Introductions

Melissa Haswell, Ph.D.

Associate Dean - Sci-Math

Delta College

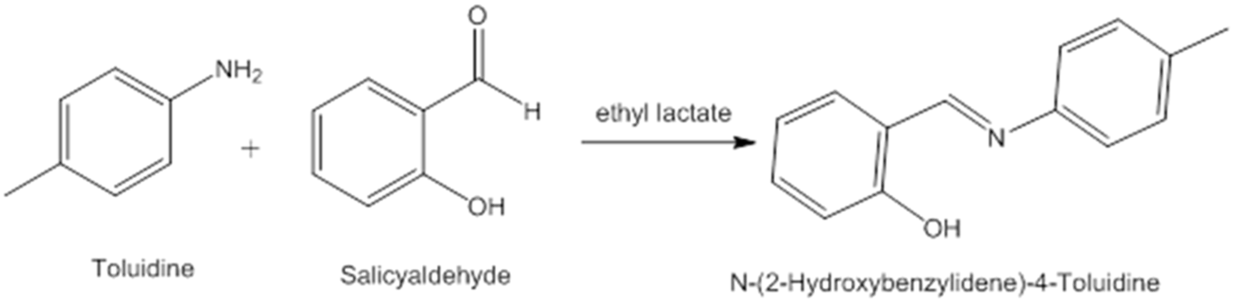
David Baker, Ph.D.

Professor of Chemistry

Delta College

Integrating Authentic Research Experience into Organic Chemistry to Promote Science Identity

David Baker, Professor of Chemistry
Melissa Haswell, Associate Dean of Science & Mathematics Division
Delta College



Link to Resource Page

What is a CURE?

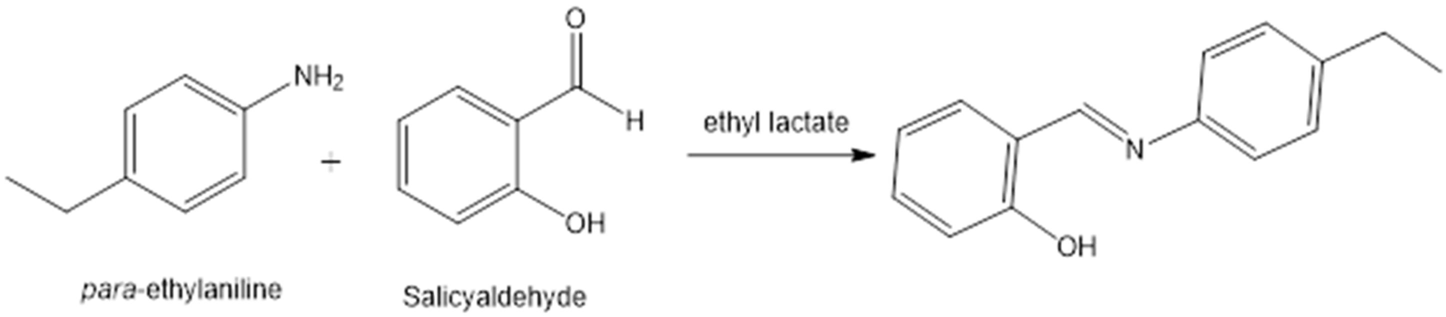
- Pedagogical strategy based on backward design.
- Embeds authentic research into a course.
- Students involved in design and feedback.
- Emphasizes collaboration with classmates and instructor.
- Important aspects:
  - Incorporate opportunities to make relevant discoveries & generate novel results that are novel.
  - Engage in iterative work - troubleshoot, problem-solve, and repeat aspects of their work for the research to progress.
  - Engage with the literature related to their research.
  - Opportunities to communicate their research results to that group of stakeholders, either orally or in writing or both.

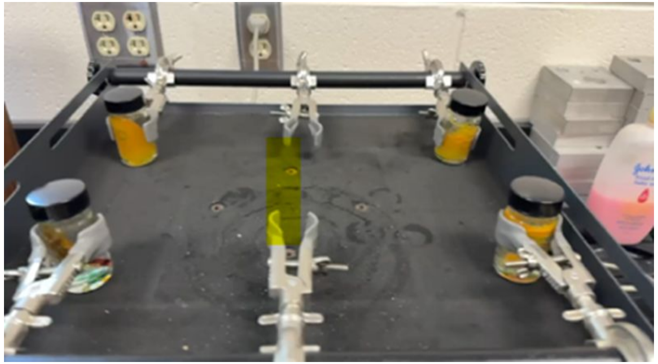
Impact of Undergraduate Research Experience

