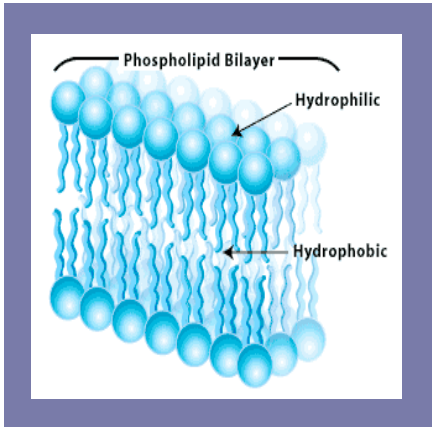
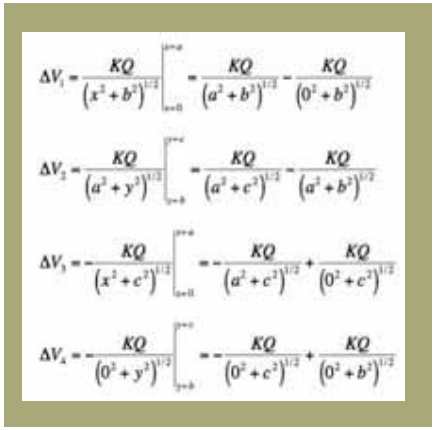


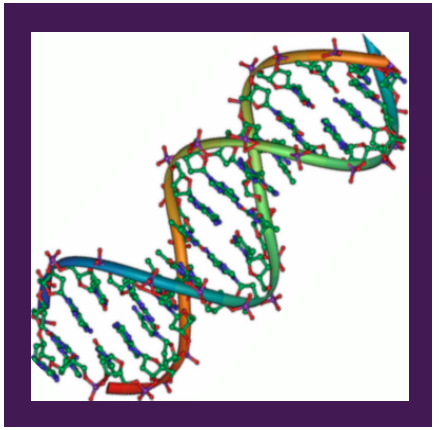


$$\Delta V_1 = \frac{KQ}{\left(x^2+b^2\right)^{1/2}}\Bigg|_{x=0}^{x=a} = \frac{KQ}{\left(a^2+b^2\right)^{1/2}} - \frac{KQ}{\left(0^2+b^2\right)^{1/2}}$$

$$\Delta V_2 = \frac{KQ}{\left(a^2+y^2\right)^{1/2}}\Bigg|_{y=0}^{y=b} = \frac{KQ}{\left(a^2+c^2\right)^{1/2}} - \frac{KQ}{\left(a^2+b^2\right)^{1/2}}$$

$$\Delta V_3 = -\frac{KQ}{\left(x^2+c^2\right)^{1/2}}\Bigg|_{x=0}^{x=a} = -\frac{KQ}{\left(a^2+c^2\right)^{1/2}} + \frac{KQ}{\left(0^2+c^2\right)^{1/2}}$$

$$\Delta V_4 = -\frac{KQ}{\left(0^2+y^2\right)^{1/2}}\Bigg|_{y=0}^{y=b} = -\frac{KQ}{\left(0^2+c^2\right)^{1/2}} + \frac{KQ}{\left(0^2+b^2\right)^{1/2}}$$



Sources of Affect around Interdisciplinary Sense Making

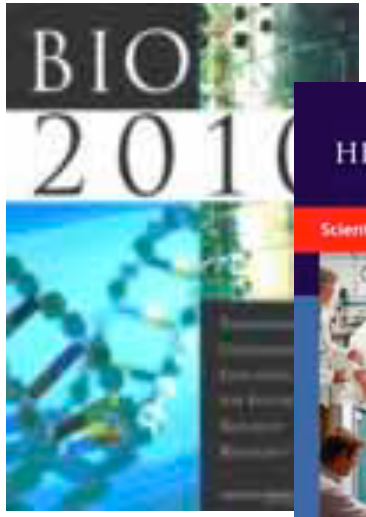
Benjamin Geller, Julia Gouvea,
Vashti Sawtelle, Chandra Turpen
University of Maryland, College Park

