The Small Things We Do That Add Up

Improving the Learning Environment for our Students

Joe Tranquillo
Bucknell University

This is NOT a research talk

The Case Against Teaching
Larry Spence

- A 12th century farmer would only recognize the cows in a modern dairy
- A 13th century physician would run screaming from a modern operating room
- Galileo could only gape in wonder touring NASA’s Johnson Space Center
- Columbus would be terrified of a nuclear sub
- A 15th century professor would feel right at home in most classrooms

The Junkyard

The Changing Educational Paradigm

Old	New
Information is one-way	Information emergent
Factory Model of learning	Student-driven learning
Extrinsic Motivation	Extrinsic and Intrinsic Motivation
Lecture	Interactive, creative, social
Sequential model of knowledge	Networked Model of Knowledge
Individual is the focus	Groups/Teams are the focus
Skills and Knowledge	Skills, Knowledge and Mindsets

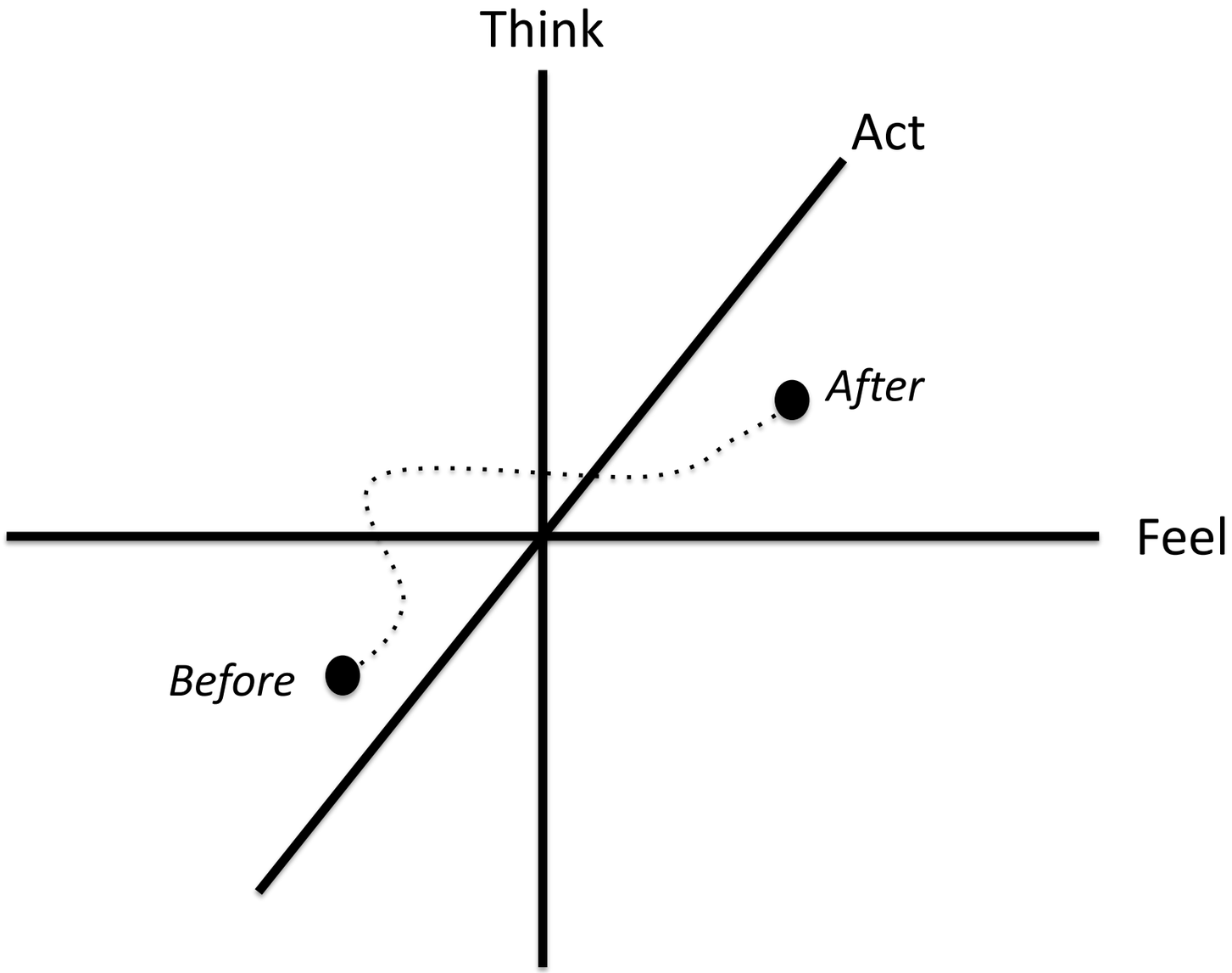
Learning is a Delta (Δ)

“Learning is when students think, act or feel differently”

- Ken Bain

$$\frac{d(learning)}{dt} = \frac{d(think)}{dt} + \frac{d(act)}{dt} + \frac{d(feel)}{dt}$$

Learning is a Delta (Δ)



The power of frameworks

The Elephant, the Rider and the Path

Emotional Elephant	Tone	Empathy
Rational Rider	Clarity	Reflection
The Path	Challenge	Onion

Course: Date:

Elephant	**Rider**	**Path**
Tone 	Clarity 	Challenge 
Empathy  $\frac{d(feel)}{dt}$	Reflection  $\frac{d(think)}{dt}$	Onion  $\frac{d(act)}{dt}$

Notes

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What this talk is NOT

Institute for Leadership in Technology and Management

Product Archaeology Canvas		
Broader Impacts		
Marketing	Customers/Stakeholders	Sales and Distribution
Legal and Regulatory	Value Proposition	Technical Design
Finance	Operating	Resources
Project Title:		Date:

Medical Product Archaeology Course

BMEG350 Biomusical Instruments

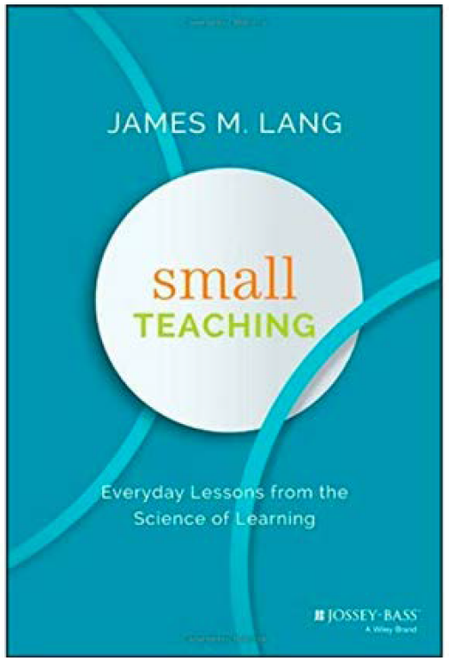
Landmine Detecting Rats

Engineering in a Global and Societal Context (in Chile)

