ECR Hub
EDU Core Research

Panel Discussion

What Can Newer BCSER Individual Investigator Development PIs Learn From More Experienced Ones?

Regency B
Tuesday, 3:15 – 4:30 pm

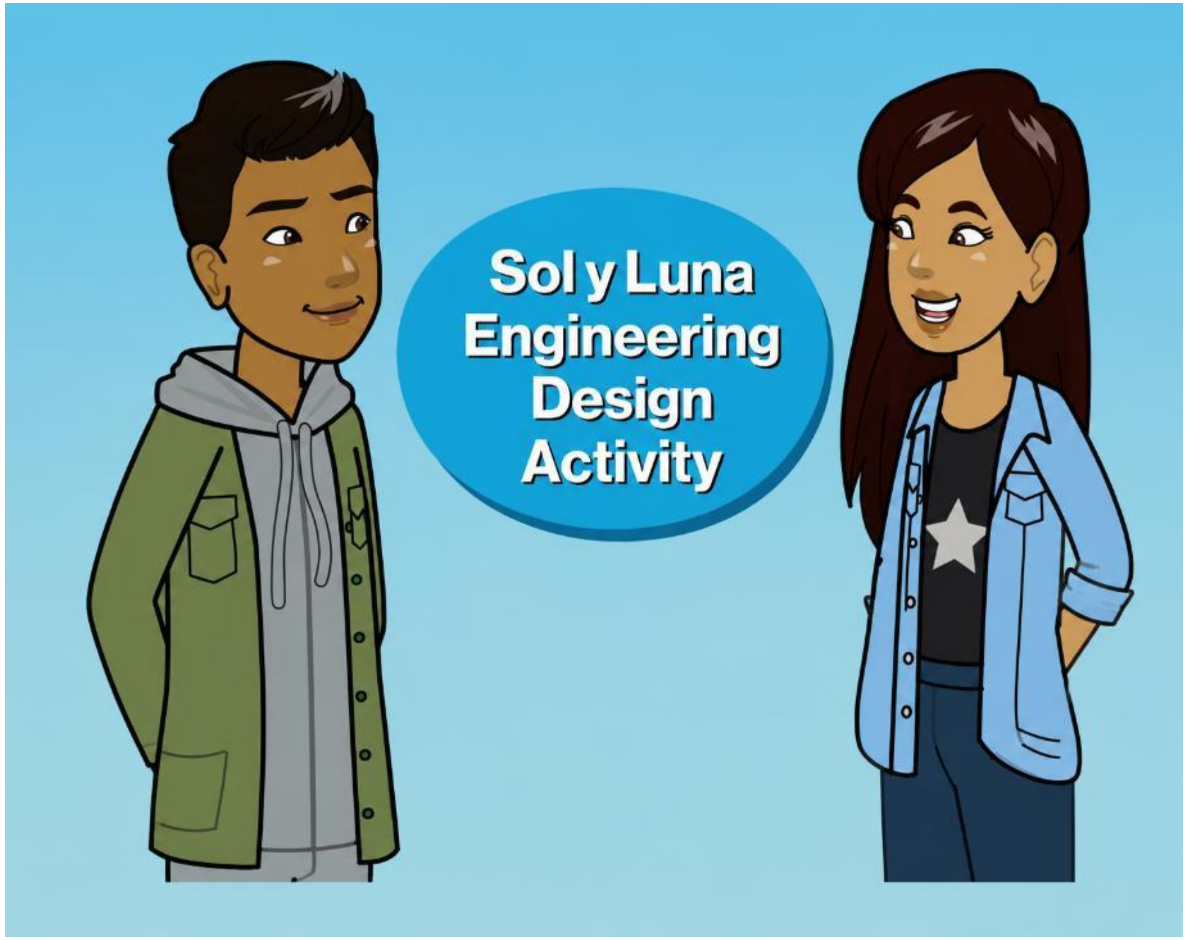
Presenters

Panelists

- Dina Verdín, Arizona State University
- Nicole Panorkou, Montclair State University
- Ryan Stowe, University of Wisconsin at Madison

Moderator

- Terri Pigott, Georgia State University



BCSER: Empowering Children of Migratory/Seasonal Farmworkers with Gamification and Culturally-Responsive Engineering Design Instruction

Dina Verdín, PhD

Associate Professor

Arizona State University

BCSER #2225306

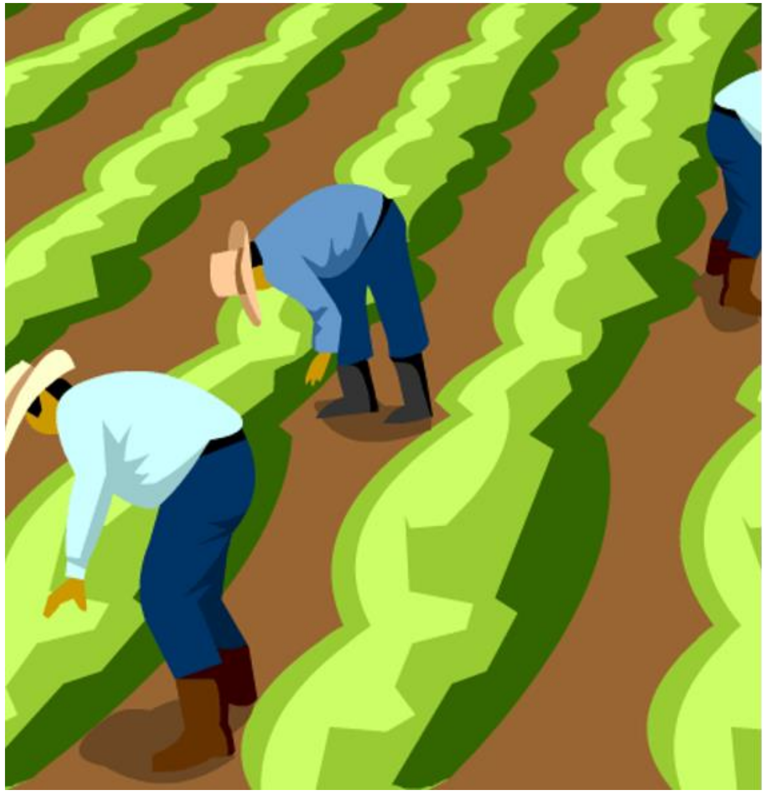
Background on my BCSER

Purpose: Build foundational knowledge on how a culturally responsive gamified activities support migratory students' exposure to engineering, foster engineering identity development, cultivate a critical agentic perspective, and promote engineering career pathways.

Project started 2022 → Issued 1 year no cost extension → Requested 2nd no cost extension

America's Invisible High School Youth

Children whose parent(s) are migratory agricultural workers and live a mobile lifestyle.



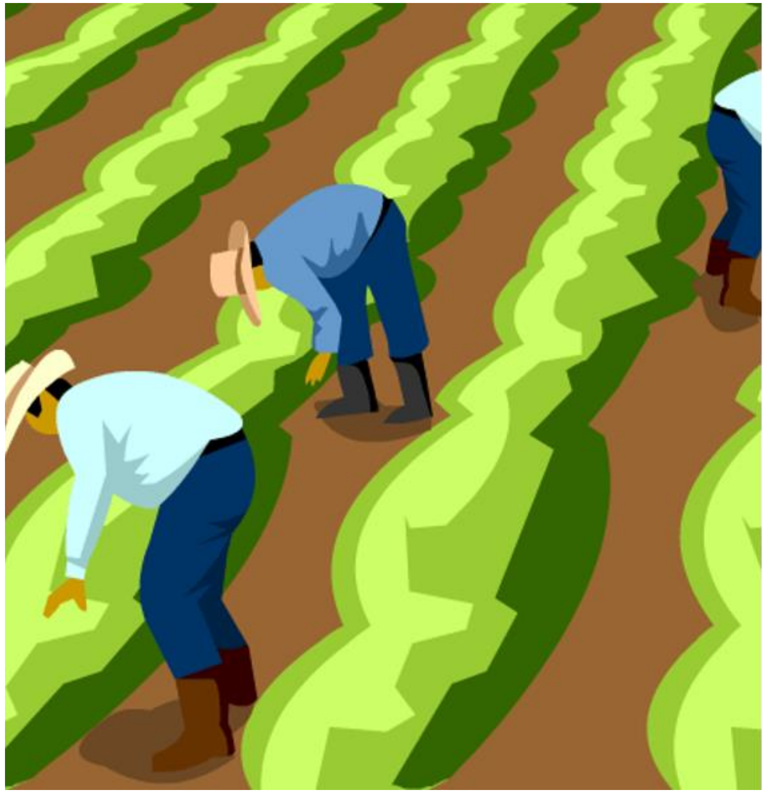
Due to the mobile lifestyle of agrarian work

- high levels of interrupted schooling,
- falling behind in their school's curriculum,
- their family's income is below the federal poverty level,
- Many are English Learners, etc.

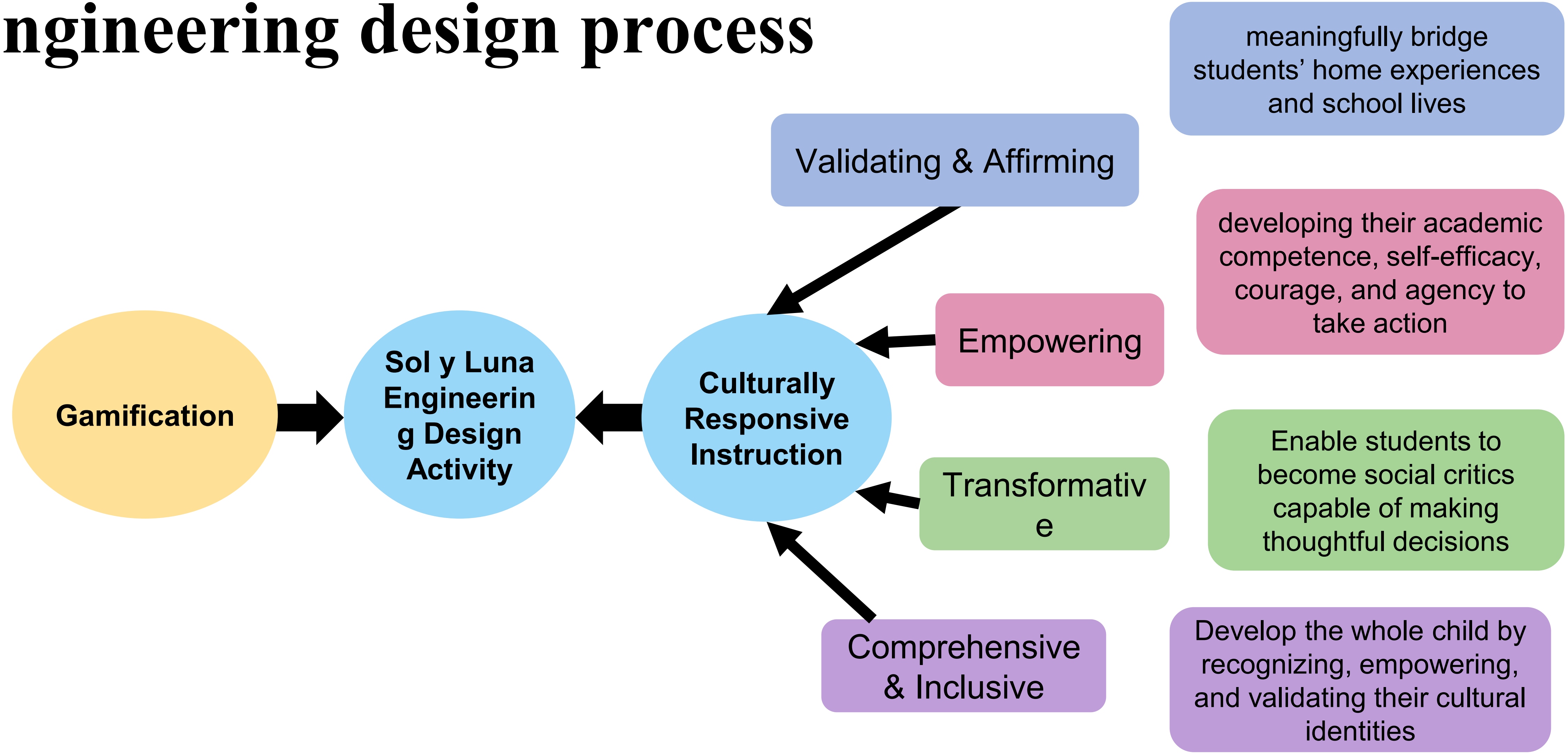
STEM opportunities should not be denied to these students