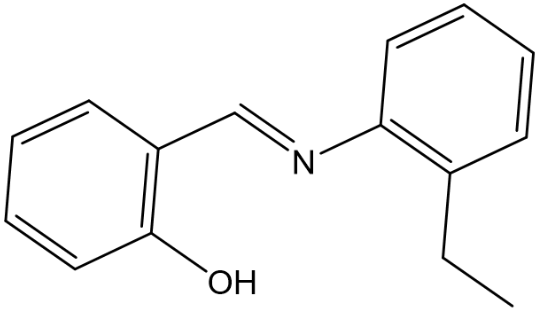
- Student impact
  - Increase gain in self-confidence & problem-solving skills
  - Early engagement increases persistence because of increased understanding of failure aspect of science.
- Faculty impact
  - Intellectual invigoration.
  - Enhances quality of teaching.
- Institutional impact
  - Increases student retention.
  - Increases engagement with local community.
- Equity
  - Greatest impact on historically underrepresented groups in STEM.
  - Prevents gatekeeping of traditional research experience.

Our CURE

Evaluating *Ortho* and *Para*-Ethylaniline as Reactants in the Synthesis of Imines for a Course-Based Undergraduate Research Experience







NO product obtained.

Shaking Reaction Systems

Synthesis of N-(2-hydroxybenzylidene)-X-ethylaniline derivatives

The *ortho*-ethylaniline did not yield any imine product, despite differing reaction containers and methodology used to initiate the reaction of reagents.

The *para*-ethylaniline always yielded product,.

Shaking the reaction containers at 100 RPM was inefficient

Using the Infrared spectrometer, confirmed that all imine products generated from these experiments were all the

Reactant	Shaking Conditions	Yield	Melting Point
Toluidine	100rpm	72.10%	98°C
	100rpm	83.40%	97°C
Para-ethylaniline	100rpm	0.00%	N/A
Ortho-ethylaniline	100rpm	0.00%	N/A
Para-ethylaniline	200rpm	112.00%	32°C
Para-ethylaniline	200rpm	104.00%	29°C
Ortho-ethylaniline	200rpm	0.00%	N/A
Para-ethylaniline	400rpm	71.10%	40°C
Para-ethylaniline	400rpm	81.60%	38°C
Ortho-ethylaniline	400rpm	0.00%	N/A

<u>Future Work:</u>

•The usage of the shaker
•Potential sonication rather than shaking. Smaller containers while shaking the product to test surface area viability.
•Holding the containers horizontally while shaking, as the shaker moves side to side rather than up and down,
•Using a vortexer in addition to or substituting

Synthesis of N-(2-hydroxybenzylidene)-4-ethylaniline

The *ortho*-ethylaniline imine was not synthesized. The steric hindrance of the ethyl group in an ortho position clearly prevents the attack of the nitrogen nucleophile

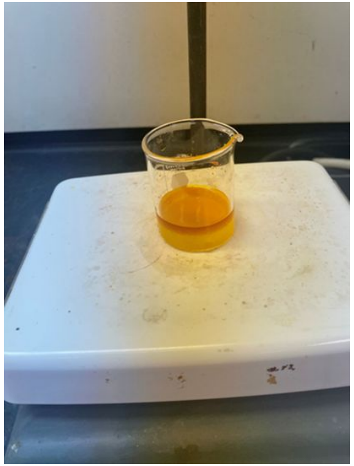
For the successful *para*-aniline -cooling, especially in low concentrated products in solution, may be important to yielding products

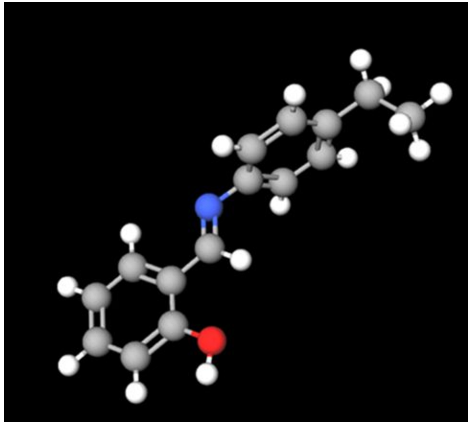
<u>Future Work:</u>

•A faster shaking device such as a vortexed may assist in the creation of a higher yield in a larger container to increase the area in which the chemicals may react.
•A large round bottom flask may assist in the creation of a fine product at a higher yield.
•Heating the mixture slowly over time or microwaving at a lower wattage may help create a product faster without risking boiling.