Gunpowder Joe

KEEN Winter Interdisciplinary Design Experience

Small Teaching



It’s too hard to make big changes

Small changes are easier to try and receive feedback quickly

Small incremental changes can have a powerful effect, especially when they add up

Course: Date:

Elephant	Rider	Path
Tone 	Clarity 	Challenge 
Empathy 	Reflection 	Onion 

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The Elephant: Emotions and Learning

- Individuals are social and emotional creatures
- Emotions flag learning (Somatic Marker Hypothesis)
- Emotions (often) precede rational decision making
- Individuals have needs that when not met interfere with learning
- Emotional relationships bind people together
- Groups build knowledge together (Social Constructivists)
- Cultures can be be healthy or unhealthy
- Tone and Empathy speak to the Emotional Elephant

Your students are NOT you!

There is more going on in your classroom than just the content

Tone

A Tale of Two Professors

There is no “right” tone!

Beginnings and Endings are Critical

Routine → Ritual

What is your favorite color?

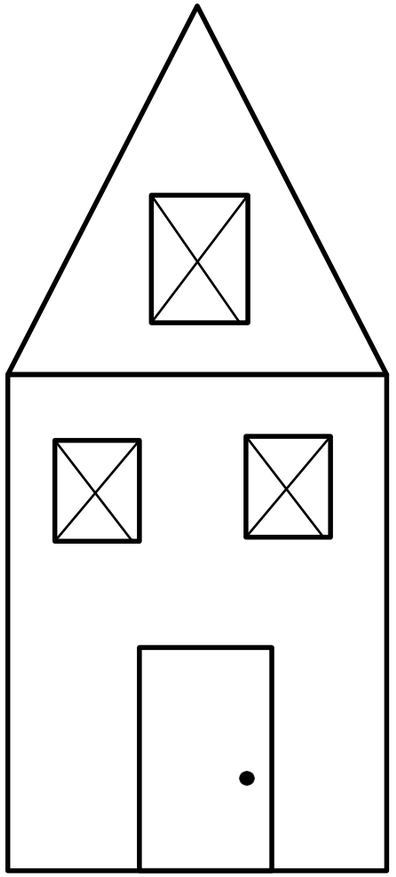
How you answer questions is a key to signaling tone

What else can kill the tone in a class?

Empathy

How can you be empathetic?

Help your students to become empathetic too!



Remember…..

- Students have perceptions of every class
- Their perceptions are their reality
- It is important students know you know their perceptions (and that you have adapted the learning environment)
- How might you collect student perceptions?

Getting a bit more personal

Felder and Brent Learning Inventory
Share the results with the class
https://educationdesignsinc.com/index-of-learning-styles/

Active												**Reflective**
11 kab	9 jvt	7	5 jwb	3	1 dpc dme	|	1 eak	3	5	7	9	11
Sensing												**Intuitive**
11 kab	9 dme	7 eak	5 dpc	3	1	|	1	3	5	7 jvt	9 jwb	11
Visual												**Verbal**
11 kab	9 eak jvt dpc	7 jwb	5 dme	3	1	|	1	3	5	7	9	11
Sequential												**Global**
11	9 dme	7 kab dpc	5	3	1	|	1	3	5 eak	7	9 jvt	11 jwb

Superhero Cards

Superhero name:
Superhero Description: *Backstory including pets, siblings, birthday etc..*
Superpowers: *Hobbies, special talents, fun facts*
Superpowers I want in the future: *Projects you are working on* *What do you want to learn*

Course: Date:

Elephant	Rider	Path
Tone 	Clarity 	Challenge 
Empathy 	Reflection 	Onion 

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The Rider: The Rational Engineer

- Changing thinking and acting is about rationality
- Information is turned into knowledge through linking concepts
- This requires sustained practice and direction
- Clarity and Reflection speak to the Rider
- Together they provide direction in learning

We all get better at the things we practice

Clarity

Objective / Purpose

Task

Time

Technique

Team

The 4 T's

Assessment

Emily and Andrew's timeline to accomplish this proposal:

- March 6, 2006: do nothing
- March 10, 2006: do nothing
- March 31, 2006: do nothing
- April 2, 2006: do nothing
- April 10, 2006: do nothing
- April 17, 2006: do nothing
- April 24, 2006: do nothing
- April 27, 2006: Start project
- April 28, 2006: present finished project

$$\text{Value} = \frac{\text{Perceived Benefit}}{\text{Perceived Cost}}$$

Objectives, Purposes and Value

Learning Objectives

The Δ for me

Statement of specific observable actions a student should be able to perform after a period of time.

Upon completion of this _____
[course, chapter, week, lecture]

you will be able to _____
[calculate, solve, estimate, describe, design]

*and will know you have succeeded by creating*_____
[artifact here]

Impact

The Δ for others

Statement of why this matters beyond the course

Breakout Box 3.11 Generating an Initial Project Statement

It is not easy to write the first draft of a project statement. Most, however, have a similar format which can be summed up as a MadLib™.

When we heard from _____ (company/person) we learned that _____ (observations).

This got us thinking about _____ (medical/clinical need) that impacts _____ (users). As we explored more, we found _____ (statistics here on significance and magnitude of problem)

Current solutions include _____ (list of solutions), however, they do not adequately address _____ (medical/clinical need), because _____ (shortcomings).

We don't know how to address this challenge yet, but we expect the technical barriers to be _____ (technical or other barriers). However, in meeting the need we would hope to increase/decrease _____ (one or two measurable results) which may also _____ (additional benefits). We think we are well positioned to address this challenge by _____ (one line project objective statement).