NEXUS
NATIONAL EXPERIMENT
in Undergraduate Science Education

UNIVERSITY OF MARYLAND 1856

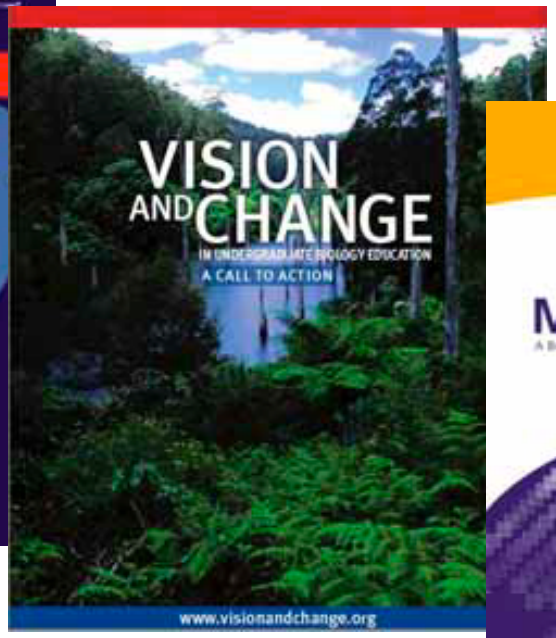
HHMI

Calls for reform in how we educate undergraduate life science students

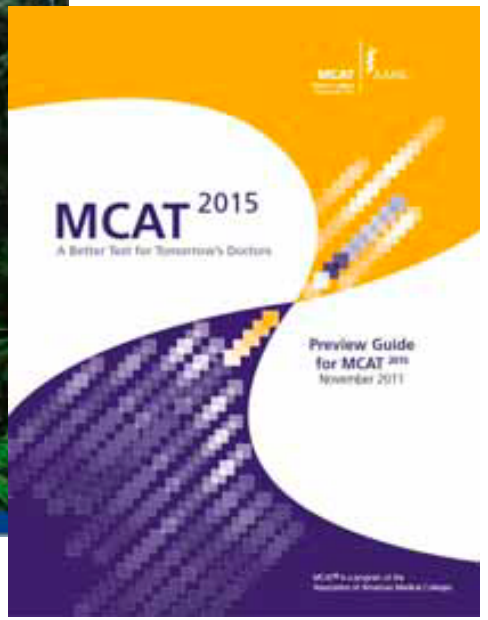


2003

2009



2011



2013

HHMI NEXUS
NATIONAL EXPERIMENT
in Undergraduate Science Education

Commonly invoked motivations for teaching Introductory Physics for Life Scientists (IPLS)

- Need to train future physicians in methods and technologies developed in the physical sciences

- Increased importance of physical modeling and quantitative approaches in upper-division biology coursework

- General recognition that science disciplines are increasingly integrated and dependent on each other for inspiration and innovation

(e.g., Meredith & Redish 2013; Redish et al. 2014; Crouch & Heller 2014)

+ If I'm being honest about what gets me up in the morning to work on teaching physics to life scientists...

…a belief in the unity of the sciences - a conviction, far deeper than a mere working proposition, that the world is orderly and can be explained by a small number of natural laws.

-- E.O. Wilson in "Consilience" (1998)

Grandiose for sure, perhaps even wrong, but it evokes the *affect* I feel and want my students to (at least occasionally) feel.

Many who work on IPLS efforts mention wanting IPLS students to find physics "**relevant**" or for them to "**like**" physics… but like for what reason?