Reactant	Reaction Conditions	Yield	Melting Point
Toluidine	Control	72.10%	98°C
	Control	83.40%	97°C
Para-ethylaniline	150mL Beaker	62.30%	43°C
Para-ethylaniline	150mL Beaker	98.60%	44°C
Para-ethylaniline	50mL Beaker	81.20%	44°C
Para-ethylaniline	Intermittent Microwave	31.80%	36°C
	30 seconds		
Para-ethylaniline	Microwave 100% Power	48.40%	30°C
Para-ethylaniline	Microwave 25% Power	61.80%	25°C

Student Videos

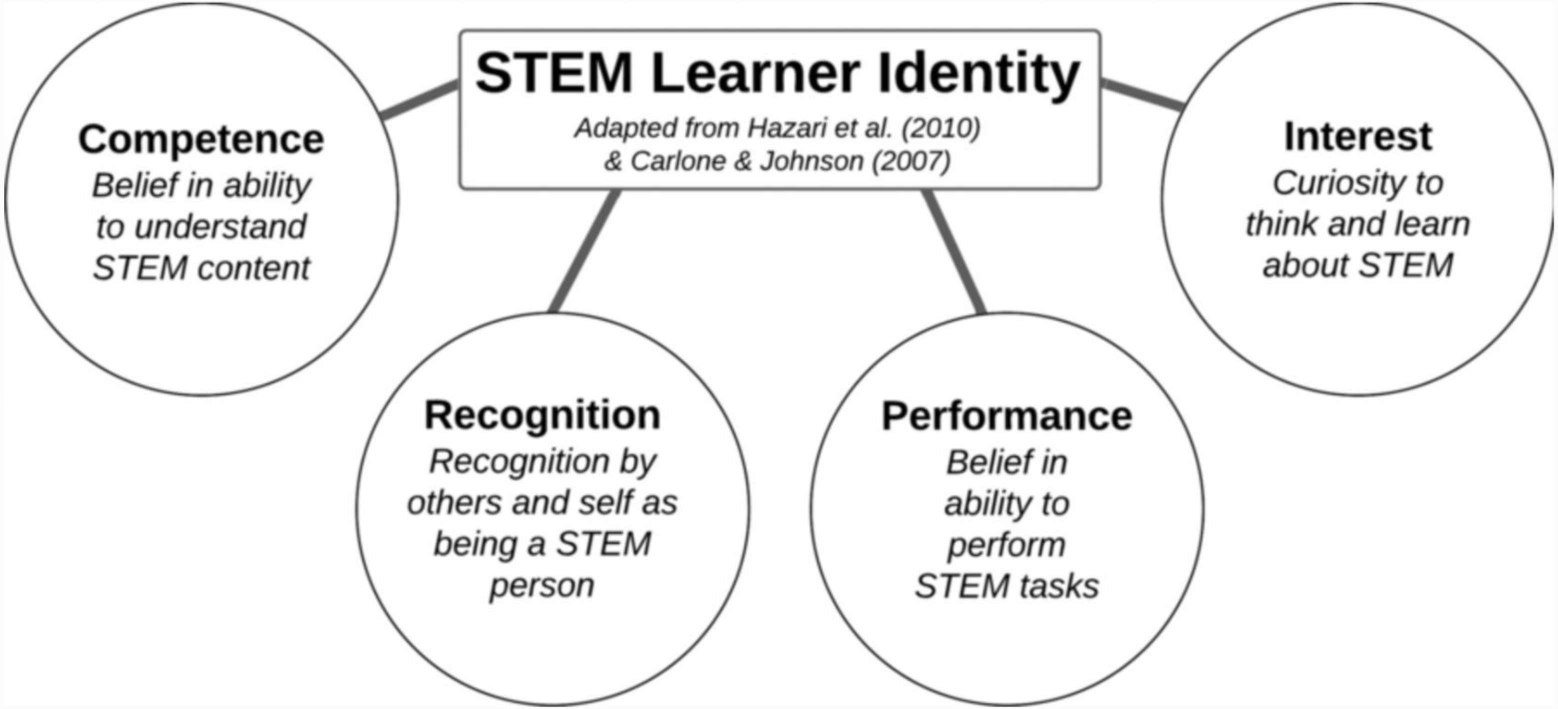




So, why do this?