America’s Invisible High School Youth

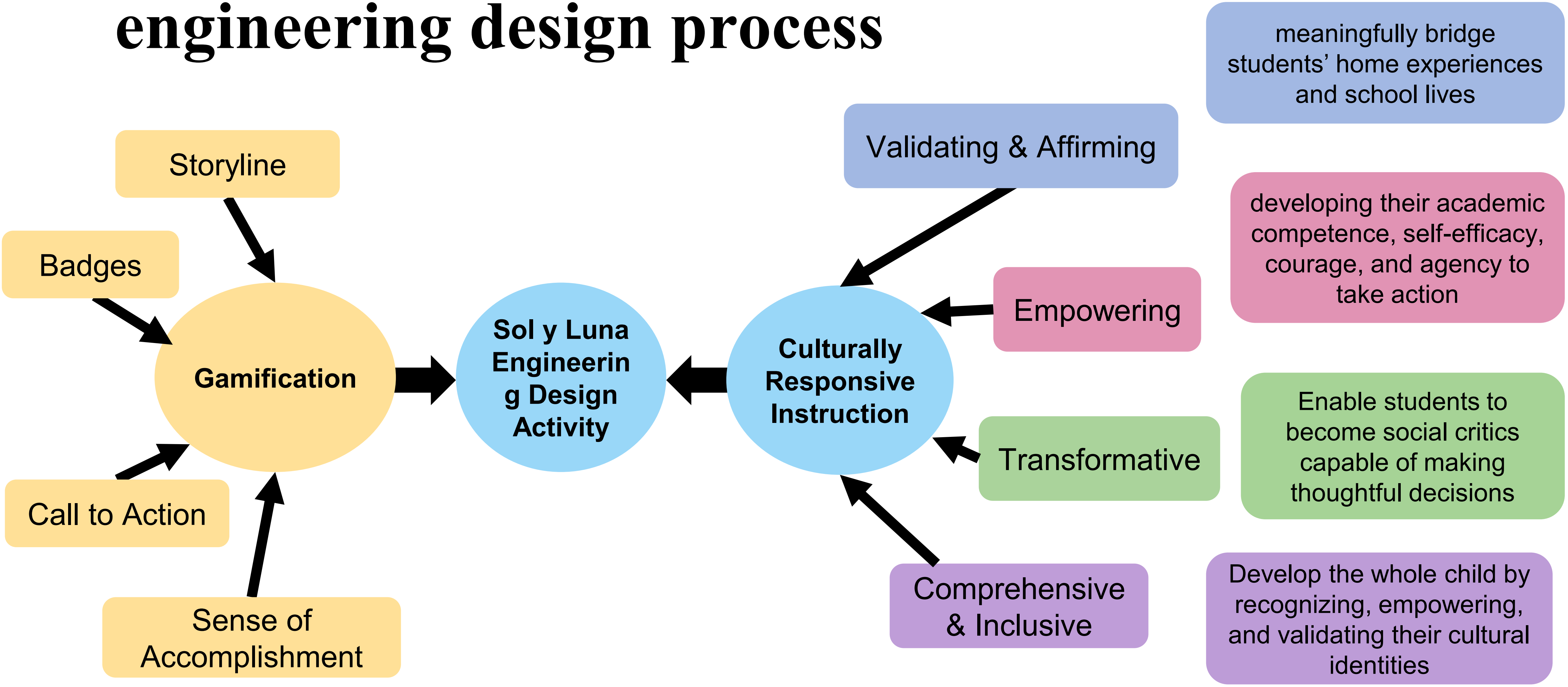
- ~10,000 migratory students in Arizona
- Only 7% of Arizona migratory students receive support and enrichment services during the summer months
- **Project created due to lack of culturally responsive, engineering-focused activities centered on the unique lived experiences of migratory students.**



Infusing Gamification & Culturally Responsive instruction to teach students about the engineering design process

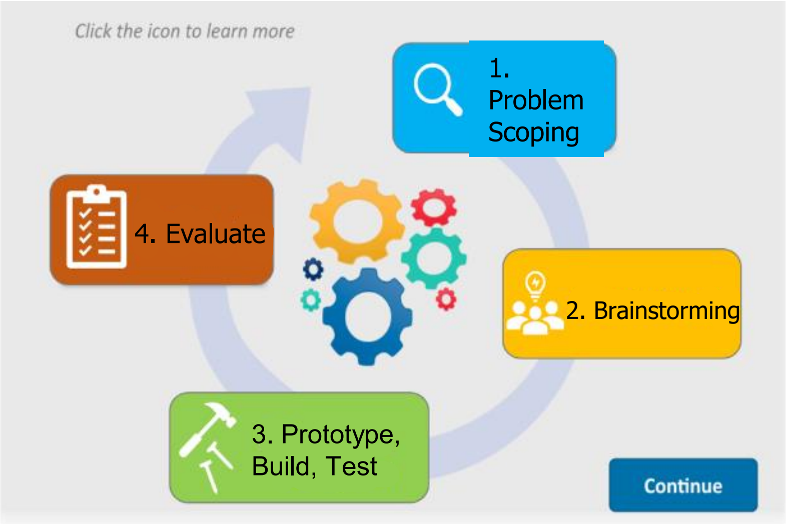


Infusing Gamification & Culturally Responsive instruction to teach students about the engineering design process



90-minute online activity learning how to use the engineering design process

Engineering design process

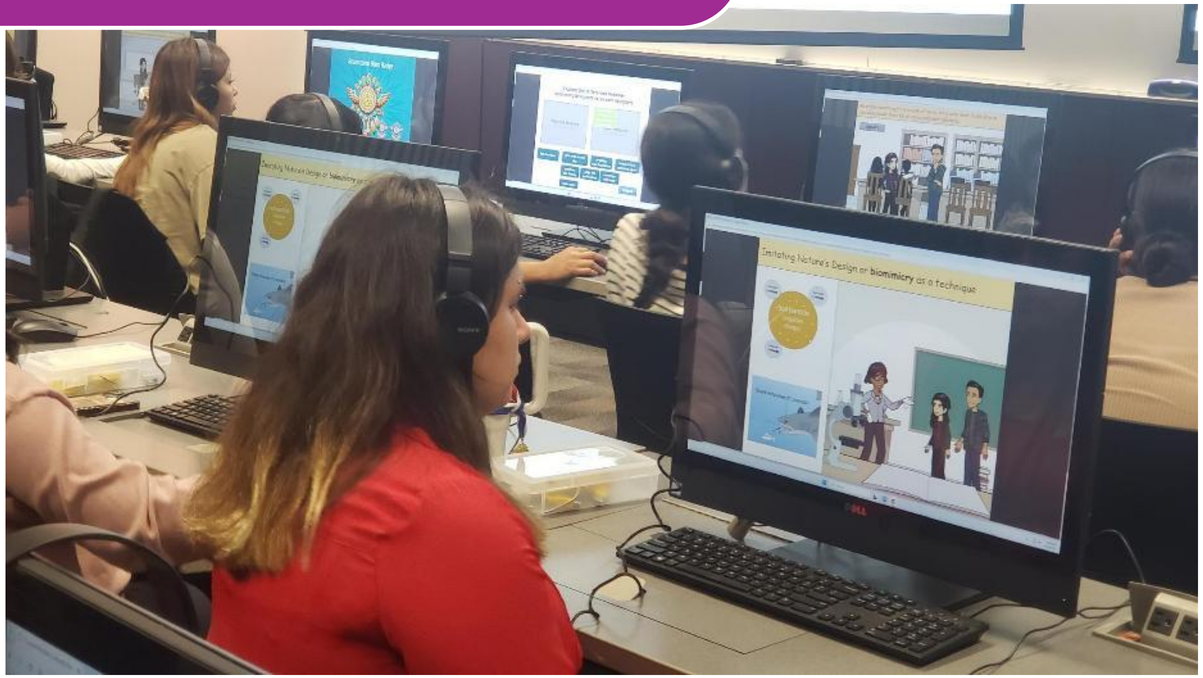


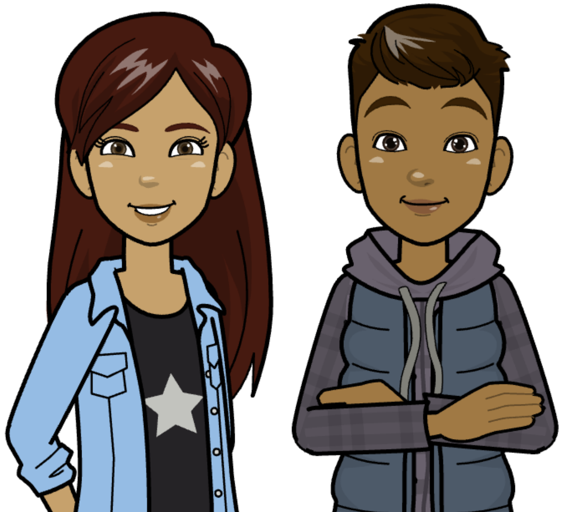
Comic book maker:

Interactive learning features:

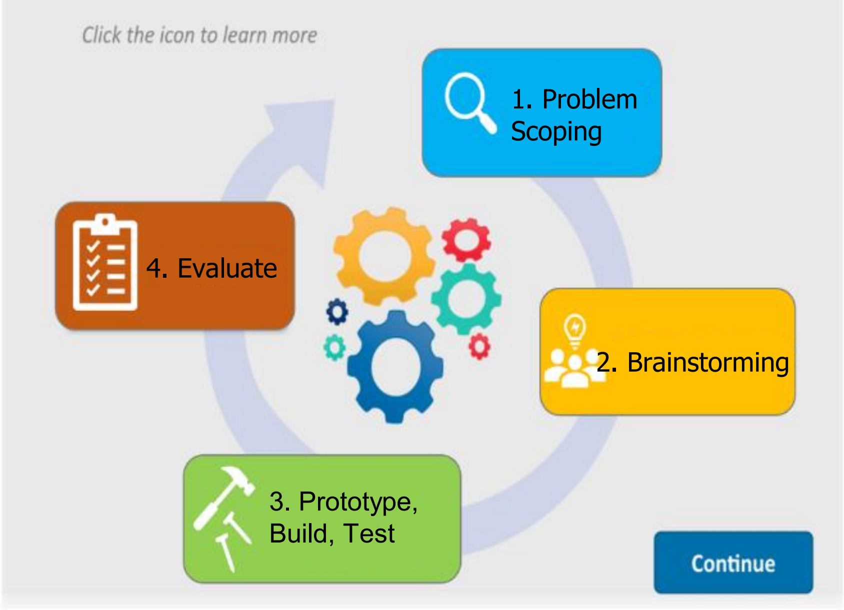
Two-Part Activity

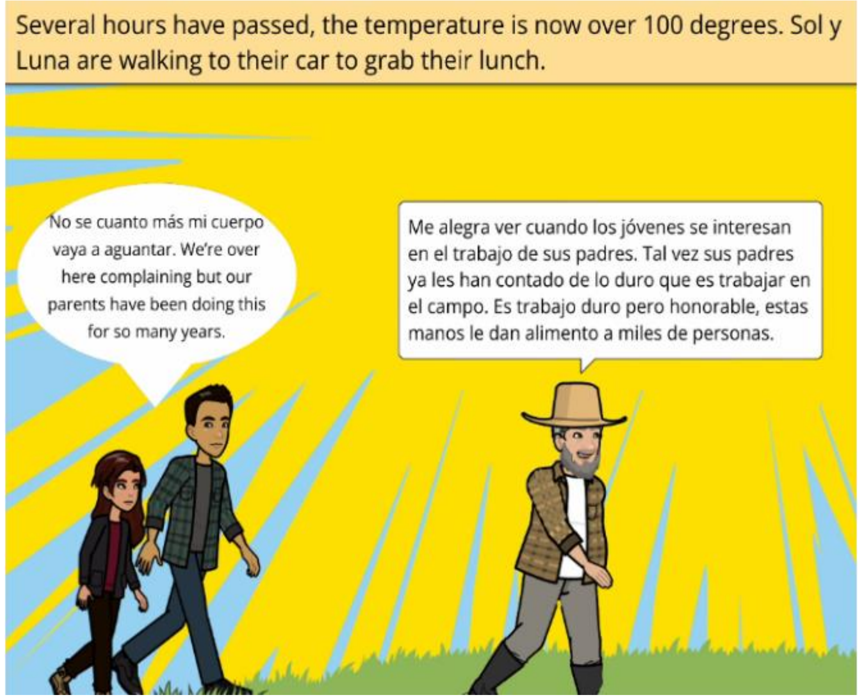
1. Culturally Responsive Gamified Storyline

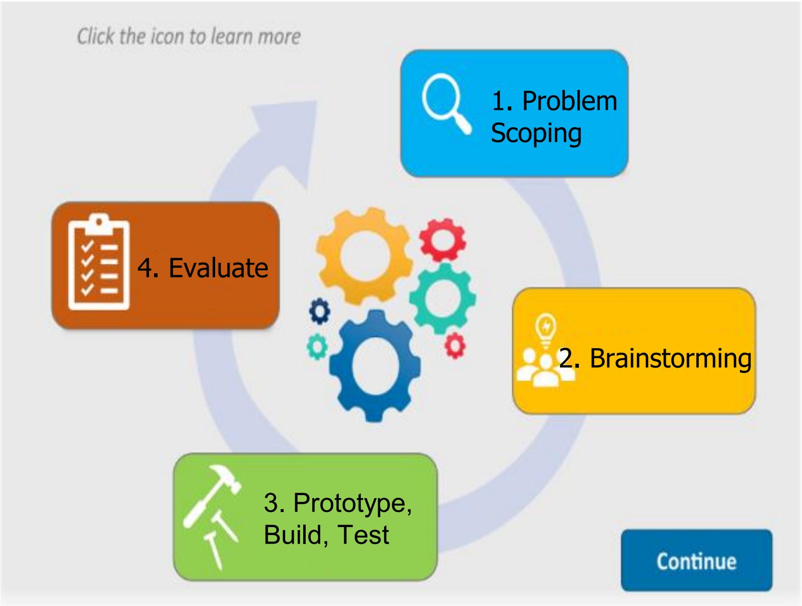




1. Culturally Responsive Gamified Storyline

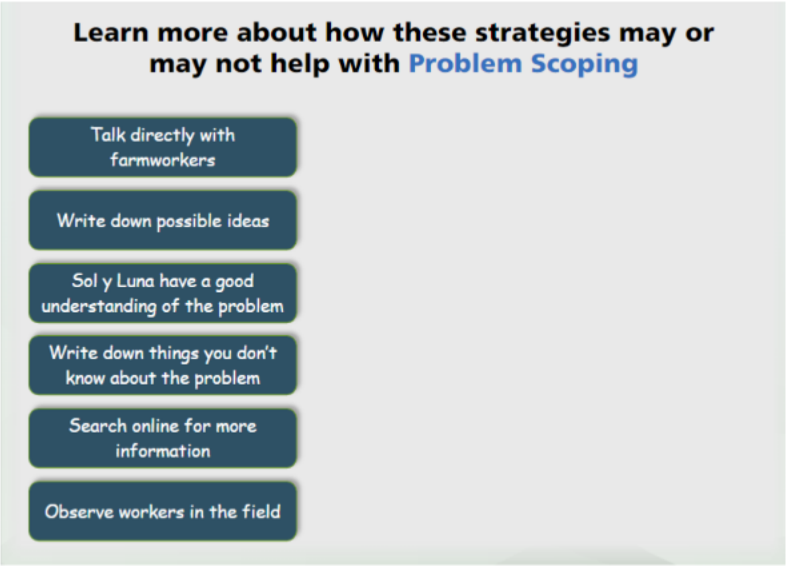


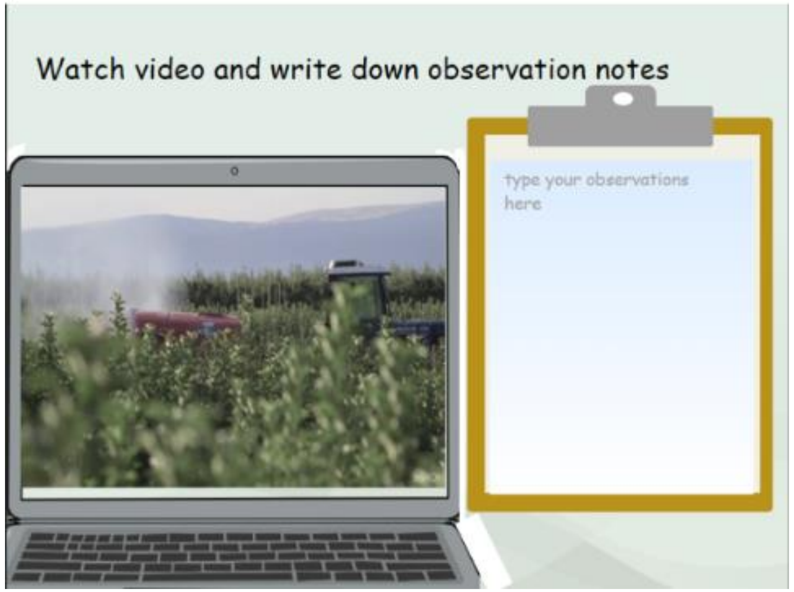



Click the icon to learn more
1. Problem Scoping
4. Evaluate
2. Brainstorming
3. Prototype, Build, Test
Continue

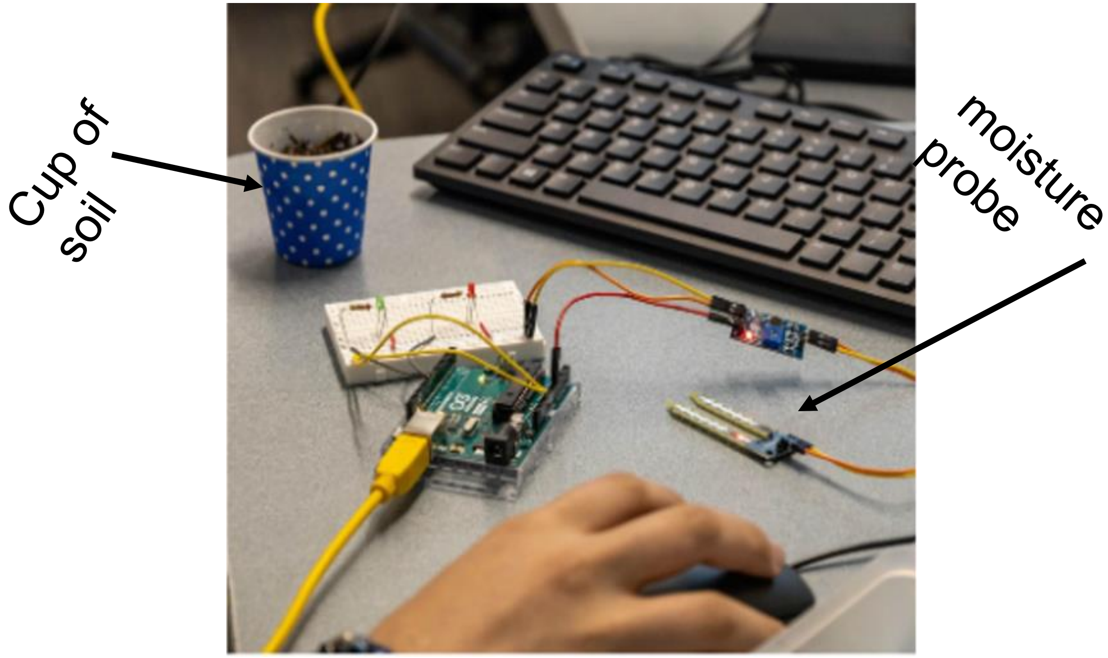

Some of the agricultural workers spend a few minutes answering Sol y Luna's questions. Additionally, Sol y Luna are going to observe farmworkers perform their job and take notes on their observations.