Possible Tasks / Techniques/ Artifacts

Build a prototype
User needs
Specifications
Validation test
Verification test
Literature review
Write a policy report
Commercial or documentary
Fact-based fictional story
Blog post
Design review
Newspaper/magazine article
Brainstorm summary
Engineering drawings
Call/ email a user or expert
Write your own learning objective
Write a reflection
Write a letter to ….
Poster Session
Formal Presentation
Skit
Pamphlet or poster
Engineering constraints
Exposition

Hook statement
Infographic
First person story
Review article
Team meeting
Educational tool or demo
Editorial
Annotated sketch
Feasibility test or study
Business pitch
Proposal
Design history summary
Funding request
Problem Statement
Business model canvas
Annotated Slide Deck
Interview
Build a survey
Execute and analyze a survey
Field trip notebook
Artistic representation or rendering
Budget and justification
Intellectual property assessment
Cost and Pricing estimate

Marketing plan
Poem or song
Failure analysis (FMEA)
Informal/Improvised Presentation
Existing solutions
Post-mortem dissection of process
Team contract
Build a website
Portfolio entry
Competition with judges
Team meeting
Team check-in
Material/part order (and justification)
Annotated photo essay
Problem concept map
SWOT Analysis
Possible partnerships
Ethical implications
Proposed macro-economic impact
Supply chain / distribution investigation
Value statement
Regulatory barriers
Sustainability statement
Non-profit charter or mission statement

Timing and Technique

- How many assignments will there be?
- How will assignments be scaffolded?
- How much time will they have to complete each assignment?
- What sources of information (or techniques/equipment) are they allowed to use?
- Are there particular processes you want them to practice?

Bad examples are instructive
(so are good examples!)

Assessment and Rubrics

	Formative	Summative
Direct	Teacher gives feedback to student on performance	Teacher gives grade/score to student on performance
Indirect	Student or peers give feedback on performance	Student or peers give a grade/score on performance

A Simple Rubric

Assignment

Authors

Score (1=novice, 5=master)