- Perhaps students see utilitarian value in their physics class in preparing them for the MCAT exam or later coursework

- Perhaps students like physics because they find it easy and it makes them feel competent or confident as a learner

- Perhaps a few students like physics because they find it intrinsically satisfying to make sense of why physical objects behave as they do

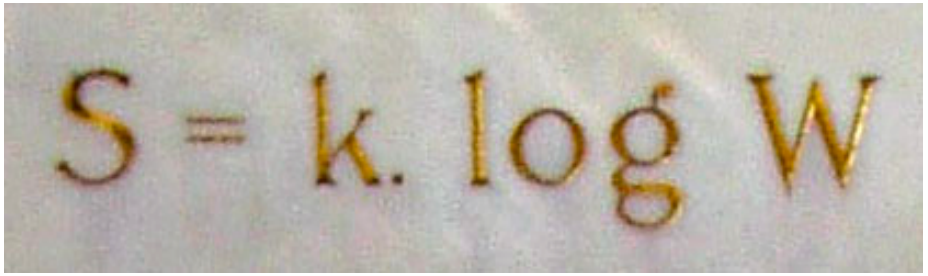
Here we attend to a different source of positive feeling about physics…

Interdisciplinary coherence as a source of affect

- We attend to affective responses that are triggered by moments in which physics is helping a student **make sense of phenomena previously encountered in his/her biology courses** by seeking coherent mechanistic accounts of these phenomena (Hammer et al. 2005).

- We suggest that, after years of being "*left [on their own] to forge connections from one subject to the next*" (Stevens et al. 2005), after experiencing their science curriculum as **fragmented into silos**, this explanatory coherence may be even more satisfying to students.

+ Disciplinary silos



$$\Delta G = \Delta H - T\Delta S$$

Does that "S" you are talking about have anything to do with the "S" in G = H – TS that they talk about in biology and chemistry?

-- Biology major taking intro physics

(Geller et al. 2013)

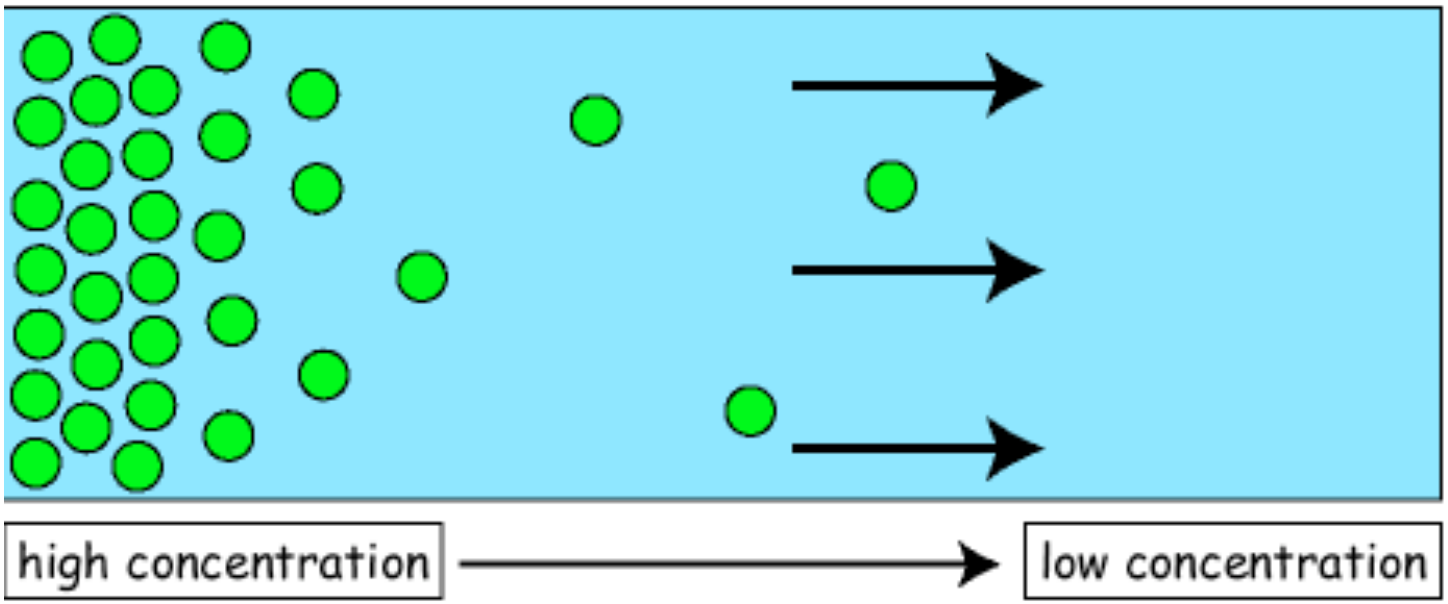
+ Meet Gavin

- Junior biology major and pre-med student enrolled in NEXUS/Physics during the 2012-2013 academic year

- We interviewed Gavin 5 times over the course of a year, and observed him in classroom and recitation settings

- Clip we will watch is from an interview conducted at the end of his two semesters in the course.