Select the 4 best questions Sol y Luna should ask agricultural workers
Have you ever felt any discomfort when working in the fields?
Have you experienced skin irritability when working in the fields?
How long have you been working in the fields?
What does a typical work day in the fields look like for you?
How many hours do you work per week?
Have you ever experienced headaches when working in the fields?
While working in the fields, have you experienced fatigue?
Do you think it would be better to change jobs?
Submit


Learn more about how these strategies may or may not help with Problem Scoping
Talk directly with farmworkers
Write down possible ideas
Sol y Luna have a good understanding of the problem
Write down things you don't know about the problem
Search online for more information
Observe workers in the field


Watch video and write down observation notes
type your observations here


NOW
THIS
A dangerous pesticide known for attacking the nervous system



2. Building a physical system

Received: 18 October 2024 | Revised: 13 November 2025 | Accepted: 17 November 2025

DOI: 10.1002/jee.70048

JEE

RESEARCH ARTICLE

Increasing Latinx migratory high school students' engineering interest and self-efficacy beliefs: A culturally responsive gamified engineering design activity

Dina Verdín | **Timothy Wells** | **Ulises Trujillo Garcia**

The Polytechnic School, Arizona State University, Mesa, Arizona, USA

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Funding information
National Science Foundation, Grant/Award Number: 2225306

Abstract

Background: The ongoing underrepresentation of Latinx students, particularly girls, in engineering calls for new approaches to broaden participation. The present study aims to address this disparity by implementing a culturally responsive gamified engineering activity for migratory high school students, an often-overlooked subset of Latinx youth. The activity integrated principles of culturally responsive instruction and elements of gamification to teach the engineering design process and boost students' engineering interest and self-efficacy beliefs.

Method: A repeated-measures mixed ANOVA was used to analyze pre- and post-survey measures from 144 Latinx migratory high school students who participated in a summer program.

Results: After engaging in the activity, Latinx migratory high school students had a significantly greater interest in engineering, and their overall confidence in their ability to academically excel in engineering increased. Students felt

BCSER Project
Designing an Equitable Approach to Multiplicative Reasoning through Dynamic Measurement for Area

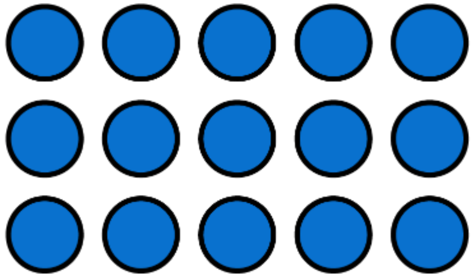
Nicole Panorkou
Professor of Mathematics Education
panorkoun@montclair.edu

Context

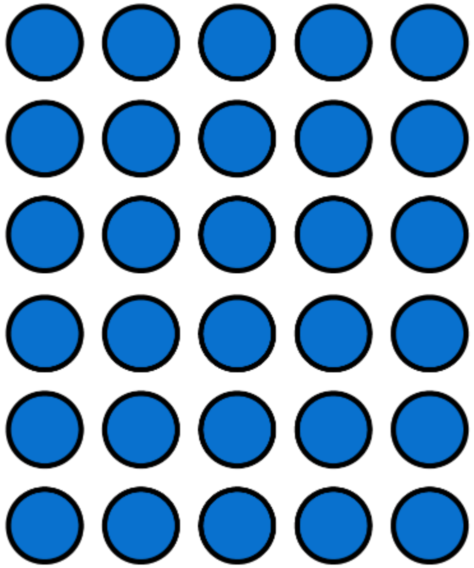
- Math Educator in the Math department
- Living in New Jersey
- First sole PI on an NSF grant
- BCSER duration: Sept 2023 → Aug 2026 → Extended to Aug 2027
- Current BCSER team: 3 doctoral assistants, 1 postdoc
- When I applied for BCSER I was an associate professor
- First time mom!