Content (25%)
1 2 3 4 5

Style/Layout (10%)
1 2 3 4 5

Text (10%)
1 2 3 4 5

Organization (10%)
1 2 3 4 5

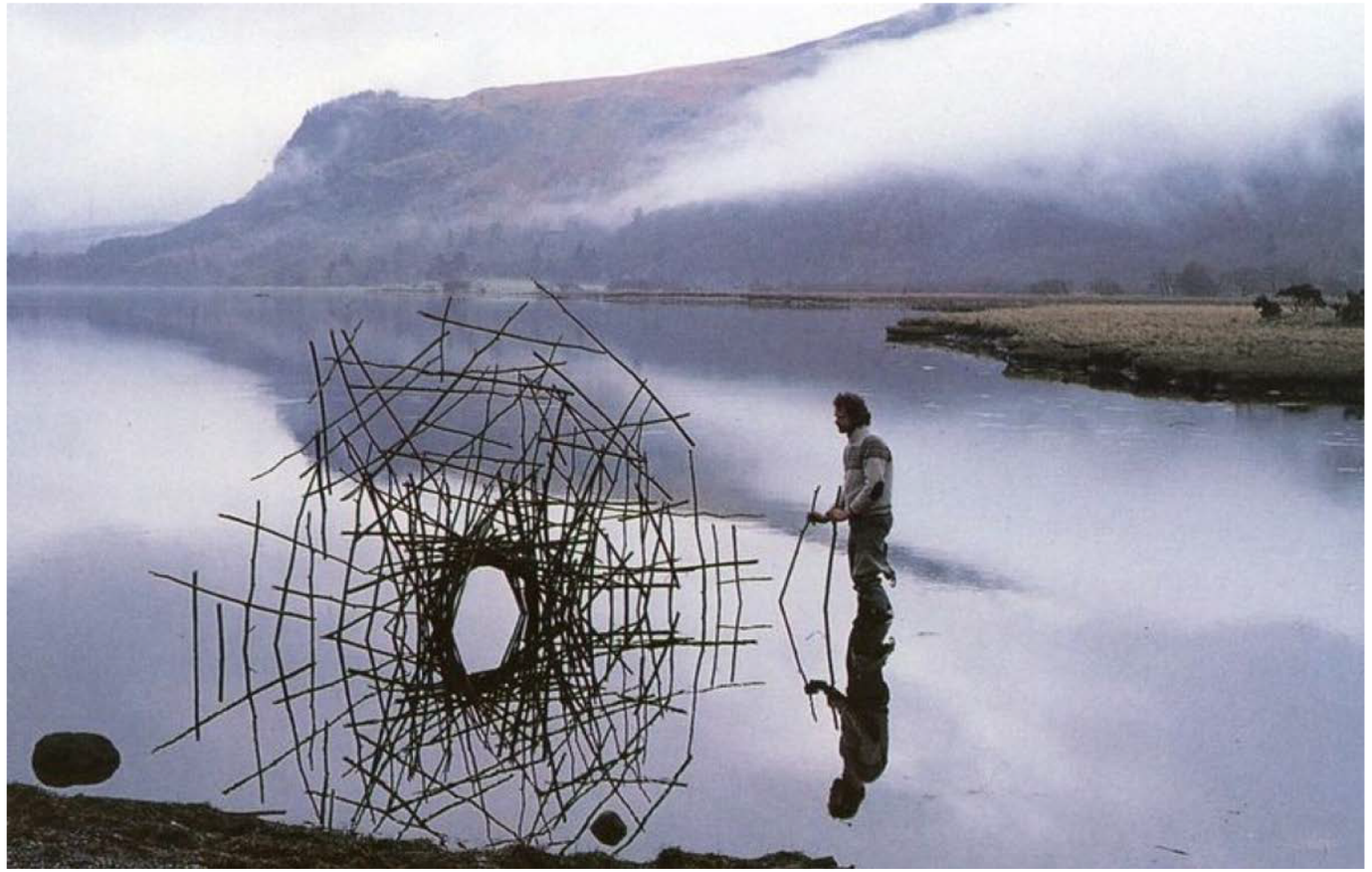
Graphics (25%)
1 2 3 4 5

Narrative (20%)
1 2 3 4 5

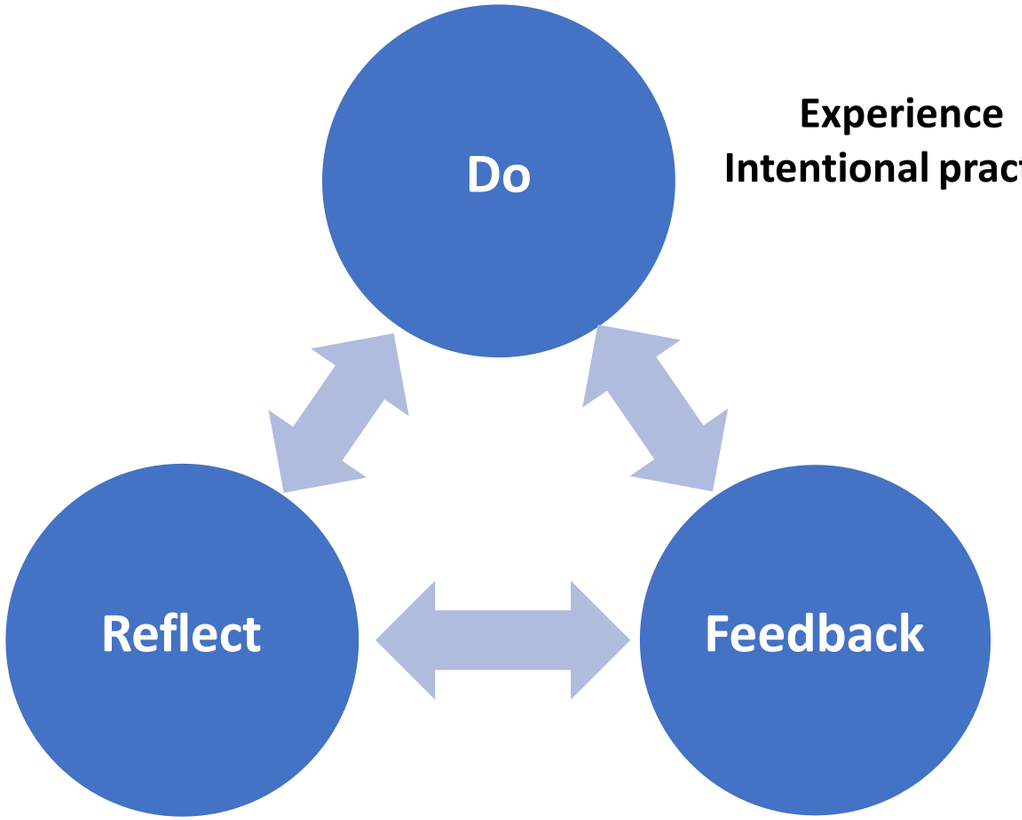
Notes

Herbert Dreyfus Model of Skill Acquisition
1 – novice
2 – competent
3 – proficient
4 – expert
5 - master

Reflection



Reflection Transforms Experiences



Experience
Intentional practice

Intentional
Before, During , After
Pointed Inward or Outward

Self, Peer, Instructor, Alumni
Is actionable

Reflection is a skill that can be learned and can become a habit

The Classic One-page Reflection

Write me a one page reflection on your experiences with this class

I felt that our team was able to create a product that delivered on many of the goals we had set out for before the build portion of the challenge took place. Due to this i felt our team worked well together, especially given the extremely small amount of time that we as a group were able to spend together due to scheduling conflicts. However, due to the group being unable to get together and meet for extended periods of time this created an environment that lead to the design challenge being about creating the simplest product possible and caused us to really gravitate towards the first idea that was thought of. This represented a major weakness in the uniqueness of our design which is why there was almost a completely similar product being made by another one of the design teams.

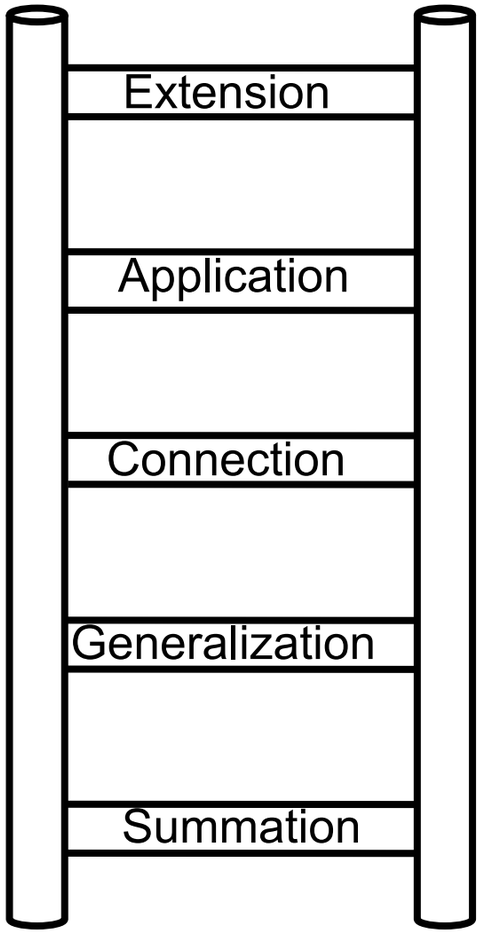
I felt that my contributions to the team were significant in that I was able to quickly change the materials we were going to be using as we ran into multiple road blocks. Between using a sealant that was overly expensive to having to put nearly half our budget on testing due to time constraints by the environmental lab. I thought as a team were able to adapt, but that I was also able to quickly think of what needed to be changed and the best and most cost effective ways to make the change.A major weakness I had during the design challenge was when our team had to market the device. Marketing is not something that I typically excel at, as if I had the choice I would simply lay down in black and white what my product does and the cost.

If i were to encounter design again I would ensure that the team members were able to meet much more frequently than my group did. This would allow a much more free flowing exchange of ideas. If there are more ideas being thrown around with maybe a set time by the group outside of class to brainstorm ideas I felt we would have been able to come up with a slightly better design that was more unique and fixed a few more of the problems that we had originally set out to solve.

One of the major skills that will carry over into the design project is my ability to think of different ways for things to be built. For instance in the design challenge the first material we used in attempt to heat the water was a travel mug. It fit all of the group's desired characteristics, metal, portable, not too large. This product though being a travel mug was insulated as a way to ensure that cold water did not get hot and due to this it prevented the water from boiling which was the main aspect of our device, being able to boil off the pesticides and bacteria.

If I were to try and market my abilities I would speak up my problem solving skills as well as my ability to work with anybody in a team. Mostly though I would talk about my ability to acknowledge not only my own strengths and weakness but my team members and make sure that everyone is in the team is working not only within their strengths but also improving their weaknesses.

Reflection Ladder



Describe another current or future situation that you anticipate will involve the same broad concept. What is one concrete step you can take to apply the concept that was reinforced during this experience?

Knowing what you know now, what would you have done differently given the same circumstances?

How did the experience reinforce the broad concept?

Describe the broader concept that the experience highlighted. Why is this concept important?

Describe the experience (who, what, where, how, why). Make sure to address “why” as this is often the most neglected aspect.