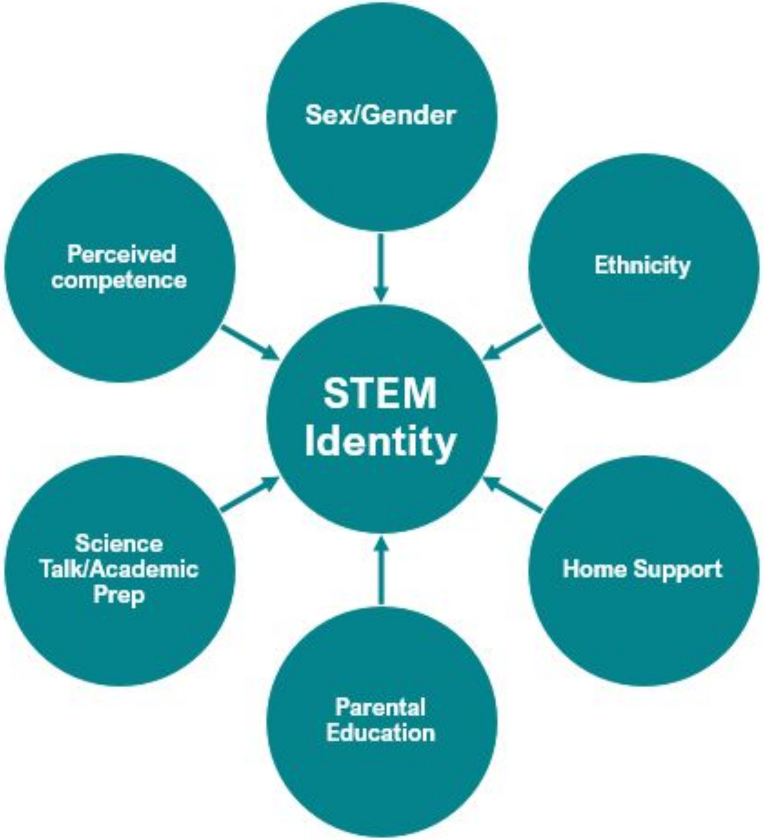
STEM Identity Word Cloud Activity

From: Beyond content and curriculum in elementary classrooms: conceptualizing the cultivation of integrated STEM teacher identity



Components of STEM learner identity (Carlone & Johnson, 2007; Hazari et al., 2010)

Factors that Influence STEM Identity



(Dau, 2021; Camacho, et al, 2021)


Mentoring Model
Place-based authentic Research Experiences
Leadership & Teamwork Training
Participation in Scientific Community
Increased Self-Efficacy
Increased Science Identity

What is humanized STEM?

- Embraces humanity
- Centers on teaching students not content
- Embraces well-being of student
- Built on an understanding & recognition of historical underpinnings of STEMM
- Connected to real-world social, political, and economic contexts
- Recognizes inherent worth and dignity of all students.
- Disrupts the current education landscape
- Acknowledging that toxic STEMM cultures exists

The Unspoken Agreements of STEM

(Recasting the agreements to re-humanize STEM education, Imad, Reder, & Rose, 2023)

The Agreement to Privilege Eurocentric Ways of Knowing

- Dominant epistemology in Western academics
- Shapes the other 2 agreements
- intentionally & unintentionally marginalizes other ways of knowing and seeing the world → creates a monoculture of thought
- Can limit our understanding of the world due to emphasis on

The Agreement of Scarcity

- Fostering of competition, nurturing fear, and cultivating a zero-sum mentality → example: focus on ‘cream-of-the crop” in gateway courses
- Emphasis on perfectionism and workaholism → leads to stress-related health issues

The Agreement of Objectivity

- Conception that science is completely objective and devoid of social and cultural influences.
- Teacher & information-focused education practices.
- Expectation of self-negation & depersonalization.