Prior Research

Current State of Multiplicative Reasoning



3×5



6×5

6 x 5

6 x 5

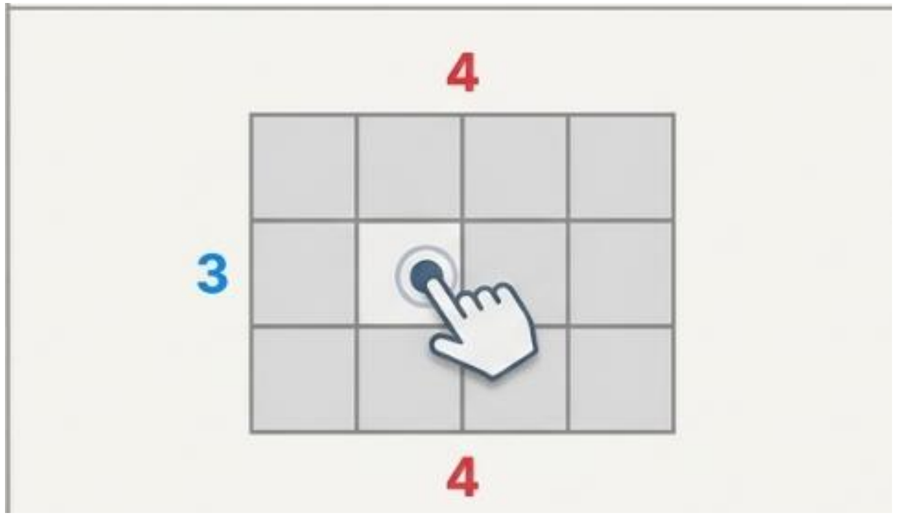
6 x 5

6 x 5

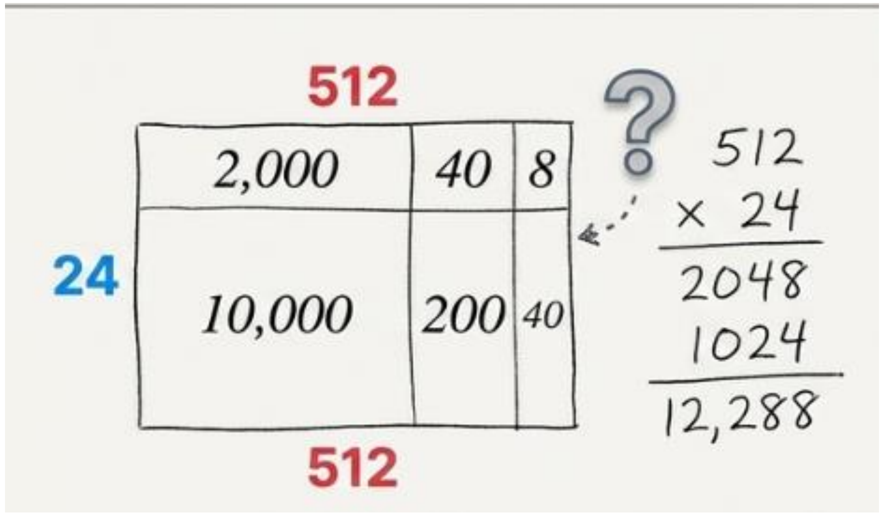
12×5

Prior Research

Current State of Multiplicative Reasoning



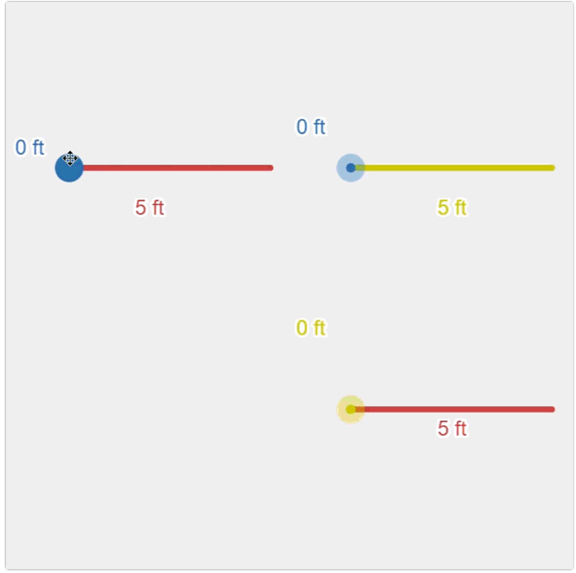
Students rely on counting

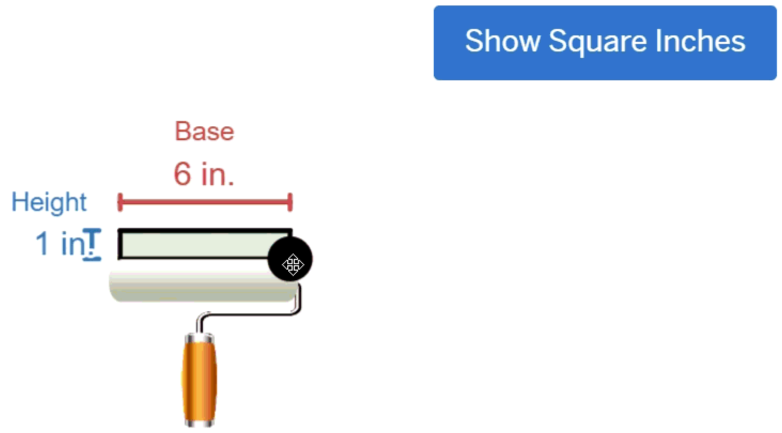


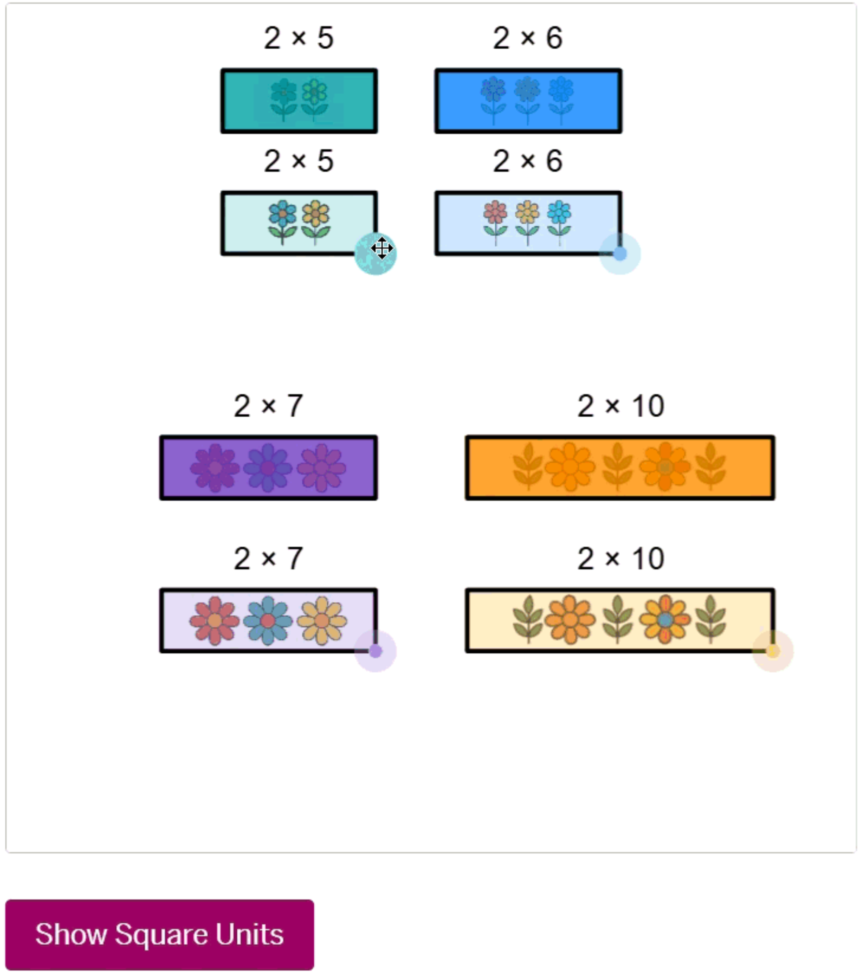
Models break at scale

Prior Research

Dynamic Measurement & Multiplicative Reasoning

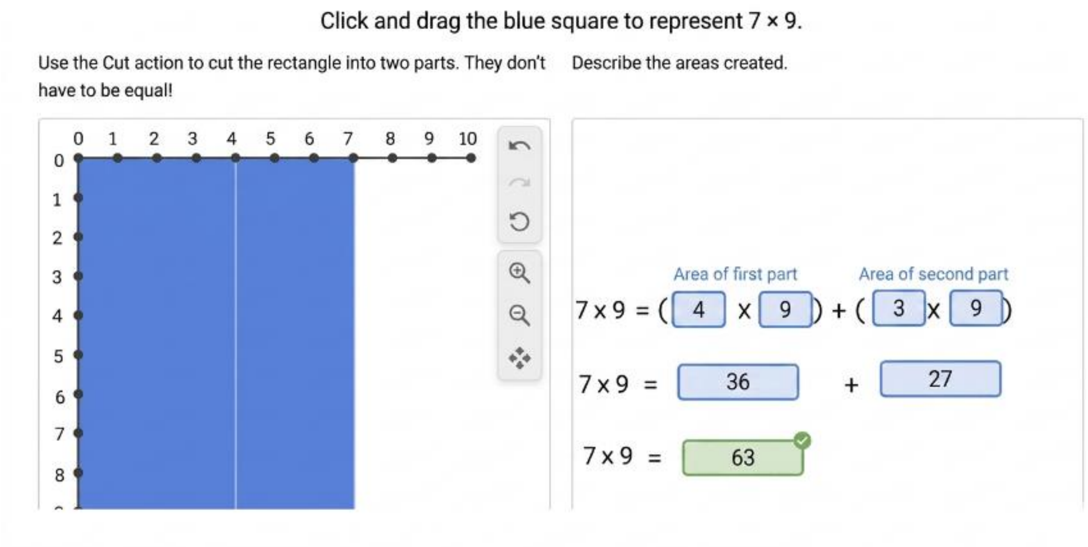


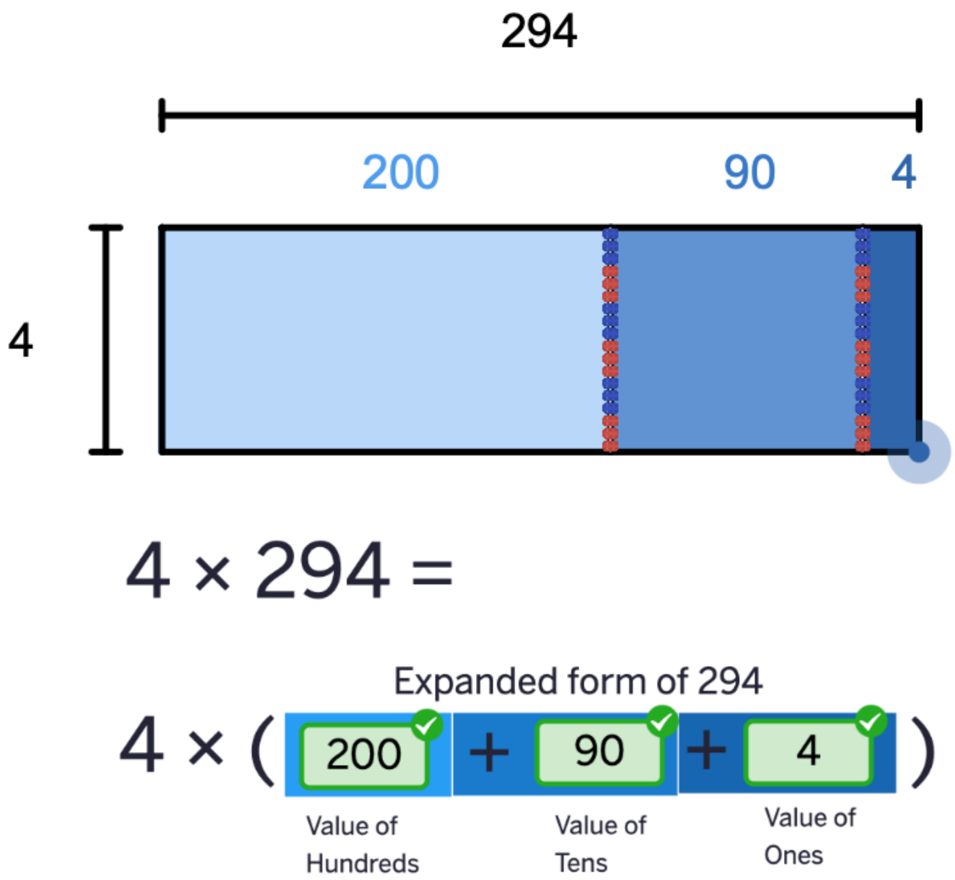




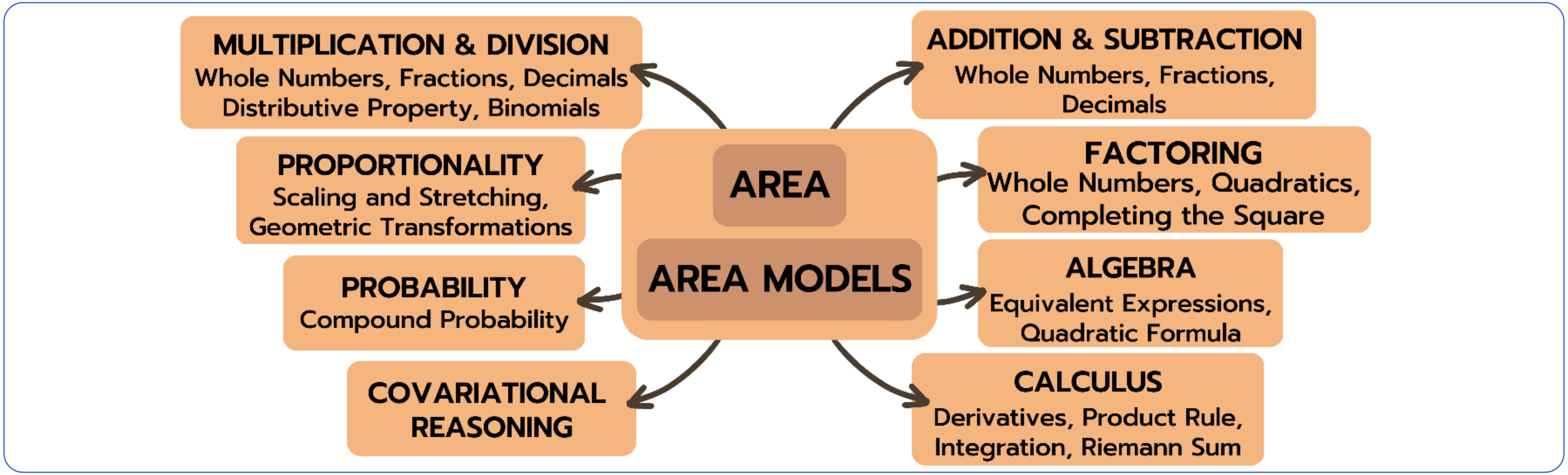
Prior Research

Dynamic Measurement & Multiplicative Reasoning





Extending this line of work



New Research Capacity - BCSER

New: Multiplicative Reasoning

(1) How can students' DYME-A reasoning support their development of multiplicative reasoning?

New: Equity in Math Education with a focus on equitable designs

(2) What type of an intervention design for DYME-A can reach a more diverse population of students and broaden its impact?

(3) How may the design experiment methodology be informed by equity research to engineer more equitable designs and theories?

Professional Development

(a) delving deeper into the multiplicative reasoning literature to describe the interplay with DYME-A, and

(b) problematizing the current use of design experiment methodology and finding ways to merge established methods used in equity research to engineer more equitable designs and theories.

Professional Development Plan

- Two mentors: (a) multiplicative reasoning and (b) design experiments
- Advisory board: Three focusing on equity

  Engaging Students of Color in Participatory Design Research

  Teaching mathematics for social justice

  Experiences of Latinx students' learning of mathematics

- Conferences
- Reading. Lots of reading!

Task Design

2. Multiplicative reasoning Whole Numbers

- 2.5 Multiplying/Dividing of a four-digit number by a single-digit number by using the distributive property in an area model
- 2.4 Dividing two-digit numbers by finding the distance of given rectangular areas using a given length for a roller
- 2.3 Multiplying two-digit numbers by growing rectangular areas
- 2.2 Dividing one-digit numbers by finding the distance of given rectangular areas using a given length for a roller
- 2.1 Multiplying one-digit numbers by growing rectangular areas

