participants and facilitators share their disciplinary viewpoints*
2. *<u>Translation</u>: creating analogies and metaphors from scientific concepts*
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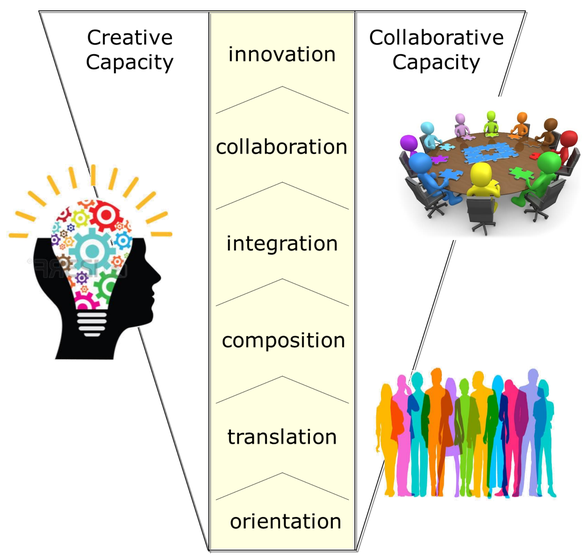

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Evaluation

Research questions	Data sources
Semester 1: Developmental evaluation - program design and implementation	
▪ What activities generate novel ways of thinking? ▪ What activities facilitate interdisciplinary collaborations? ▪ What are students' perceptions of the program? ▪ How do arts and STEM students communicate in program activities? ▪ What do faculty and students perceive to be "not working"?	<u>Students</u>: ▪ Pre-test measures of creative capacity (con-vergent and divergent thinking) ▪ Field notes of observations of activities ▪ 30-minute individual interviews ▪ Post-test measures of creative capacity <u>Faculty</u> ▪ 30-minute individual end-of-semester interviews
Semesters 2-5: Formative evaluation - inform revision of program implementation	
▪ What activities generate novel ways of thinking? ▪ In what contexts are collaborations facilitated? ▪ What are students' perceptions of the program? ▪ What learning outcomes are demonstrated? ▪ How has team revised the program to address what was not working?	<u>Students</u>: ▪ Pre-test measures of creative capacity ▪ Video-tapes of activities for creative and collaborations capacity-building ▪ 60-minute focus groups ▪ Post-test measures of creative capacity <u>Faculty</u> ▪ 30-minute interviews
Final: Summative evaluation - assess program impact	
▪ How did individuals and cohorts vary with respect to perception of, and engagement with program activities? ▪ What activities were most effective?	<u>Students</u>: ▪ Pre-test and post-test measures of creative capacity ▪ Video-tapes of activities ▪ 60-minute focus groups ▪ Comparative case analysis <u>Faculty</u> 30-minute interviews

Institutionalization

- The Graduate School will support scaling up successful elements through curriculum and trainings.
- UGA's Center for Integrative Conservation Research and Ideas for Creative Exploration will continue to coordinate workshops after NSF funding is complete.
- Launching workshops as a credit-bearing course will ensure instructors receive teaching credit.
- The Graduate School will continue to support a seminar series on "creativity and collaboration for innovation" that will be launched as part of this IGE project.

Dissemination

- We will use the Council of Graduate Schools network to share/publish in venues that reach other schools.
- We will use NSF's database of IGERT/ NRT programs to disseminate our model through established, receptive faculty and student populations.
- Our team, representing several disciplines, will extend our outreach to disciplinary conferences and journals.
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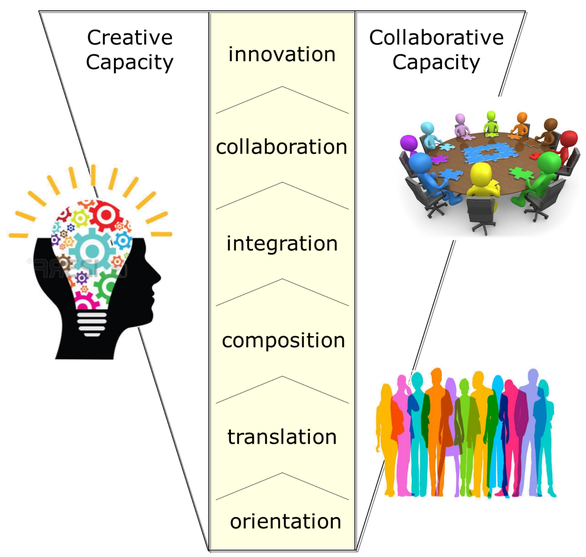

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