



Integrating Metacognitive Practices & Research to Ensure Student Success



STEM Talent Expansion
Program



Metacognition: awareness of
one's own knowledge

- *How* one learns
 - Identity, culture, affect
- Self-assessment: how *well* one has learned
- *Coherence* of what is learned (from 1 domain to another, e.g. math/physics to engineering)
 - Lateral (concurrent)
 - Longitudinal (past to present to future)




Overview

- Improve retention Deaf/HoH & 1st gen STEM majors through explicit metacognitive activities
 - 2 week summer experience
 - 1st year courses
 - 2nd year *Learning Assistant* program
- Colleges of Science, Engineering, CS and App. Sci. & Tech.
- 20 summer students, 48 in all course



Summer Experience

- The Science of Climate Change
- Journal writing
- Quiet reflection
- Group metacognition activities
 - Create a sign for metacognition
 - Stereotypes
 - What makes an expert?
 - Mindset
 - Self-assessment, unskilled/unaware
 - Personal struggles




IMPRESS Activities

Morning: Investigating climate change

	6	7	8	11	12	13	14	15	18
10am - 11am	Ice Breaker	Radiation Temperature exercises 1+2	Radiation temperature exercises 4,5	Albedo exercise	Metabolism produces CO ₂	Pond trip	Decomposition release CO ₂ ↓	Solubility of CO ₂	Deriving equation for CO ₂ flux to atmosphere
11am - Noon	Peer Assessment logistics			X					
Noon - 1pm	Lunch		X	reflection Journal			"Fossil Fuel"	X	
1pm - 2pm	Fermi Questions	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
2pm - 3pm		Sharing Session	reflection Journal	Sharing Session	reflection Journal	reflection Journal	reflection Journal	reflection Journal	
3pm - 4pm	Intro to reflections Journal		Sharing Session		Sharing	Sharing	Sharing	Sharing	
4pm - 5pm	Signs		Perceptions	16. fields		Struggles		expert advice	Project
5pm - 6pm									
6pm - 7pm									

Afternoon: Reflection, journaling, metacognitive activities



IMPRESS Research Projects

- Mixed (D/Hoh) group communication (agency, authority)
- Conceptions of expertise
- Increase of metacognitive statements over time




impress Fall Metacognition Course


- Designed to guide students to think metacognitively about **concurrent** (introductory) STEM courses
- “Ethical perspectives” foundational course, satisfies Institute general education requirement



impress Metacognitive Topics

- Mindset
- Bloom’s Taxonomy
- Self-assessment (Unskilled & Unaware)
- Experts and Novices
- Transfer
- Stereotype Threat
- Student-centered learning
- Diversity and Inclusivity in STEM

 impress		Course Readings
Class	Topic	Readings
2	Mindset	<i>Mindset</i> (Dweck) Ch 1, 2
3	Bloom's Taxonomy	<i>Biology in Bloom</i> (Crowe, 2008), <i>Questions about Questions</i> (Allen 2002)
4	Unskilled and Unaware	<i>Unskilled & Unaware</i> (Kruger & Dunning, 1999)
5	Self-assessment	<i>How Chronic Self-Views Influence (and Misperceive) Self-Assessments</i> (Critcher & Dunning, 2009)
10	Mindset	<i>Mindset</i> (Dweck) Ch 3, 8
11	How People Learn - Intro	<i>Learning: From Speculation to Science. HPL, Ch. 1</i>
12	HPL: Experts vs. Novices	<i>How Experts Differ from Novices. HPL, Ch. 2</i>
13	HPL: Transfer	<i>Learning and Transfer. HPL, Ch. 3</i> (Bransford, 2002)
14	Stereotype Threat	<i>Thin Ice: Stereotype Threat and Black College Students</i> (Steele, 1999), <i>Reducing the Gender Achievement Gap in College Science: Values Affirmation</i> (Miyake, 2012)
22	Learning Style Preferences	<i>Matching Teaching Style to Learning Style may not help Students</i> (Glenn 2009)
23	Stereotype and Gender	<i>Of Geeks and Girls</i> , Grossman 2009