Commutative Property

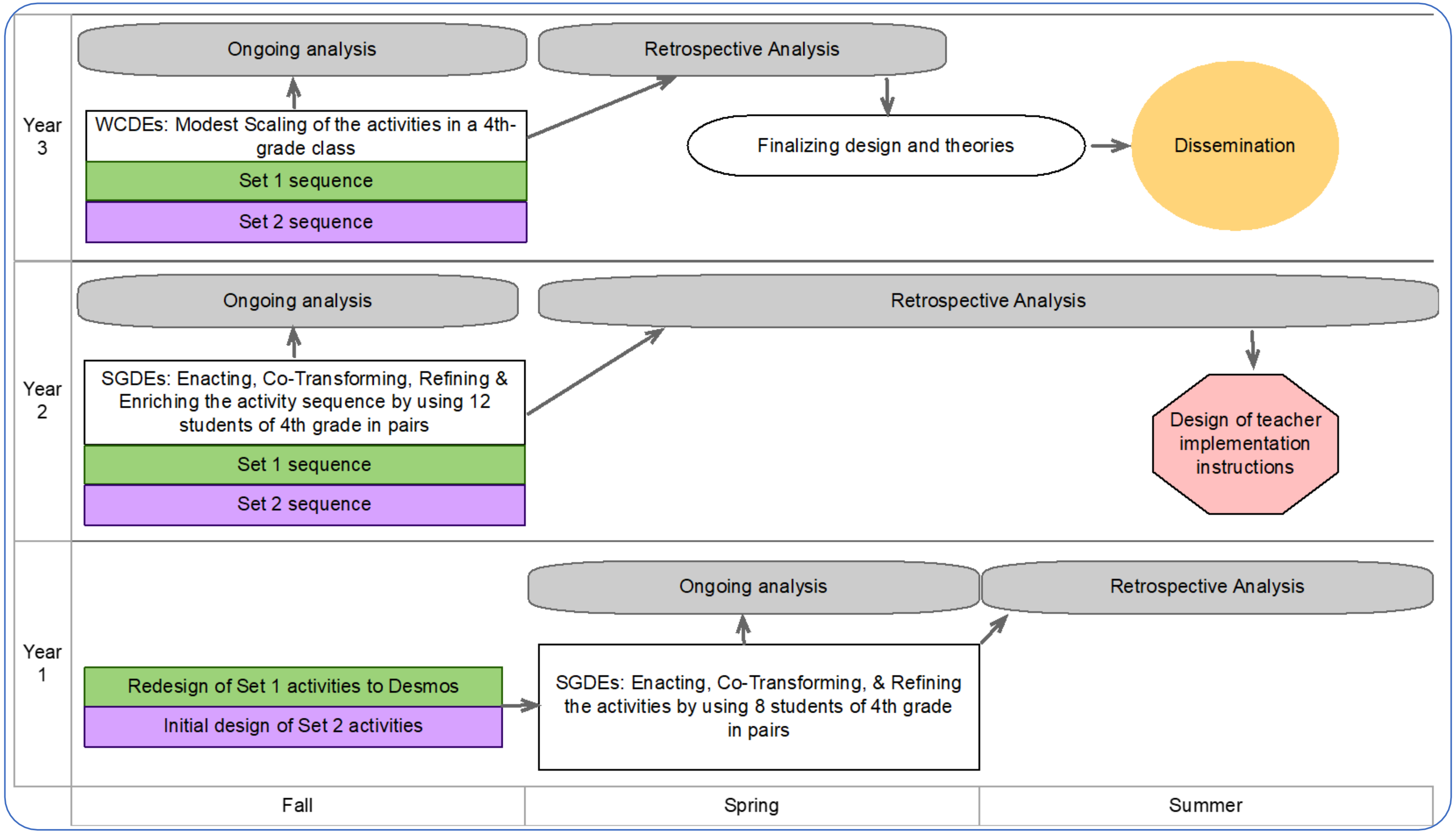
Distributive Property

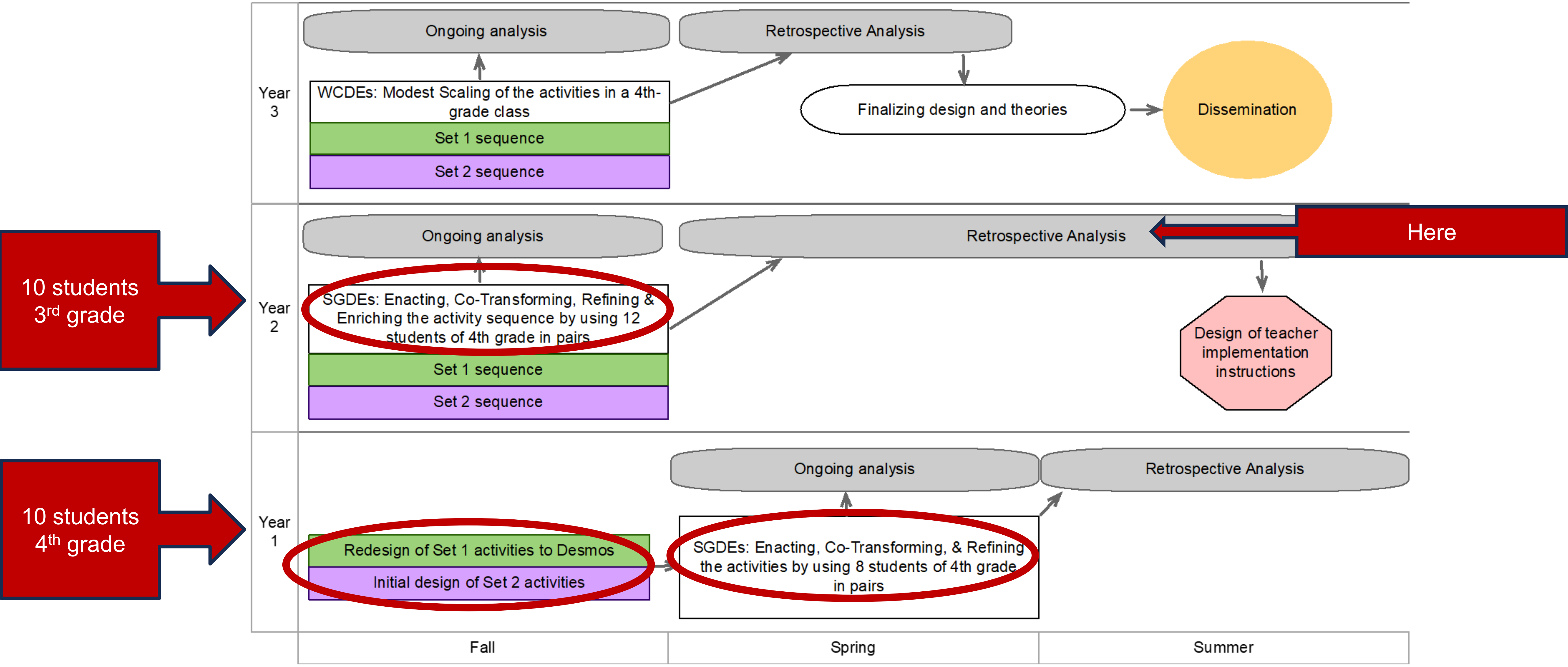
1. DYME-A

- 1.5 Growing and shrinking areas multiplicatively by multiplicatively changing lengths and/or widths
- 1.4 Creating rectangles with same area but different dimensions
- 1.3 Using *an a*-inch roller and b rollers of a/b to paint surfaces of various lengths and widths and find the space covered
- 1.2 Using 1-inch rollers to paint surfaces of various lengths and widths and find the space covered
- 1.1 Generating rectangular areas using rollers of same size dragged over various distances, or using rollers of different sizes dragged over the same distance. Comparing the space covered

Factors

Research Design




Ongoing analysis
Retrospective Analysis
WCDEs: Modest Scaling of the activities in a 4th-grade class
Set 1 sequence
Set 2 sequence
Finalizing design and theories
Dissemination
Year 3
Ongoing analysis
Retrospective Analysis
Here
10 students 3rd grade
SGDEs: Enacting, Co-Transforming, Refining & Enriching the activity sequence by using 12 students of 4th grade in pairs
Set 1 sequence
Set 2 sequence
Design of teacher implementation instructions
Year 2
Ongoing analysis
Retrospective Analysis
10 students 4th grade
Redesign of Set 1 activities to Desmos
Initial design of Set 2 activities
SGDEs: Enacting, Co-Transforming, & Refining the activities by using 8 students of 4th grade in pairs
Year 1
Fall
Spring
Summer

Current State of the Project

2023 – 2024: Task Design (Merged)

2024 – 2025: DE & Ongoing Analysis, co-design with teachers and students

2025 – 2026: Retrospective Analysis using three different lenses (reasoning, embodied actions, co-design)

Next steps:

- Modest scale in a classroom
- More analysis
- Dissemination

Lesson Learned

- ✓ Research is a **dynamic** process.
- ✓ My idea will **evolve** and **transform** as the research unfolds.
- ✓ New ideas will **emerge** through the process
- ✓ Embrace the unexpected as opportunities for growth and future discovery!

Looking forward to your questions!

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How BCSER Catalyzed a Program on Epistemological Messaging

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Nicole Becker
Anna Bierbrauer
Andy Elby
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Kimberly DeGlopper (Ph.D.)
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Megan Deshaye (M.S.)
Tom Kuborn (M.S.)
Vanessa Rosa (postdoc)
Adam Schafer (postdoc)

WARF
Wisconsin Alumni Research Foundation
NSF
DUE 2225025
DRL 2003680
DUE 2452886

Why should students take chemistry classes?

Chemistry knowledge and practices are useful in daily life

Useful in daily life: *"help people solve personally meaningful problems in their lives, directly affect their material and social circumstances, shape their behavior, and inform their most significant and practical political decisions"* (Feinstein, 2011, p 169)

Feinstein, N. (2011). Salvaging science literacy. *Science Education*, *95*(1), 168–185.

Constructing Knowledge in Daily Life

Gas Stoves | Could They Be Banned? | Climate and Health Concerns | How to Lower Your Risk | Alternatives to Gas Stoves

Gas Stoves Are Tied to Health Concerns. Here's How to Lower Your Risk.

Emissions from gas stoves have been connected to an increased risk for childhood asthma, among other things. You can mitigate the effects with a few simple steps.

Give this article | 751

Tamir Kalifa for The New York Times

When you use a gas stove, it emits poisonous gases called nitrogen oxides, including nitrogen dioxide, a respiratory irritant thought to trigger asthma.

Blum, D. (2023, January 14). Gas Stoves Are Tied to Health Concerns. Here's How to Lower Your Risk. *The New York Times.* https://www.nytimes.com/2023/01/11/well/live/gas-stoves-health-risks.html

Constructing Knowledge in Daily Life

Gas Stoves | Could They Be Banned? Climate and Health Concerns How to Lower Your Risk Alternatives to Gas Stoves

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Emissions from gas stoves have been connected to an increased risk for childhood asthma, among other things. You can mitigate the effects with a few simple steps.