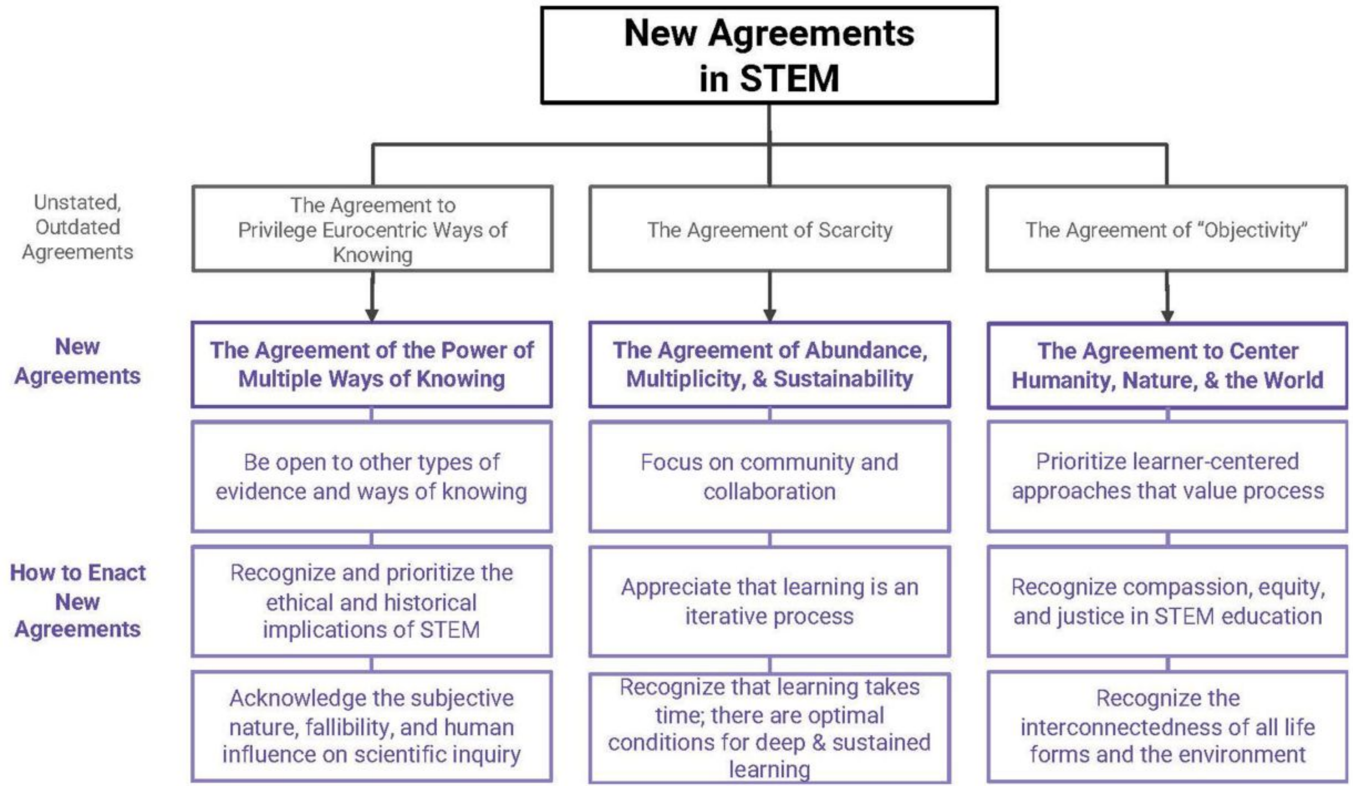


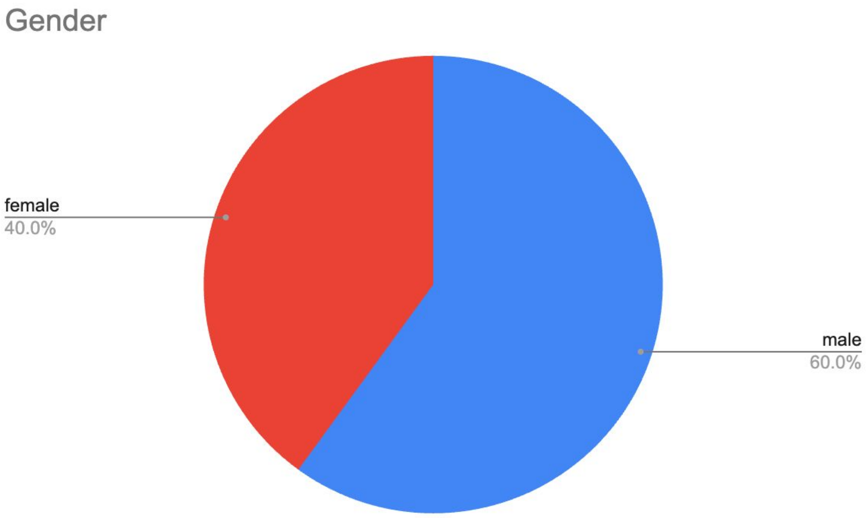
FIGURE 4

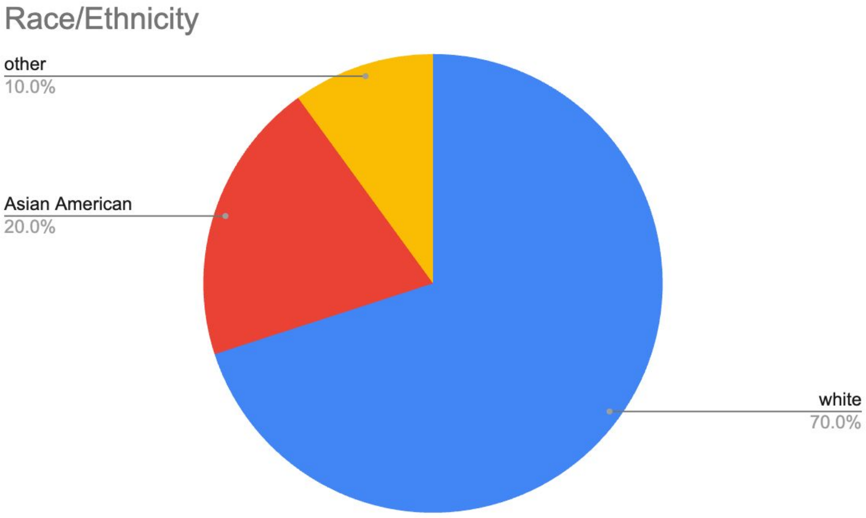
Suggested ways to enact the new recasted agreements.