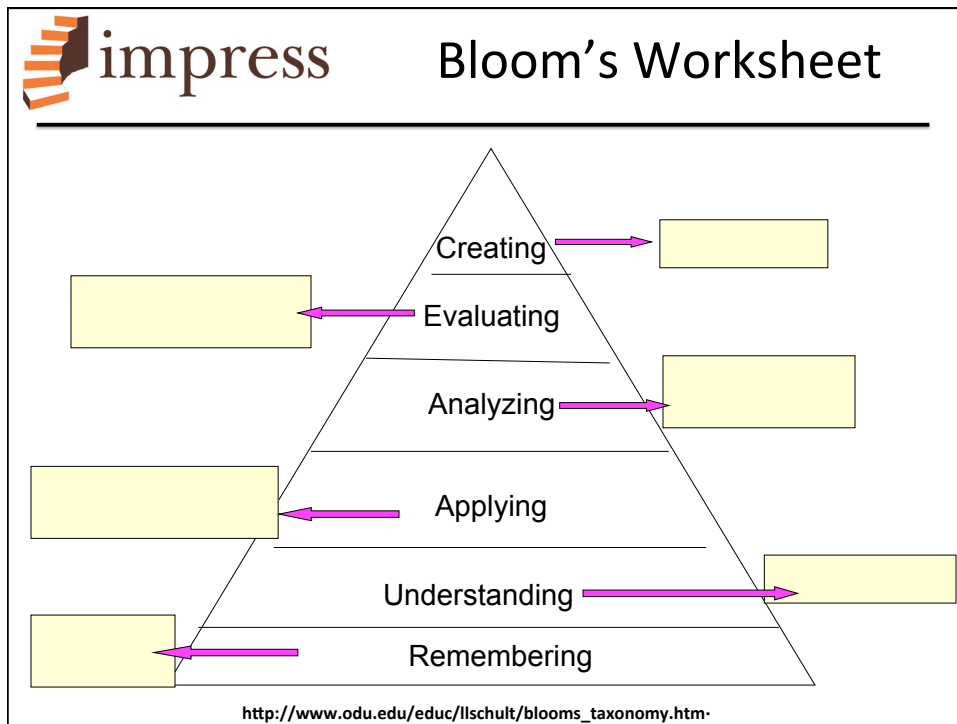
 impress		Class environment
<ul style="list-style-type: none"> • Discussion-based <ul style="list-style-type: none"> • Small-groups w/worksheets • Class-wide guided discussion • Free-ranging, very loosely guided by syllabus • <i>Need to formalize for secondary implementation</i> 		


 **impress** Bloom's Taxonomy

- Categorizes types of thinking into 6 levels:
 - remembering
 - understanding
 - applying
 - analyzing
 - evaluating
 - creating
- Categorize HW/test questions
("Blooming")

 **impress** Bloom: Class Schedule

- Class discussion
 - What we know about learning
 - Bloom's taxonomy
 - At what level do students operate at in high school
- 5 minute reflective period
- Group work defining characteristics of Bloom levels
- Class discussion on characteristics
- Group work: Blooming HW questions at different levels
- Generate questions at different Bloom levels



 **impress** Blooming Questions

- Students brought in homework questions from classes, discussed and Bloomed them
- Generated new questions extending their homework questions to higher Bloom's levels



impress Stereotypes

- Stereotype threat: fear of being stereotyped causes anxiety that leads to underperformance
- [Claude Steele discussing stereotype threat](#)
- Readings on how stereotypes depress women's interest in computer science (Cheryan)



impress Stereotype: Class Activities

Below is a list of majors in Science & Technology:

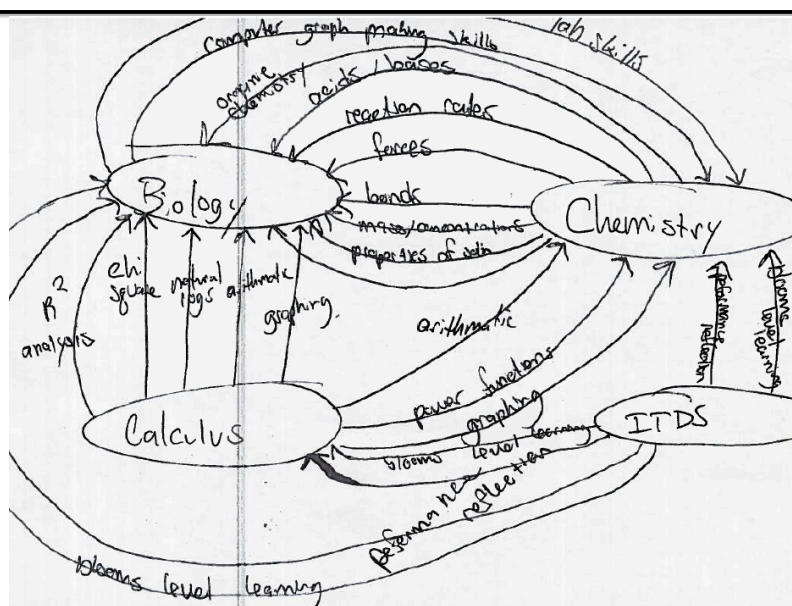
Physics Math Information Technology
 Biology Engineering Engineering Technology
 Chemistry Computer Science
 Network/System Administration

**Choose someone from the class with that major and
 What stereotypes exist for your major? Which do
 you embody? Which do you not?
 that come to mind when thinking about someone
 with that major.**

impress Coherence and *Concept Maps*

- depict/emphasize relationships
- *Concepts* connected by *propositions*
- Use them to get students thinking about how different classes relate to one another: “lateral transfer map”

impress Lateral Transfer Map




impress Evolution of LTM

impress Identity

- List five characteristics that are important to your identity


- Fixed vs. growth mindset traits



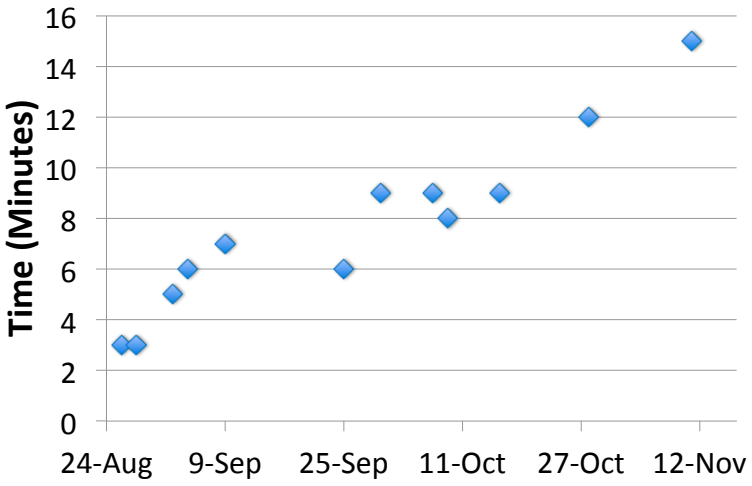
Quiet reflective times

Just think: The challenges of the disengaged mind
Wilson et al., Science 2014

Participants typically did not enjoy spending 6 to 15 minutes in a room by themselves with nothing to do but think...and that **many preferred to self-administer electric shocks (that they would pay to avoid) instead of being left alone with their thoughts.**



QRT in Class



Date	Time (Minutes)
24-Aug	3.0
24-Aug	3.2
5-Sep	5.2
5-Sep	6.2
9-Sep	7.2
25-Sep	6.2
25-Sep	9.2
11-Oct	9.2
11-Oct	8.2
11-Oct	9.2
27-Oct	12.2
12-Nov	15.2



impress Reflections on QRT

- No students complained about QRT in student evaluations
- “Most, but not all, summer students enjoyed QRTs. Those who enjoyed them, *really* enjoyed them. Those who didn’t were bored.”
- Most anecdotal data positive:
 - Post-QRT discussions richer
 - Led to more connected lateral transfer maps
 - Some students reported very productive QRT



impress Conclusions/reflections

- ***Impact unknown***
- Student feedback extremely positive
 - Cited comfort in expressing their opinions
 - 70% felt they learned a great deal
 - Some even cited QRT as a strength!
- Need to export to secondary implementation!
- 15 students continuing on in special First-year Writing course