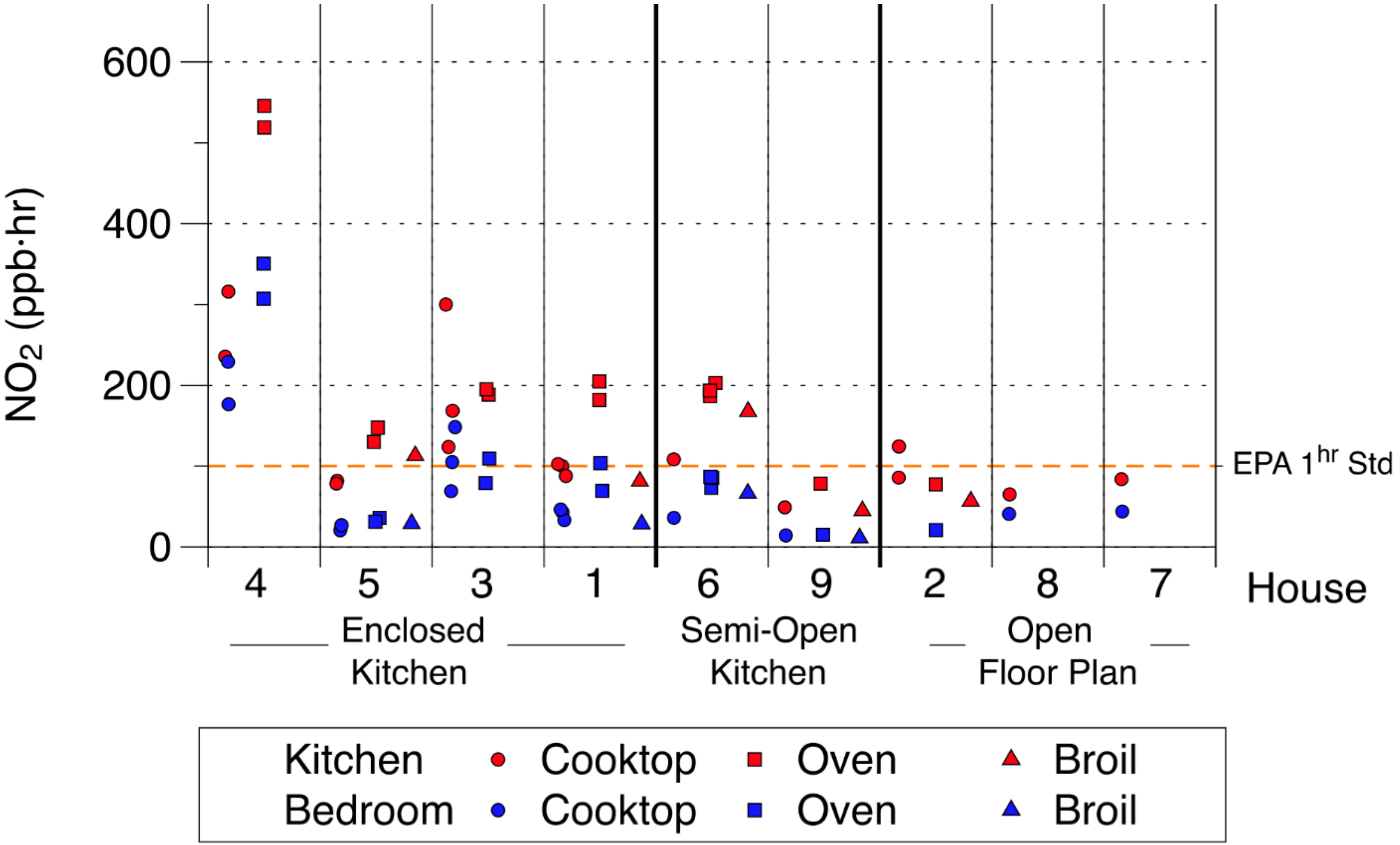
Give this article 751

Tamir Kalifa for The New York Times

A study published last year found that families who use gas stoves in homes with poor ventilation, or without range hoods, can blow past the national standards for safe hourly indoor explores to nitrogen oxides within just a few minutes

Blum, D. (2023, January 14). Gas Stoves Are Tied to Health Concerns. Here's How to Lower Your Risk. *The New York Times.* https://www.nytimes.com/2023/01/11/well/live/gas-stoves-health-risks.html

Constructing Knowledge in Daily Life



Singer, B.C., Pass, R.Z., Delp, W.W., Lorenzetti, D.M., & Maddalena, R.L. (2017). Pollutant concentrations and emission rates from natural gas cooking burners without and with range hood exhaust in nine California homes. *Building and Environment, 122,* 215-229.

Constructing Knowledge in Daily Life

I know a lot about this topic that could be useful!

Should I be worried about my stove?

PV=nRT

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

$$p = \frac{RT}{V_m - b} - \frac{a}{\sqrt{T}V_m(V_m + b)}$$

NO_2 has pi bonding interactions

Molecules interact via elastic collisions

Average KE of a gas depends on temp

Gas stoves work by emitting gas molecules via the flames

Some gases are good for me and some gases are bad for me.

Stuff spreads out when it moves into a new area

If stuff has nowhere to go, it will build up in one area

I know a lot about this topic that could be useful!

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I need a causal story for how this works.

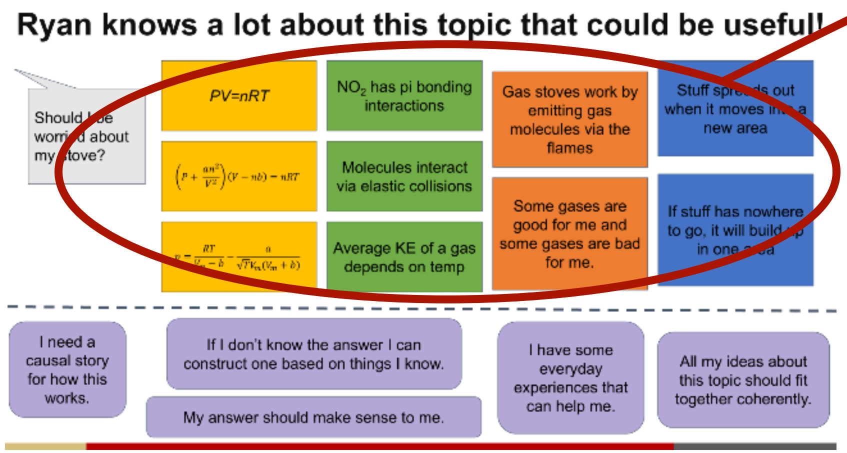
If I don't know the answer I can construct one based on things I know.

My answer should make sense to me.

I have some everyday experiences that can help me.

All my ideas about this topic should fit together coherently.

Different kinds of knowledge I have to work with

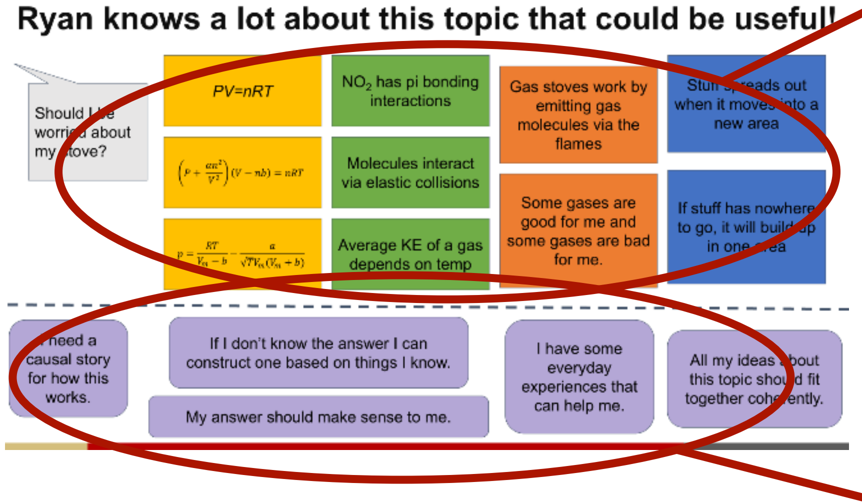


- **Conceptual or Content Knowledge:**
  - Knowledge about the science topic
  - Standard focus of chemistry education research (e.g., Holme, Luxford & Brandriet, 2015; Pazicni et al., 2021)

Holme, T.A., Luxford, C.J., & Brandriet, A. (2015) Defining Conceptual Understanding in General Chemistry. *Journal of Chemical Education, 92*(9), 1477-1483.

Pazicni, S., Wink, D.J., Donovan, A., Conrad, J.A., Darr, J.P., Morgan Theall, R.A., Richter-Egger, D.L., Villata-Cerdas, A., & Walker, D.R. (2021) The American Chemical Society General Chemistry Performance Expectation Project: From Task Force to Distributed Process for Implementing Multidimensional Learning. *Journal of Chemical Education, 98*(4), 1112-1123.

Different kinds of knowledge I have to work with



- **Conceptual or Content Knowledge:**
  - Knowledge about the science topic
  - Standard focus of chemistry education research (e.g., Holme, Luxford & Brandriet, 2015; Pazicni et al., 2021)
- **Meta-Knowledge about Explanation Construction:**
  - Tacit knowledge about appropriate ways to construct knowledge and appropriate types of knowledge to use
  - Referred to as "personal **epistemologies**" within education research (e.g., Collins & Ferguson, 1993; Hammer, 1994; Hofer & Pintrich, 2002; Sandoval, 2005)

Collins, A., & Ferguson, W. (1993). Epistemic forms and epistemic games: Structures and strategies to guide inquiry. *Educational psychologist*, *28*(1), 25-42.

Hammer, D. (1994). Epistemological beliefs in introductory physics. *Cognition and Instruction. 12*(2), 151-183.

Hofer, B. K., & Pintrich, P. R. (Eds.). (2002). *Personal epistemology: The psychology of beliefs about knowledge and knowing.* Lawrence Erlbaum Associates Publishers.

Sandoval, W. A. (2005). Understanding students' practical epistemologies and their influence on learning through inquiry. *Science Education*, *89*(4), 634–656.

Epistemologies

Epistemologies *"consist of [people's] systems of beliefs [tacit or explicit] about (1) the nature of knowledge and (2) the process of knowing"*

- Chinn, Buckland, Samarpungavan, 2011, p. 141

Epistemologies include ideas about aims for knowledge construction, reliable processes for achieving aims, how knowledge is justified etc.

Chinn, C. A., Buckland, L. A., & Samarapungavan, A. L. A. (2011). Expanding the dimensions of epistemic cognition: Arguments from philosophy and psychology. *Educational Psychologist*, *46*(3), 141-167.

What do epistemologies do?

Should I be worried about my stove?

Procedural knowledge

PV=nRT

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

$$p = \frac{RT}{V_m - b} - \frac{a}{\sqrt{T}V_m(V_m + b)}$$

Formal fact like knowledge from school

NO_2 has pi bonding interactions

Molecules interact via elastic collisions

Average KE of a gas depends on temp

Everyday experiential knowledge

Gas stoves work by emitting gas molecules via the flames

Some gases are good for me and some gases are bad for me.

Generic schematic knowledge

Stuff spreads out when it moves into a new area

If stuff has nowhere to go, it will build up in one area

What do epistemologies do?

Should I be worried about my stove?

Procedural knowledge	Formal fact like knowledge from school	Everyday experiential knowledge	Generic schematic knowledge
$PV=nRT$	NO_2 has pi bonding interactions	Gas stoves work by emitting gas molecules via the flames	Stuff spreads out when it moves into a new area
$\left(P+\frac{an^2}{V^2}\right)(V-nb)=nRT$	Molecules interact via elastic collisions	Some gases are good for me and some gases are bad for me.	If stuff has nowhere to go, it will build up in one area
$p=\frac{RT}{V_m-b}-\frac{a}{\sqrt{T}V_m(V_m+b)}$	Average KE of a gas depends on temp		

My answer should sound science-y.

What do epistemologies do?

Should I be worried about my stove?

Procedural knowledge

- $PV=nRT$
- $\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$
- $p = \frac{RT}{V_m - b} - \frac{a}{\sqrt{T}V_m(V_m + b)}$

Formal fact like knowledge from school

- NO_2 has pi bonding interactions
- Molecules interact via elastic collisions
- Average KE of a gas depends on temp

Everyday experiential knowledge

- Gas stoves work by emitting gas molecules via the flames
- Some gases are good for me and some gases are bad for me.

Generic schematic knowledge

- Stuff spreads out when it moves into a new area
- If stuff has nowhere to go, it will build up in one area

I need an explanation that makes sense to me.

How and Why I’ve Been Constructing Knowledge

Why Construct Knowledge?

- I’d rather not be poisoned by my gas stove
- I’d rather not leak a bunch of methane into the atmosphere

How Knowledge Is Being Constructed?