The higher you climb up the reflection ladder the better you can see where you have been, where you are and where you want to go next

Pointing the Spotlight of Reflection Outward or Inward

Pointing the Spotlight Outward: Models of the World

- Everyone has their own unique Model of the World
- Model of the world is a giant concept map
- Curiosity is the recognition of an incomplete network
- Creativity is recombination and new connections

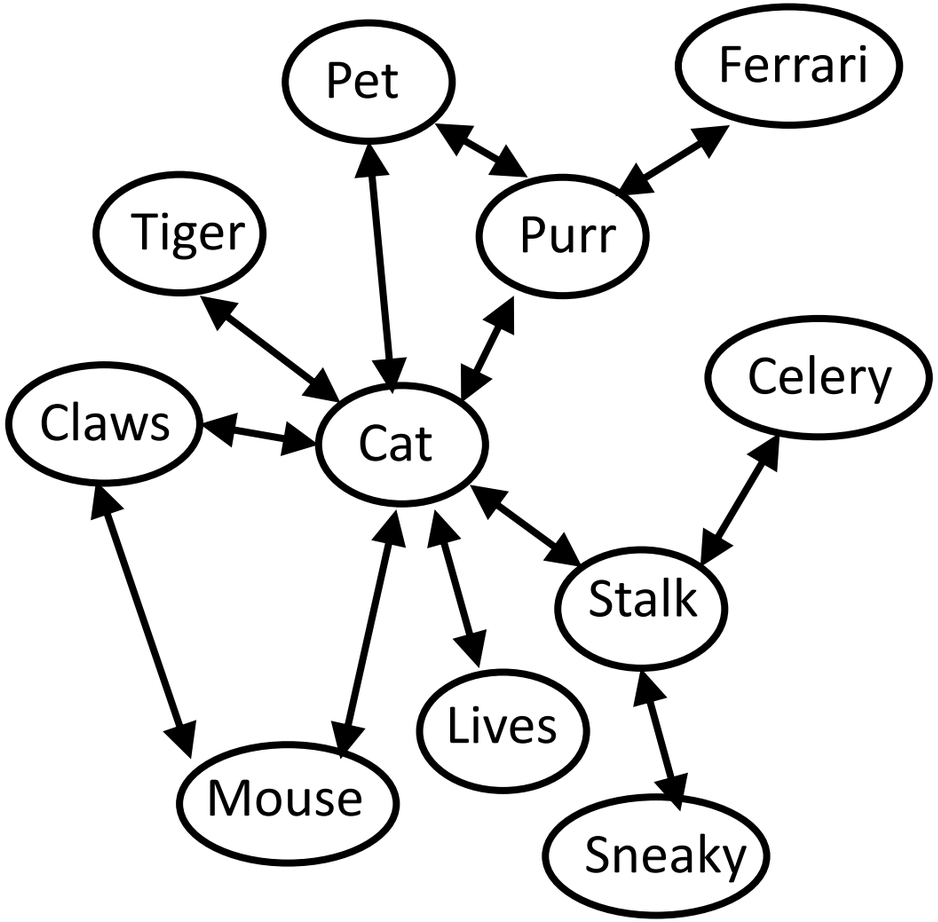
Model of World

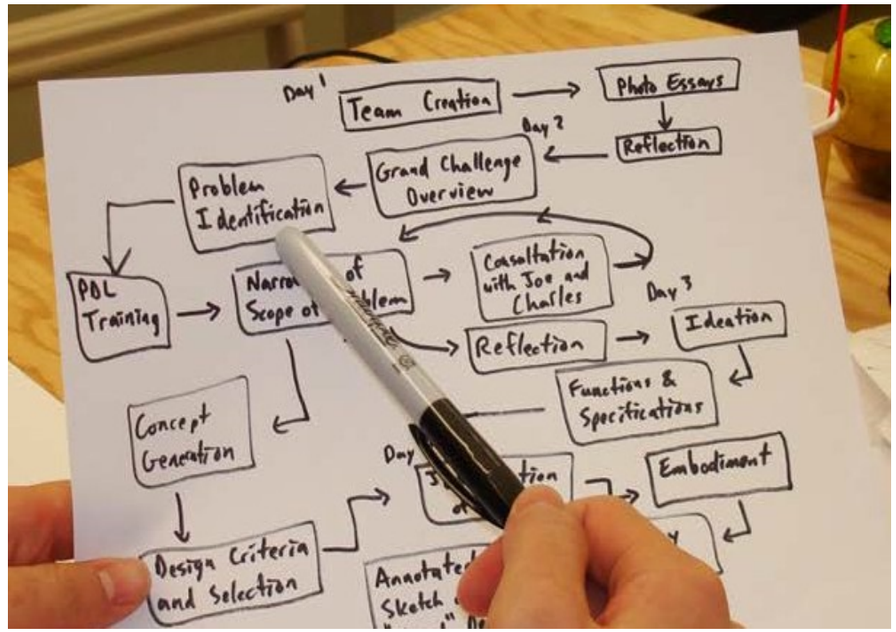
Reflection is a first step toward aligning our model of the world with the real world

Real World

Concept Maps As Reflection on World and Process

Concept Maps are networks that show relationships between ideas





Sketches show non-linear relationships between parts (real or ideas)

The Timing of Reflection Relative to Experience

Reflection-On-Action (backward looking)

Reflection-In-Action (in the moment)

Anticipatory Reflection (future looking)

Reflection-on-Action: Write a Story

To help you focus your stories, below is a list of words. You must pick three words from the list and write a story that illustrates how you embodied that word.

Drive.Grit.Resourcefulness.Integrity.Insight.Discipline.

Flexibility.Empathy.Ownership.Generosity.Playfulness.

Intrinsic Motivation.Efficiency.Inquisitiveness.

Daring.Vision.Decisiveness.Creativity.

Each story and decomposition does not need to be long (perhaps a paragraph or two at most). Your aim should be to show depth of reflection rather than simply pouring out words.

An Example of Pointing the Spotlight Inward

Reflection-in-Action

- Most people cannot truly multitask (we engage in rapid task-switching)
- Reflection-in-Action is embedding reflection into an experience
- Sometimes also call “Mindfulness” of “Metacognition”

Could you embed short reflections inside experiences?
Have “time-out” moments?
Think, Pair, (share)
Minute Papers?
Muddies Points?

Exam Wrappers (getting metacognitive)

- Questions asked during or right after an exam
- Reflection on more than the grade or what they did wrong
- Deconstruct exam preparation
- Deconstruct exam performance

33-111 Physics Post-Exam Reflection Name: _____

As with the first exam, this activity is designed to give you a chance to reflect on your exam performance and, more importantly, on the effectiveness of your exam preparation. Again, please answer the questions sincerely. Your responses will be collected to inform the instructional team; they will have no impact on your grade.