…One word about the science Gavin is discussing



+ Modeling the Gavin episode

Our focus is on the ways in which an interaction between **identity** and **disciplinary epistemology** is responsible for Gavin's **disciplinary affect** in an interview about his experiences in NEXUS/Physics.

➢ Disciplinary epistemology here refers to ways of knowing and learning associated with a particular discipline (Hammer & Elby 2003). For students, disciplinary epistemologies are likely to be closely tied to their course experiences (Watkins & Elby 2013).

➢ This framework views neither identity, nor epistemology, nor affect as stable entities that an individual carries with him from moment to moment (Gupta et al. 2010; Hammer & Elby 2002; Nasir & Saxe 2003).

Modeling the Gavin episode

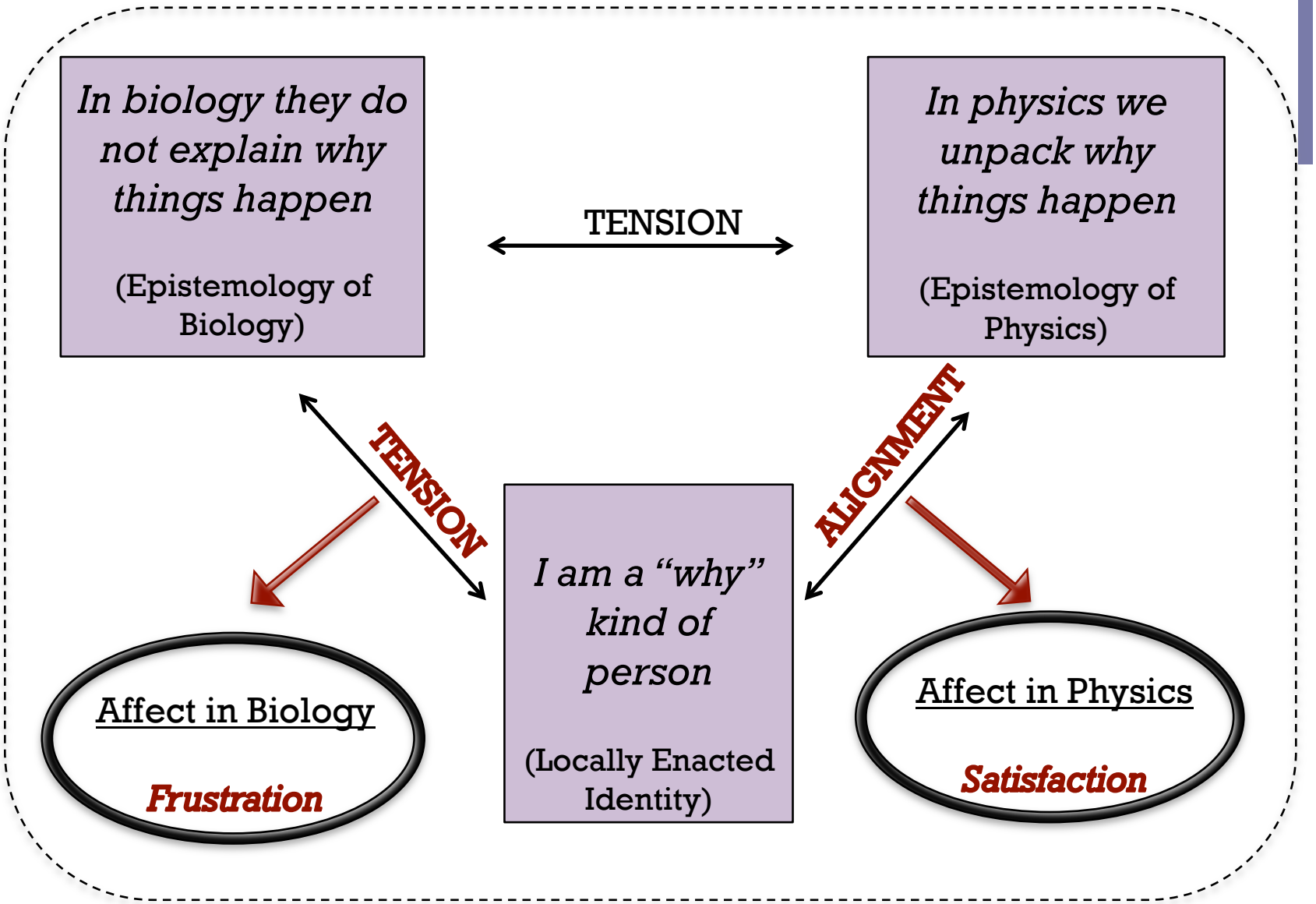
Our focus is on the ways in which an interaction between **identity** and **disciplinary epistemology** is responsible for Gavin's **disciplinary affect** in an interview about his experiences in NEXUS/Physics.

