An Interdisciplinary Approach to Holistically Educating Science and Engineering Students

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Aim of Talk

Present an innovative approach to develop resilient STEM students who possess the proficiencies of communication, negotiation, thinking outside of the box and collaborative problem solving…

Outline of Talk

1 – Guiding Thoughts and Questions
2 – Entrepreneurship and Capital
3 – Resilience, Adaptive Cycles and Panarchy
4 – Intellectual Apprenticeship
5 – Takeaways

1 – Guiding Thoughts and Questions

Thoughts

If you want to walk fast, walk alone…
If you want to walk far, walk together…

African Proverb…

Real world problems often transcend disciplinary boundaries

"Seek to understand before being understood"

Questions

What is you most precious asset?

Are we using this asset wisely to add value to the STEM education process?

Could a more holistic, interdisciplinary, or even perhaps, transdisciplinary approach add value to the education process?

2 – Entrepreneurship and Capital

As educators, we can think of ourselves as entrepreneurs who develop capital

The Capital of a System (Cap) can be thought of as at least:

$= \Sigma\ Cap_{financial} + Cap_{Human} + Cap_{Intellectual} + Cap_{Cultural} + Cap_{Environmental} + Cap_{social}$

The Capital of a System (Cap) can be thought of as at least:

Educators responsible for

$= \Sigma\ Cap_{financial} + \mathbf{Cap_{Human} + Cap_{Intellectual}} + Cap_{Cultural} + Cap_{Environmental} + Cap_{social}$

In my experience, there has been an institutional shift to an increased focus on financial capital at the expense of the other forms

$= \Sigma\ Cap_{financial} + Cap_{Human} + Cap_{Intellectual} + Cap_{Cultural} + Cap_{Environmental} + Cap_{social}$

In Higher Education, both in policy and practice, while we talk about *maximizing our return on investment,* how can we if we primarily focus on one form of capital?

Thoroughbred

High Performance

BUT

Low Resilience

Quarter Horse

Lower Max Performance

BUT

Higher Resilience

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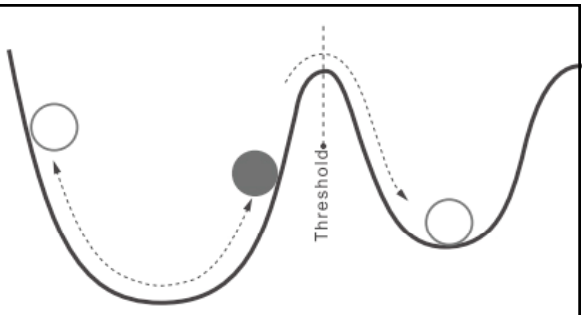
I assert that this increased focus on financial capital contributes to the production of less resilient students and citizens

3: Resilience, Adaptive Cycles and Panarchy

Resilience

The capacity of a system to absorb disturbance and still retain its basic function and structure



Ecological resilience concept

Resilience Thinking

Formal theoretical construct that has its roots in dynamic systems theory, the body of math that characterizes the behavior of complex systems.

"…the interplay between stabilizing and destabilizing (learning/re-learning & unlearning) properties is at the heart of present issues of development and the environment - global change, biodiversity loss, ecosystem restoration and sustainable development."

B. Walker…

Resilience

Built Around Maintaining/Enhancing Two Main Types of Diversity:

Functional Diversity…

Refers to the different functional groups (e.g. stakeholders the process of engaged STEM scholarship) that are represented in a system

Response Diversity…

Different responses to disturbances as a function of functional diversity

Generally,

Functional Diversity ↑ Response Diversity ↑

Resilience ↑

and…

Functional Diversity ↓ Response Diversity ↓

Resilience ↓

The Adaptive Cycle

Although often presented as being *linear*, processes within a Socio-Ecological System can be thought of as *having a cycle*.

This cycle, the **Adaptive Cycle** has four general phases:

Growth ➔ Conservation ➘

↖ Reorganization ➔ Release

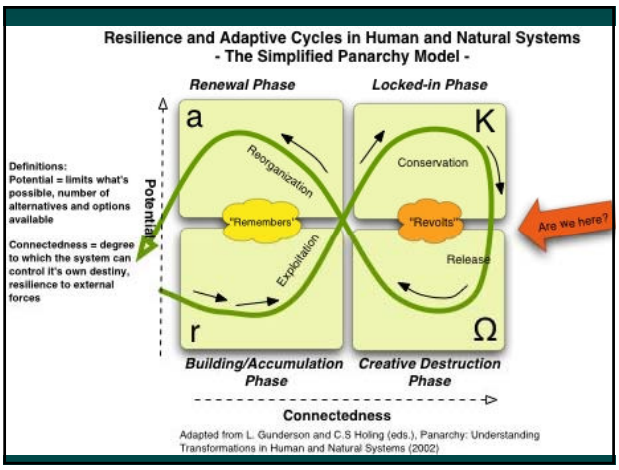
Ex. Adaptive Cycle: Playing With Legos…

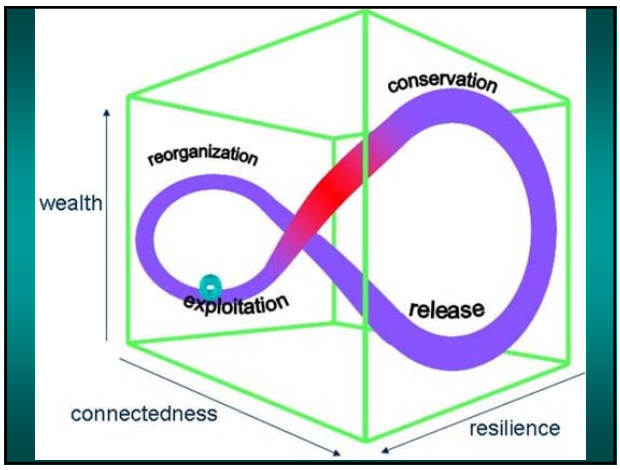
Growth ➔

↖ Reorganization

Conservation ➘

➔ Release





Phase	Potential	Connectedness	Resilience
α Reorganization	high	low	high
K Conservation	high	high	low
r Growth	low	low	high
Ω Release	low	high	low

Important Note:

High connectedness implies low flexibility; low flexibility translates to low resilience, *regardless* of system potential!

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Adaptive cycles at different scales of time and space can interact and therefore impact their system dynamics

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Panarchy

The structure in which systems, including those of nature, of humans, as well as combined human-natural systems, are *interlinked, continual adaptive cycles of growth, accumulation, restructuring, and renewal*

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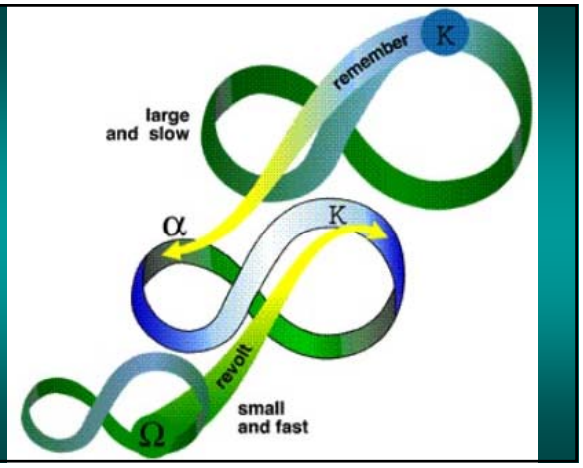

Panarchy:

Its cross-scale, interdisciplinary, and dynamic nature and essential focus is *to rationalize the interplay between change and persistence, between the predictable and unpredictable.*

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Another Way to Define Resilience?

"Resilience, in short, is largely about learning how to change in order not to be changed. Certainty is impossible. *The point is to build systems that will be safe when they fail, not to try to build fail-safe systems.*"

Read more at http://www.project-syndicate.org/commentary/what-is-resilience-by-brian-walker#6etCf1VtDqYK52ey.99

What does this imply for educational approaches to STEM?

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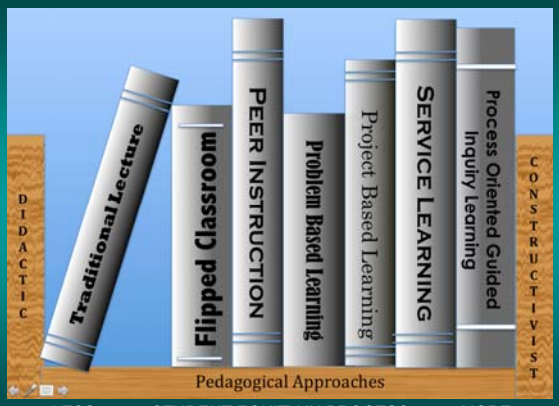
4: Our Intellectual Apprenticeship for Engaged Scholarship

Modes of Engaged Scholarship



LESS ⟵ STUDENT EQUITY IN PROCESS ⟶ MORE

Faculty Student Mindsets:

☑ **Asset Based Approach**

☒ **Deficit Based Approach**

The foundational tenets of the 3 **R**'s

- **R**espect
- **R**eciprocity
- **R**elationship

☒Extractive ☒Transactional ☑Transformative

Commitment to the 5 **C**'s

- **C**uriosity
- **C**ulture
- **C**ontext/Connection
- **C**ivic Engagement
- **C**o-Construction*

**Knowledge is not created in a vacuum*!

Adherence to the Etiquette of Engagement – the 3 **P**'s

☑ **P**eople ➔ **P**rocess ➔**P**roduct

☒ **P**roduct➔ **P**rocess ➔**P**eople

The Five Steps of the Intellectual Apprenticeship

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1. Snow Globe…

Creates cognitive dissonance and challenges existing frames of reference by forcing students (*and faculty*) to look beyond their "bubble"

2. Water Wings

This stage provides the students with an opportunity to practice in house with close supervision.

During the course of short term immersive experiences, students are mentored through the process of engagement and are introduced to rather than imposed upon potential partners.

3. Summer Camp

An extended stay away learning experience with mentoring primarily from practitioners and professionals in the field, ***but*** with enough freedom for students to struggle with the complications of the work of engaged scholarship

4. Decanting the Wine - Letting it Breathe

Students reflect and analyze how their actions and co-constructed understandings stemmed from their own particular context.

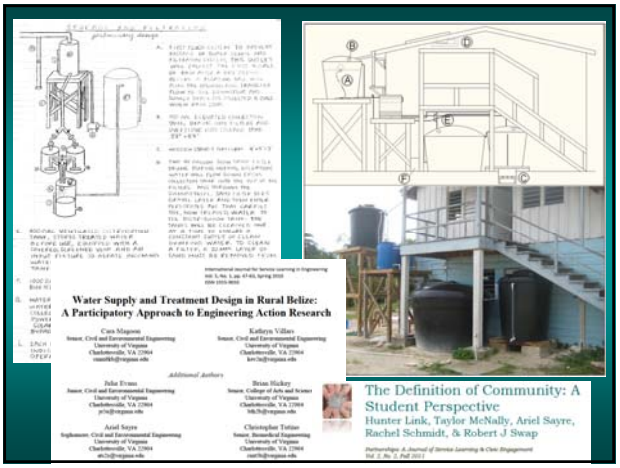
Intensive faculty mentoring during post engagement helps students make sense of their experience from personal, professional, technical, cultural, and socio-economic perspectives.

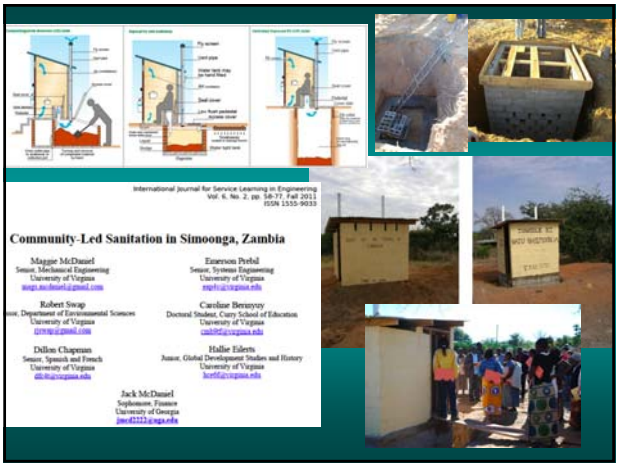
5. The Handoff…

The handoff signifies what goes into the effective communication, transmission and dissemination of knowledge.

Further, it gets students thinking about their ***roles and responsibilities*** as holders of knowledge that they helped generated and that has been entrusted to them to carry.

Examples of ***Collaborative*** Service Learning Community Engagement Water and Sanitation Student Projects and Knowledge Products





5 – Takeaways

Here are just a few…

- Our most precious asset is time – how are we best utilizing it as entrepreneurial educators?
- Respect, Reciprocity and Relationship
- People, Process, and then Product
- Coupled Human Natural Systems Flow in Adaptive Cycles
- Value in exposing students to uncertainty, adversity and non-linear, interdisciplinary problem solving

Lastly…

"…The point is to build systems that will be safe when they fail, not to try to build fail-safe systems."

Read more at http://www.project-syndicate.org/commentary/what-is-resilience-by-brian-walker#6etCf1VtDqYK52ey.99

How do you want to walk?

Xie xie!

Please email with additional questions:

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