1. Approximately how much time did you spend preparing for this exam? _____
2. What percentage of your test-preparation time was spent in each of these activities?
   a. Reading textbook section(s) for the first time _____
   b. Re-reading textbook section(s) _____
   c. Reviewing homework solutions _____
   d. Solving problems for practice _____
   e. Reviewing your own notes _____
   f. Reviewing materials from blackboard _____
      (What materials? _____)
   g. Other _____
      (Please specify: _____)
3. What aspect(s) of your preparation for this exam seemed different from your exam 1 preparation? Did these changes have any effect?
4. Now that you have looked over your graded exam, estimate the percentage of points you lost due to each of the following (make sure the percentages add up to 100):
   a. Trouble with vectors and vector notation _____
   b. Algebra or arithmetic errors _____
   c. Problem with force-body diagram _____
   d. Lack of understanding of the concept _____
   e. Not knowing how to approach the problem _____
   f. Careless mistakes _____
   g. Other _____
   (Please specify: _____)
5. Students sometimes have difficulty drawing appropriate force-body diagrams and applying Newton's second law appropriately. Was either of these a difficulty for you (check question 2 on the exam)? If so, try to self-assess your understanding: Identify what aspect of these skills are causing you difficulty and what you can do to improve your ability to solve problems using these skills.

PLEASE CONTINUE ON THE BACK ON ANY QUESTION WHERE YOU NEED MORE ROOM.

For more information on using exam wrappers in your course or for help in designing an exam wrapper handout, please contact Dr. Marsha Lovett, Associate Director, Faculty Development, Eberly Center for Teaching Excellence.
http://www.cmu.edu/teaching/eberly/index.html

Pointing the Spotlight Inward: The Confessional

Team

It has been **days since we**

_____ last reached out to our mentor
_____ last met with our faculty advisor
_____ last gained information from someone not on our team
_____ performed a test or built a portion of our device
_____ made a critical decision
_____ made a technical calculation
_____ used information from a previous class
_____ had a team meeting (no mentor or advisor present)
_____ wrote up what we are doing
_____ posted to our design history file

Individual

It has been **days since I**

_____ last took the lead on something
_____ last did a task I did not want to do
_____ last did a task that I enjoyed
_____ contributed something original to the group effort
_____ took on a challenge
_____ used something from another class
_____ started building a habit that I hope to continue later

Anticipatory Reflection: Student Learning Objectives

Project Proposal

Post to the Google Website on 10/9 and 10/26 by 5pm

Each design group is required to submit a preliminary plan for their design project. This plan will be evaluated and reviewed by Dr. Tranquillo with appropriate comments being directed back to each group. The purpose of the preliminary plan is to communicate the narrowed project scope and demonstrate that you have thought through the project. Since a *feasibility demonstration* will occur later in the semester (November 10th), a thorough preliminary plan will help each group later on in the project. You will then be given the opportunity to revise your work and turn it in as a final proposal.

Each proposal should address the following areas (in no particular order)

1. Block diagram accompanied by annotations and labels. Be sure to clearly indicate which biological signals you will be recording and your actuators.
2. Biomedical motivation for the project. Here you can speculate on how you might use the technology you will develop in clinical or research settings.
3. Background research on the components of your device and/or other devices that are similar in nature as well as the biological signals you will record.
4. Detailed project goals listed in a hierarchical order.
5. List of any additional equipment or supplies you will need to complete your project
6. A description of how a user would control your device (e.g. a preliminary users manual).
7. Discussion of at least three (3) pertinent calculations that tie aspects of your project to signals and systems theory. These may include transfer functions, filter evaluation, stability analysis or other concepts from the theoretical portion of class.
8. Discussion of any pertinent experiments you may need to perform to determine feasibility of your product.
9. How will you verify that your device works?
10. Weekly timeline for your project with delegation of tasks
11. What roadblocks do you anticipate?
12. Develop at least 4 team learning objectives (Based on the Bloom's Framework). You will be required to demonstrate that you have met these objectives by the end of the course.

Individual Learning Goals

Due 10/7 by 4:30
This is an INDIVIDUAL exercise

Introduction

Writing down goals is a very important mechanism for becoming better. This class has learning goals that are generic and focused on the content associated with signals and system. In this exercise you will develop at least two individual professional learning goals that you will be expected to work on during the course

Task 1: Drafting Learning Goals

You must draft up at least two learning goals for yourself. These are not meant to be about the course but rather about your own professional development. They should not include personal/athletic/music or other characteristics or skills. Be thoughtful and chose something that you think really matters. You do not need to use Bloom's Taxonomy, but it can be a useful to craft your learning goals.

Task 2: Developing Mechanisms for Self-Assessment

Below each learning goal you must write one or two sentences on how you will know that you have met your goal. As much as possible these should be demonstrable (yes/no) or on some scale. You are in effective creating the metrics by which you will judge your progress. You will need to apply your metrics in your final reflection

Reflective and the Curiosity Cabinet

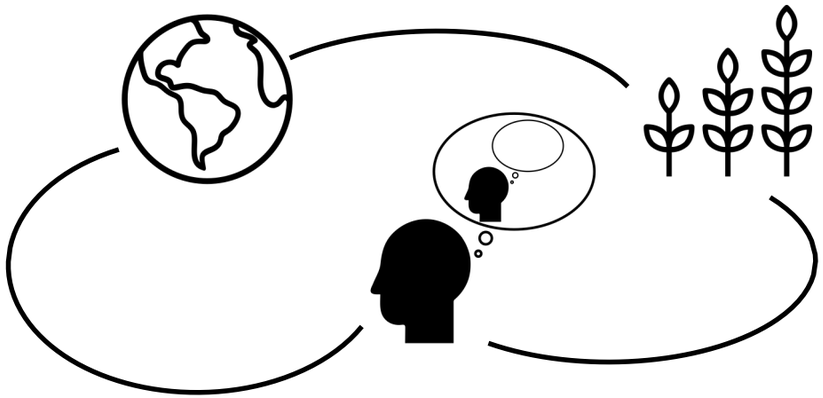
Description
An intriguing phenomenon arose in the 1600s - to create a curiosity cabinet. A collection of strange, interesting and meaningful objects would be displayed for others to see. Often each item would come with some origin story that would reveal something unique about the owner.

Activity
Create your own digital curiosity cabinet that you have curated yourself. Choose things that are intriguing or meaningful to you and have a story for each. Make sure it is a sharable form (e.g.
PDF, YouTube)

Questions
Why did you choose the items you did? Are there any themes? Tell the story behind at least one of your items.
Are there items you considered but did not include? Why? How might this change throughout your life?