Source: Recasting the agreements to re-humanize STEM education, Imad, Reder, & Rose, 2023

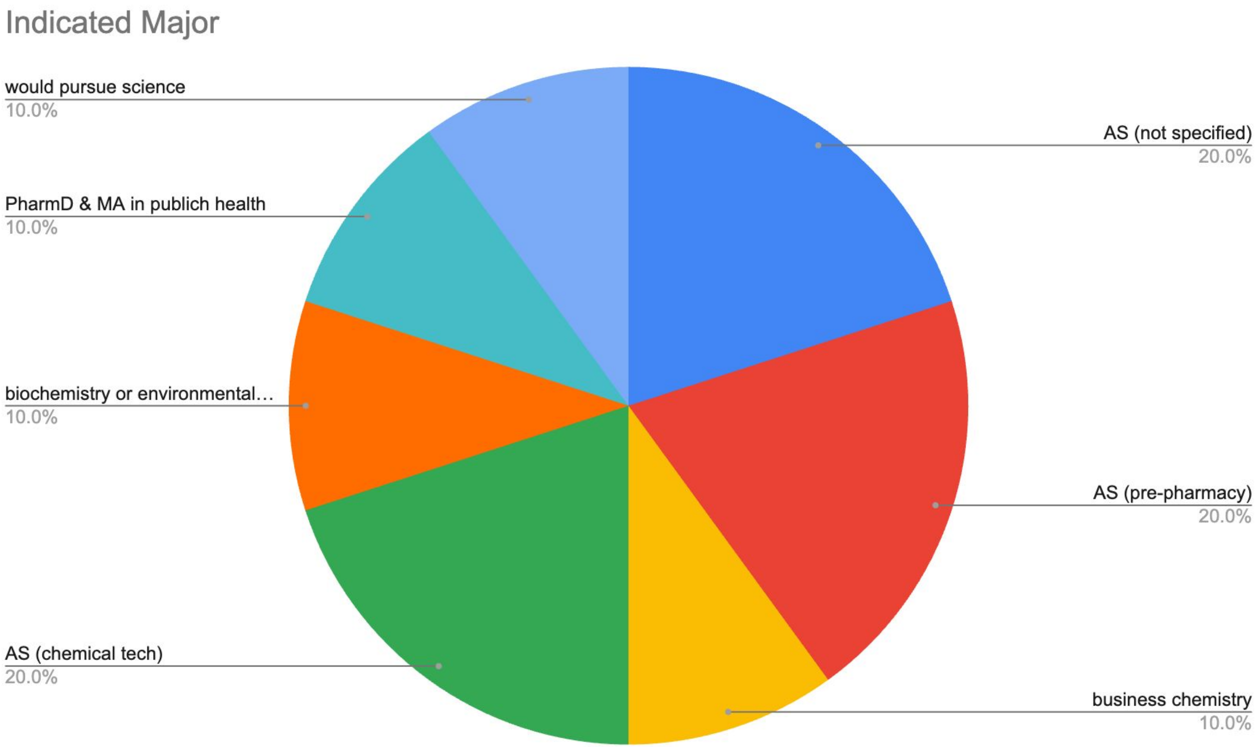
Science Identity Data from our CURE

Demographics

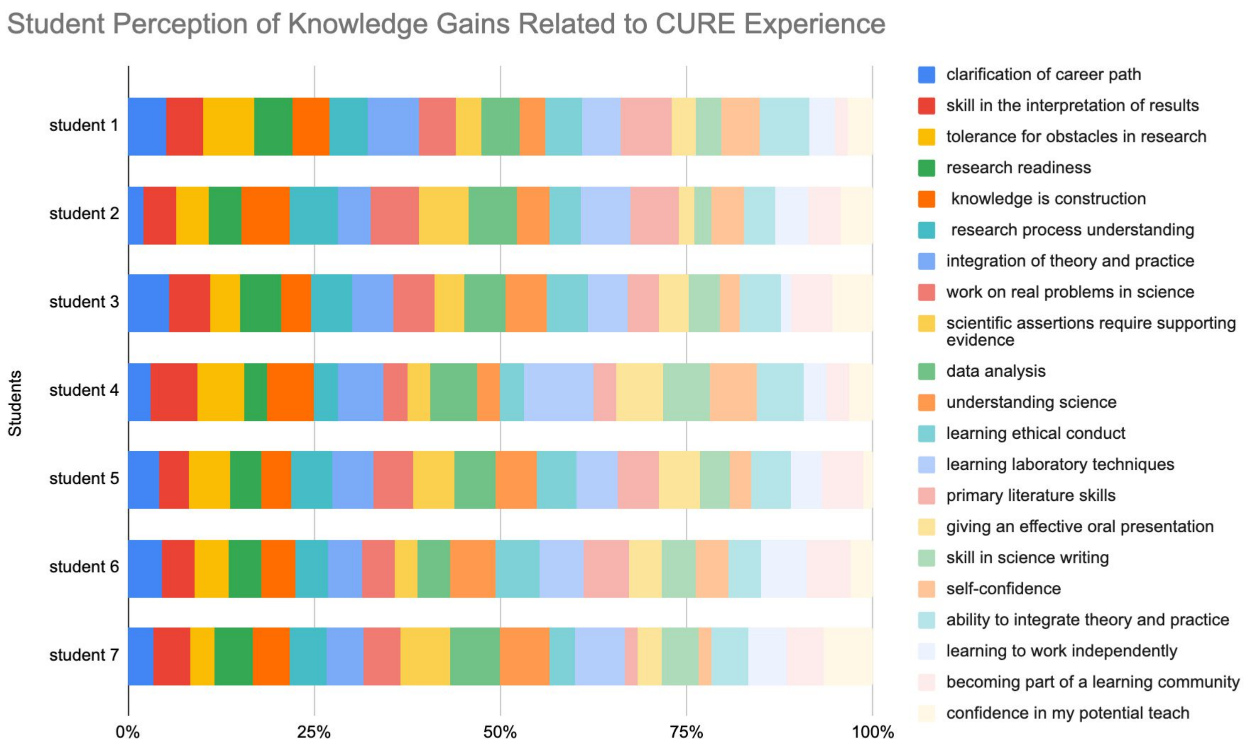




Identified Major



Student Perceptions of Knowledge Gain



Observational Data

Observations were conducted of the students while interacting in the laboratory setting, as well as their final project presentations. Following the presentations, students participated in a short focus group in which they were asked questions regarding their experience.

In the lab:

- Collaborative work.
- Comfortable using lab equipment.

Final project presentations:

- Students were able to articulate their mistakes.
- Excitement.
- Deeper understanding about the process of science and that this process is not linear.
- Sense of accomplishment.
- Collaborative nature and confidence was exhibited by all students.