- "Identities may shift in meaning or salience as one moves from one context to the next" (Esmonde 2009). A student may over time begin to define herself as "a biology person," but may in other moments feel alienated from or excluded from that discipline (Nasir & Saxe, 2003).

- Disciplinary identity and disciplinary epistemology sometimes evolve together (Danielak et al., 2014; Osbeck & Nersessian, 2010).

G: And so I felt like that's when things started to click... I was like that's why molecules go from higher concentration to lower concentration...

Sources of affect in IPLS



Geller and Gouvea et al. (2014). *ICLS*.

Implications

- Gavin positions his satisfaction with the role that physics is playing in direct contrast to his **dissatisfaction with the incompleteness of explanations in biology**.

- Gavin's frustration with the lack of attention to mechanistic explanation in his biology courses might actually serve to **strengthen his sense of interdisciplinary connectedness** and satisfaction.

- The feelings of satisfaction may **reinforce** Gavin's belief that he is a sense-maker who values mechanistic explanation, and he may seek out future opportunities to do that sense making.

+ Implications

➢ Regardless, **affect is an end in and of itself**, and a reason in and of itself to facilitate interdisciplinary sense making (perhaps as important as STEM workforce arguments).

➢ For Gavin, unpacking a biochemical heuristic in terms of physical interactions is satisfying. We have seen **other sources** of satisfaction stemming from interdisciplinary coordination in NEXUS/Physics.

When defining what it is that we hope our students will learn in interdisciplinary courses, we would be well served to consider also what we hope they might *feel*.

THANK YOU!

• UMD PERG/Sci.Ed past and present (especially productive conversations with Lama Jaber).

• UMD BERG past and present

• These folks!

Vashti Sawtelle, Chandra Turpen, Julia Gouvea, Edward Redish, Benjamin Dreyfus

Interdisciplinary coherence is satisfying

… I think that biology has done obviously very brilliant things and I love biology, but as far as the professors, they're very knowledgeable but they have to go over so much **stuff** that they don't really take time to explain **why** things happen. And I'm a very "**why**" kind of person; I want to understand **why** does this happen. And that's why I struggle with [organic chemistry] so much, because it's like 'memorize the mechanisms and take the test' [*throws up his hands*]… well how the hell do I know **why** the mechanism is happening in the first place?!...

– Gavin

Geller and Gouvea et al. (2014). Sources of affect around interdisciplinary sense making. *ICLS*.

Interdisciplinary coherence is satisfying

… When I take this [IPLS] class and understand, oh, this is why molecules interact the way they do, this is why you are going to have this expansion of particles over space…**that was very satisfying**… understanding the why really gave me the confidence in order to go into tests and be able to rationalize why things work the way they do and what to look for...

– Gavin

Geller and Gouvea et al. (2014). Sources of affect around interdisciplinary sense making. *ICLS*.