Modifications
- If you could put historical figures in your cabinet who would you pick and why?
- What would you include if you were creating a physical curiosity cabinet?
- Who else that you know would have an intriguing curiosity cabinet? What would be in their cabinet?

Reflection Collection™



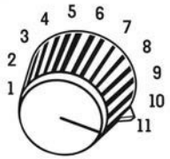
- You can **Order Decks in Bulk** for your friends at a discount.
- Fire up a group with a **Workshop or Talk**. I can customize based upon your needs and you will get a discount on any cards you order.
- Tapping in to local knowledge and insights is the key to building a vibrant culture of reflection. You can **License** the Reflection Collection™ to create and print your own customize version.

Course: Date:

Elephant	Rider	Path
Tone 	Clarity 	Challenge 
Empathy 	Reflection 	Onion 

Notes

Challenge



Support

Scope

Tuning the Four T's

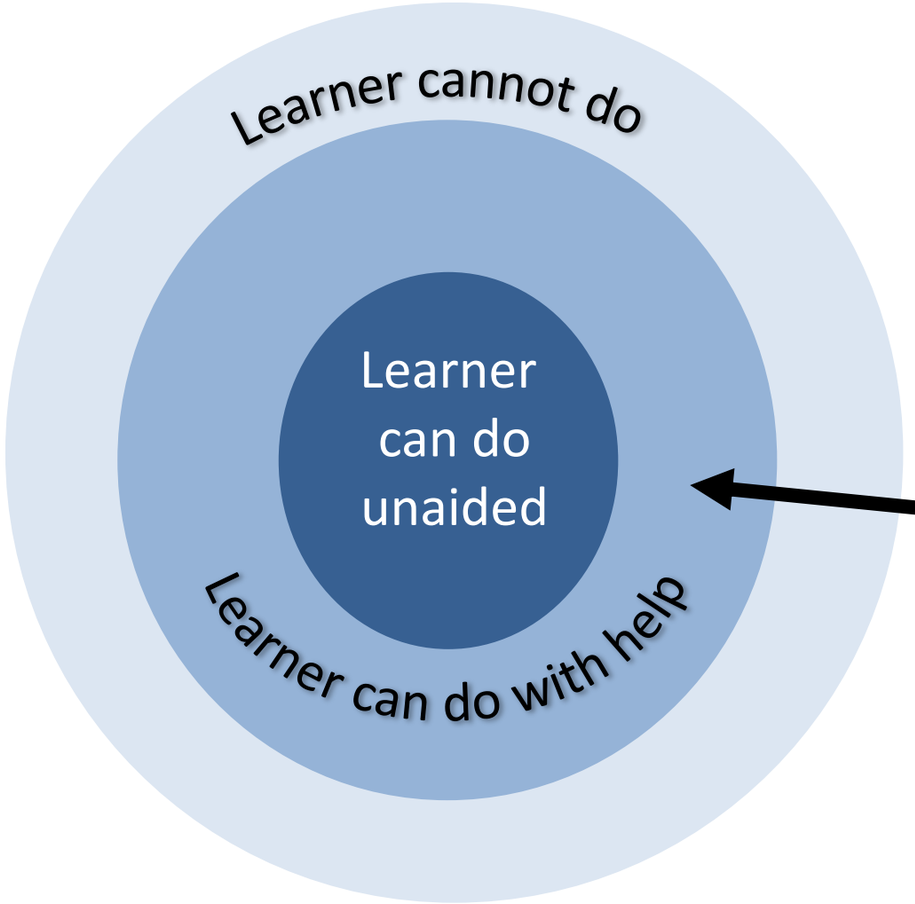
Time
Task
Technique
Team

Stage requirements/instructions

Progressively reveal information (just-in-time)

Challenge requires "Goldilocks Tasks"
Challenge can motivate or de-motivate
We want intrinsic motivation to come from the students

Vygotsky's Zone of Proximal Development

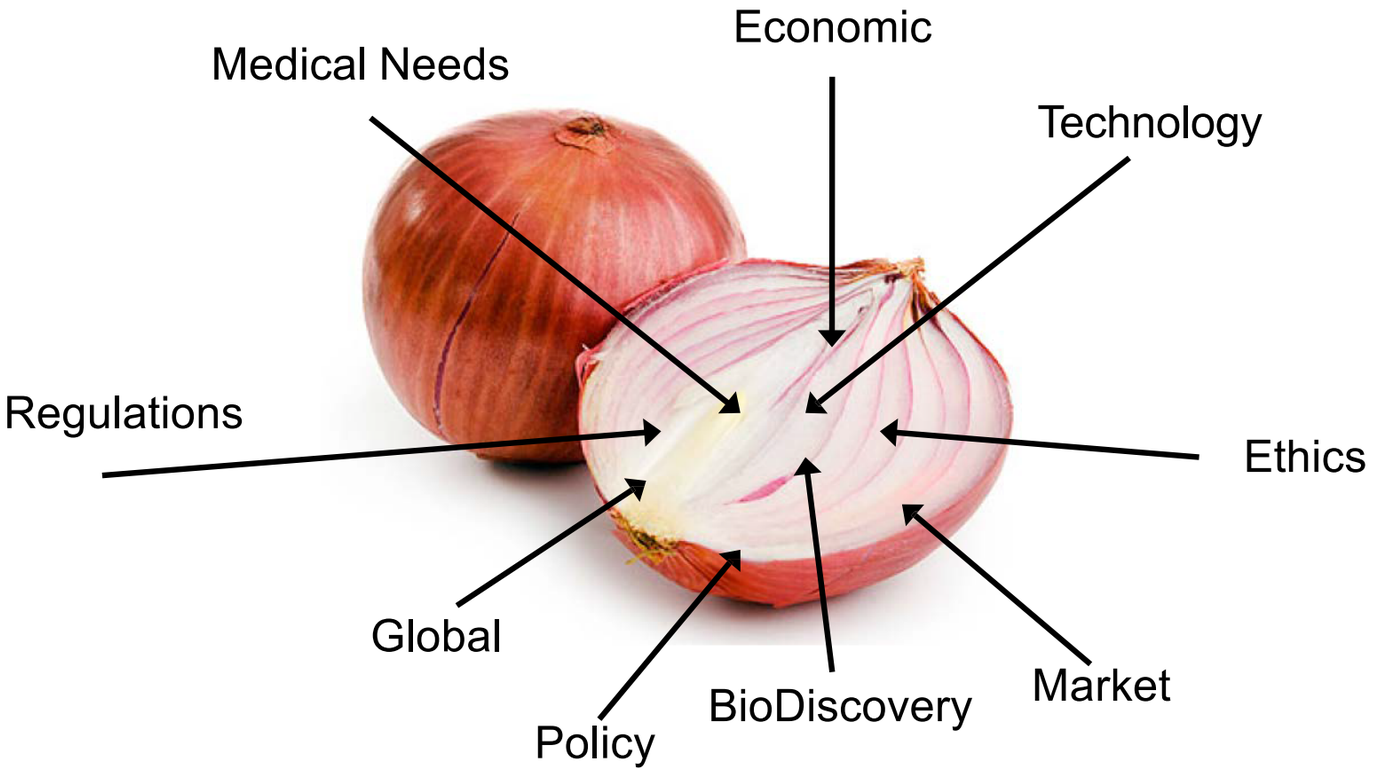


This is where you (and others) come in!