Future exploration: Importance and value of Dr. Baker's mentorship to the students. It was apparent that mentorship, especially from a knowledgeable, patient, mentor, was a key component to the success of this project. Therefore, these observations complement the results of the survey as students and further prove the richness of the CURE experience.

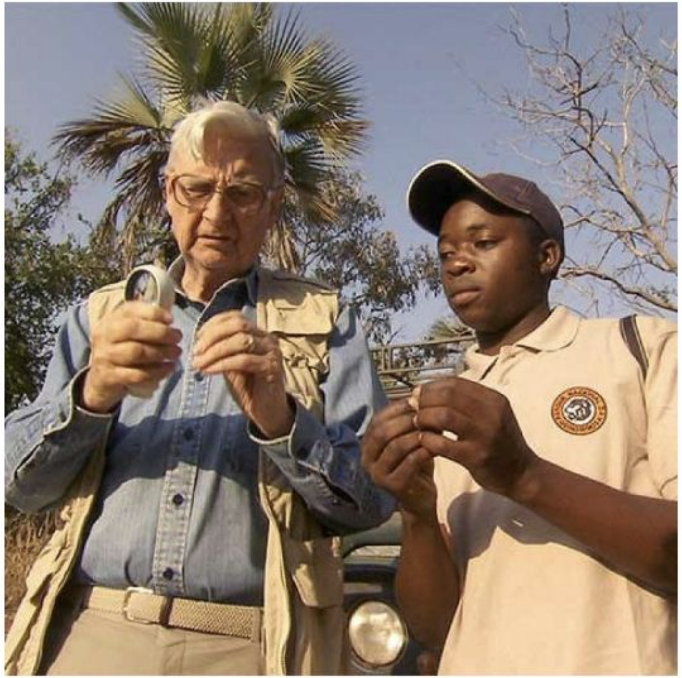
Tips for Setting up a CURE

Student Engagement & Course Opportunities

- Have two class meetings to solve a problem - offer practice opportunities before starting the CURE.
- Integrate a research question or problem into the course.
- Small group work is very important to facilitate full participation and engagement.
- The questions must involve hands on work and be practical in nature.
- Emphasize how and what data collection is required.
- Students always respond positively.
- The challenge - How do we as faculty sustain student enthusiasm?

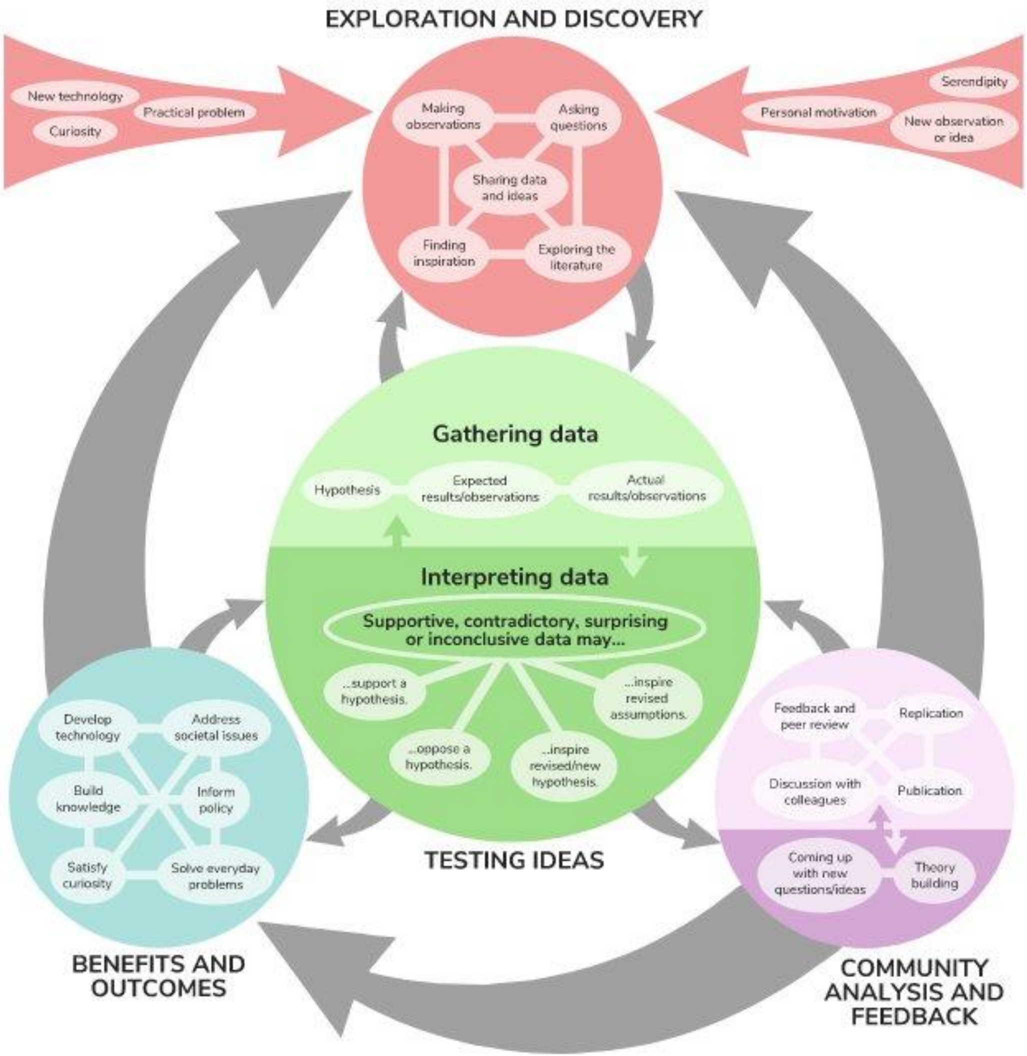
Key Concepts

- Science involves **more activities and events** than hypothesis testing.
- Science relies on individual researchers and the **larger scientific community**.
- Science both is **shaped by and shapes the broader community** in which it is embedded.
- Science often takes a more **winding path** than is typically portrayed in journal articles or most science media.



From *The Guide: A Biologist in Gorongosa*

How Science Works Model



Source: HHMI BioInteractive

Hands On Break Out Activity - Oreos

- How do we evaluate these oreos? - Starter questions:
- What does “thin oreos” actually mean?
- Are double stuffed oreos really double stuffed?
- Are gluten free oreos equivalent to a regular oreos?
- What parameters can we consider size, width, height, radius, weight, edibility, flammability

Oreo Analysis

- What did you discover
- What did you observe?
- How observant where you, did you use your phone?
- Did you critically thinking before you began?
- How important are are hands on and practical skills?
- What techniques did you use?
- How could this be expanded and improved?

YOre’ o Analysis

- What did you discover about yourself
- How invested did you become?
- Experience a sense of ownership?
- Did you want to obtain more data?
- How good are your own practical skills?
- Improvements? Suggestions?

Faculty Perspective

- Could this be a simple take home lab? Maybe reconsider the idea.
- How good are student observational skills?
- Are there challenges to learning practical skills?
- Endless possibilities….. Experimental science offers this!
- Does each course need a leader/champion to direct and provide focus and a coherent discourse with research possibilities?

Administrative Perspective

- Collaboration with faculty is rewarding and essential.
- How does this fit into course transferability and your programs.
- Follow a theory for cultural change
  - Increases faculty buy-in
  - Recommend Chapter 7 (Ambros) in Transforming Academic Culture & Curriculum to get started.
- Collect data
  - Leverage IR data
  - Do you have someone that can do discipline-specific or action research (qualitative research)?
  - Do you have an IRB
- Consider budget - are internal and external funding opportunities available?
  - NSF grants?
  - Other funding sources or collaborations with 4-year schools?
- What training is needed for faculty?
  - What connections do you have to leverage?
  - Are there funds available?


QUESTIONS