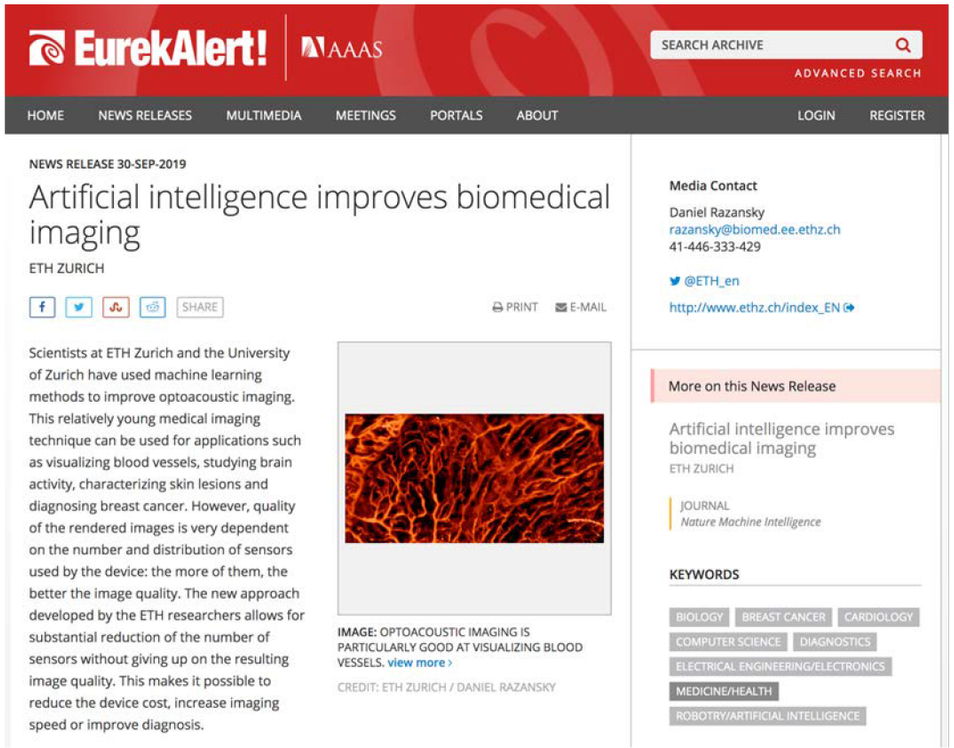
The ”Real” Elevator Pitch

+

The Onion


Economic
Medical Needs
Technology
Regulations
Ethics
Global
Policy
BioDiscovery
Market

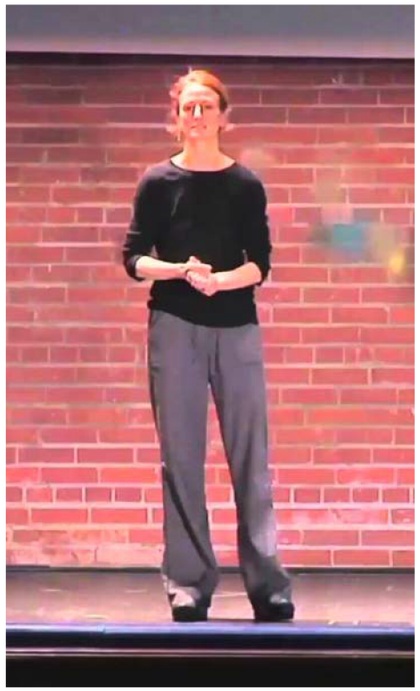
EurekAlert and Professional Moments



eurekalert.org

- Pick out three food and drink on an interview, then order in kind
- Gladwell U-shape - How to view hardship as opportunity
- Keep notes at meetings and talks
- Managing Up – do your research!
- Make a personal budget (money but also other stuff)
- Making a hierarchy of goals (both personally and professionally)
- Pay attention to who the stars are in your organization.
- Are you a Hedgehog or a Fox?
- Marshal Goldsmith's List of 20 things to stop doing
- Learn to cook one dish really well
- The power of habit – what habits are you forming?
- Always have a notebook with you.
- Collect stories of excellence – Ram doing surgery left handed.

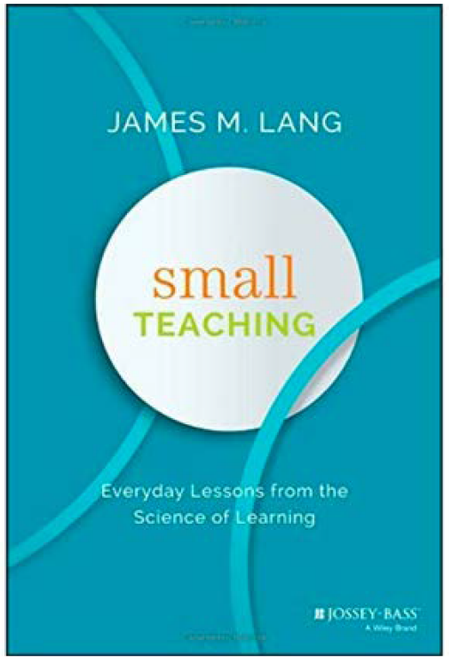
Guest Speakers



The Changing Educational Paradigm

Old	New
Information is one-way	Information emergent
Factory Model of learning	Student-driven learning
Extrinsic Motivation	Extrinsic and Intrinsic Motivation
Lecture	Interactive, creative, social
Sequential model of knowledge	Networked Model of Knowledge
Individual is the focus	Groups/Teams are the focus
Skills and Knowledge	Skills, Knowledge and Mindsets

Small Teaching



Pick one thing from this talk and try it!

We all get better at the things we practice

The Small Things We Do That Add Up

Improving the Learning Environment for our Students

Joe Tranquillo
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