- Accumulation from several sources
- Knowledge is justified by aligning with data or trusted authorities
- Arguments are being crafted related to our options

How and Why I've Been Constructing Knowledge

What hasn't been happening:

- No answer key has been consulted
- No one told me how and why to construct knowledge
- No one forced me to come to a conclusion in a set time - my partner and I decided when we were "done"
- I was not constrained to the bounds of school chemistry

Epistemologies are key to our goal

Supporting useful chemistry learning requires that students (tacitly) see similarities between the nature and purpose of class activities and the nature and purpose of daily life activities.

Hammer, D.; Elby, A.; Scherr, R. E.; Redish, E. F. Resources, Framing, and Transfer. In *Transfer of Learning from a Modern Multidisciplinary Perspective*; Mestre, J. P., Ed.; IAP: Greenwich, CT, 2005; pp 89–119.

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Chemistry classes should help learners *“explore and discuss the differences between knowledge in multiple contexts”* (Elby & Hammer, 2001, p. 564) they will likely encounter in post-school life.

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Elby, A., & Hammer, D. (2001). On the substance of a sophisticated epistemology. *Science Education. 85*(5), 483-614.

BCSER Catalyzed Partnerships

Rosemary Russ theorizes about how classes "tell" students allowed ways to know and learn

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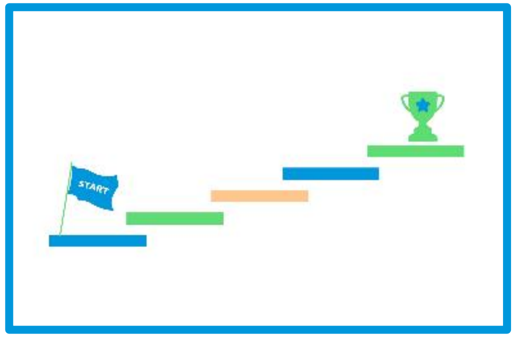
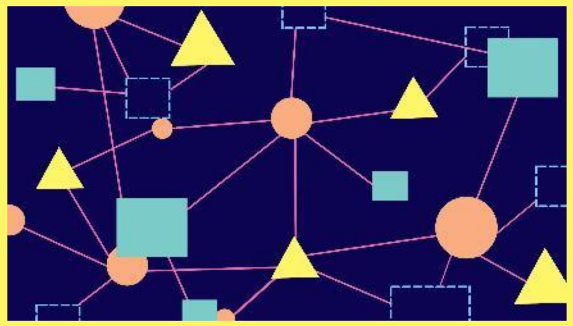
Conceptualizes epistemologies made of small "pieces" compiled in-the-moment

How We Understand Epistemology



Beliefs Model

- Stable over time
- Able to be articulated explicitly
- Hierarchical
- Multi-dimensional



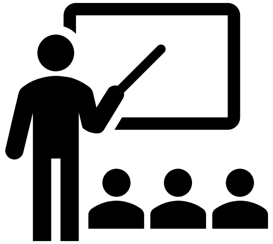
Network Model

- Dynamic over a timescale of minutes
- Tacit and inferable from behavior
- Have varying utility in different times and places
- Multi-dimensional

DeGlopper, K. S., Russ, R. S., Sutar, P. K., & Stowe, R. L. (2023). Beliefs versus resources: A tale of two models of epistemology. *Chemistry Education Research and Practice*, *24*(2), 768–784.
DeGlopper, K. S., & Stowe, R. L. (2024). Modeling students' epistemic cognition in undergraduate chemistry courses: A review. *Chemistry Education Research and Practice*, *25*(3), 594–612.
Greco, N. C., Russ, R. S., & Stowe, R. L. (2025). Keeping our Research Plumb: Theory-Driven Design and Analysis for the Study of Instructor Epistemologies. *Journal of Chemical Education, in press*.

Epistemological Messaging Landscape

Epistemological messages embedded in



Instruction

“The best way for you to prepare for course assessments is to practice explaining how/why chemical phenomena happen on problem sets, during discussion and on practice quizzes/exams”

Russ, R. S. (2018). Characterizing teacher attention to student thinking: A role for epistemological messages. *Journal of Research in Science Teaching*, *55*(1), 94-120.

Ke, L., & Schwarz, C. V. (2021). Supporting students' meaningful engagement in scientific modeling through epistemological messages: A case study of contrasting teaching approaches. *Journal of Research in Science Teaching*, *58*(3), 335-365.

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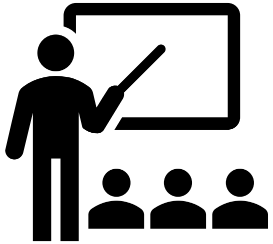

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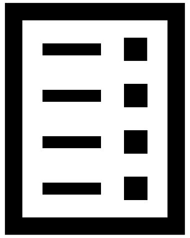
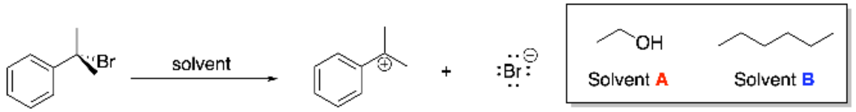
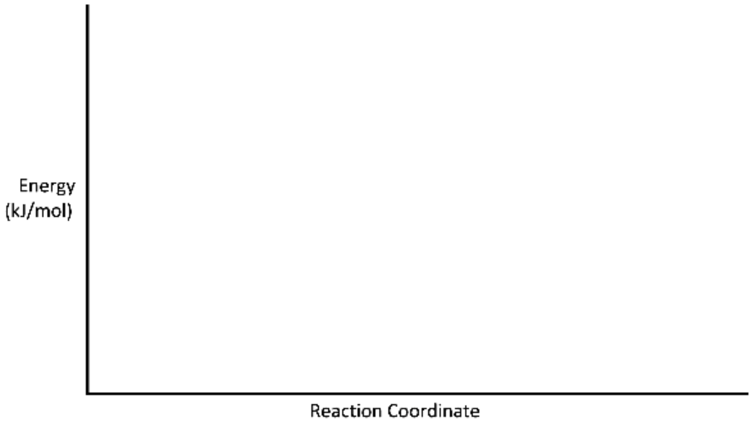


Assessment

IV. Solvents play a key role in reaction systems by favoring or disfavoring particular reaction pathways. Generation of a cation from a highly substituted alkyl halide is one example of a process that is highly solvent-dependent. For the purposes of this problem, consider formation of the corresponding carbocation and halide from 2-bromo-2-phenylpropane. **(15 pts total)**



A. On the axis below, draw the potential energy surface corresponding to generation of the cation shown above when 2-bromo-2-phenylpropane is added to solvent **A** **(solid line)**. Overlay this with the potential energy surface corresponding to the generation of the cation when the alkyl halide is added to solvent **B** **(dotted line)**. **Start both potential energy surfaces at the same location.** Make sure to label the transition state, activation energy and relevant intermediate(s) for these processes. **(10 pts)**



B. Using the potential energy surfaces you drew for part A, predict which of the two solvents would lead to a faster rate of carbocation formation. Explain your reasoning, making sure to connect the relative stability of the two transition states to reaction rate. **(5 pts)**

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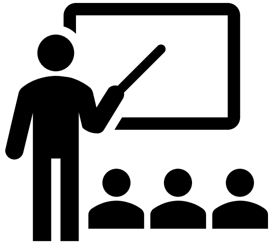

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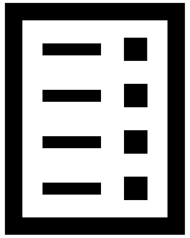

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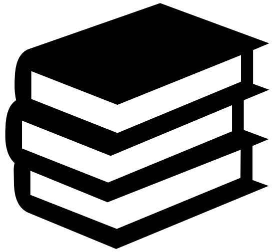
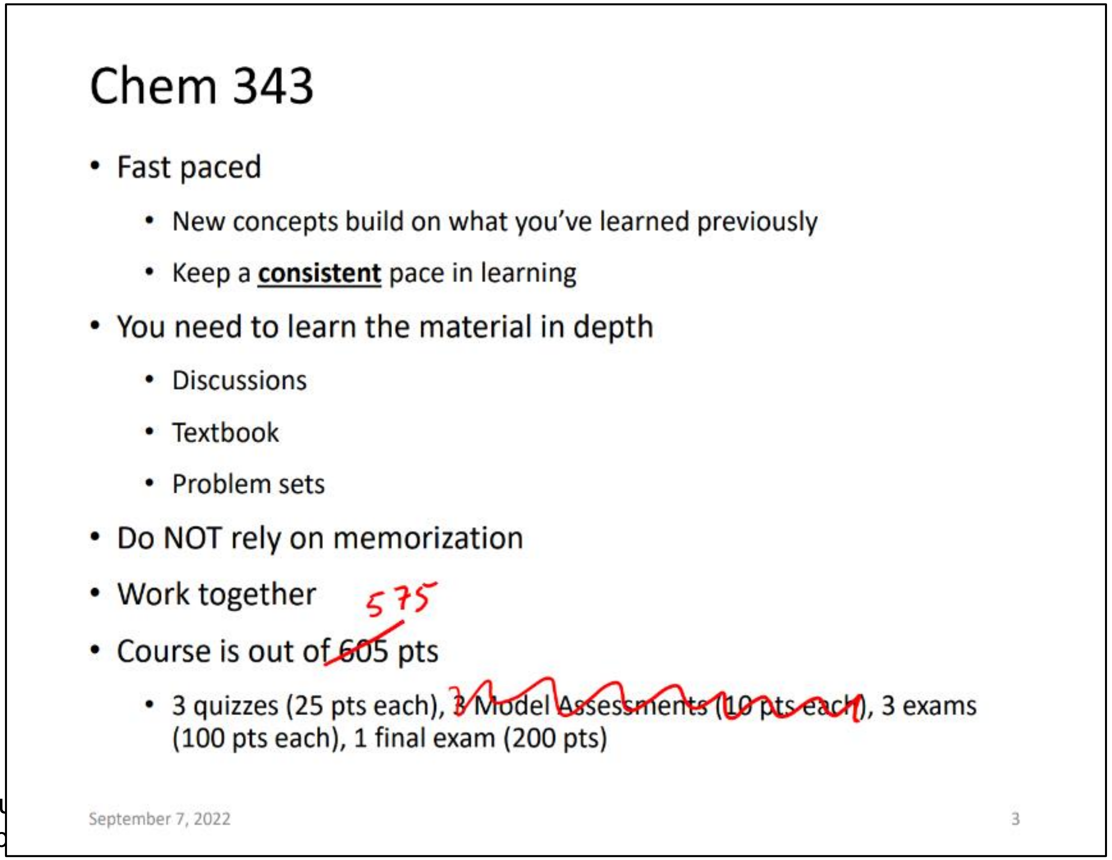


Curricular materials



Chem 343

- Fast paced
  - New concepts build on what you've learned previously
  - Keep a **consistent** pace in learning
- You need to learn the material in depth
  - Discussions
  - Textbook
  - Problem sets
- Do NOT rely on memorization
- Work together
- Course is out of ~~605~~ 575 pts
  - 3 quizzes (25 pts each), ~~3 Model Assessments (10 pts each)~~, 3 exams (100 pts each), 1 final exam (200 pts)

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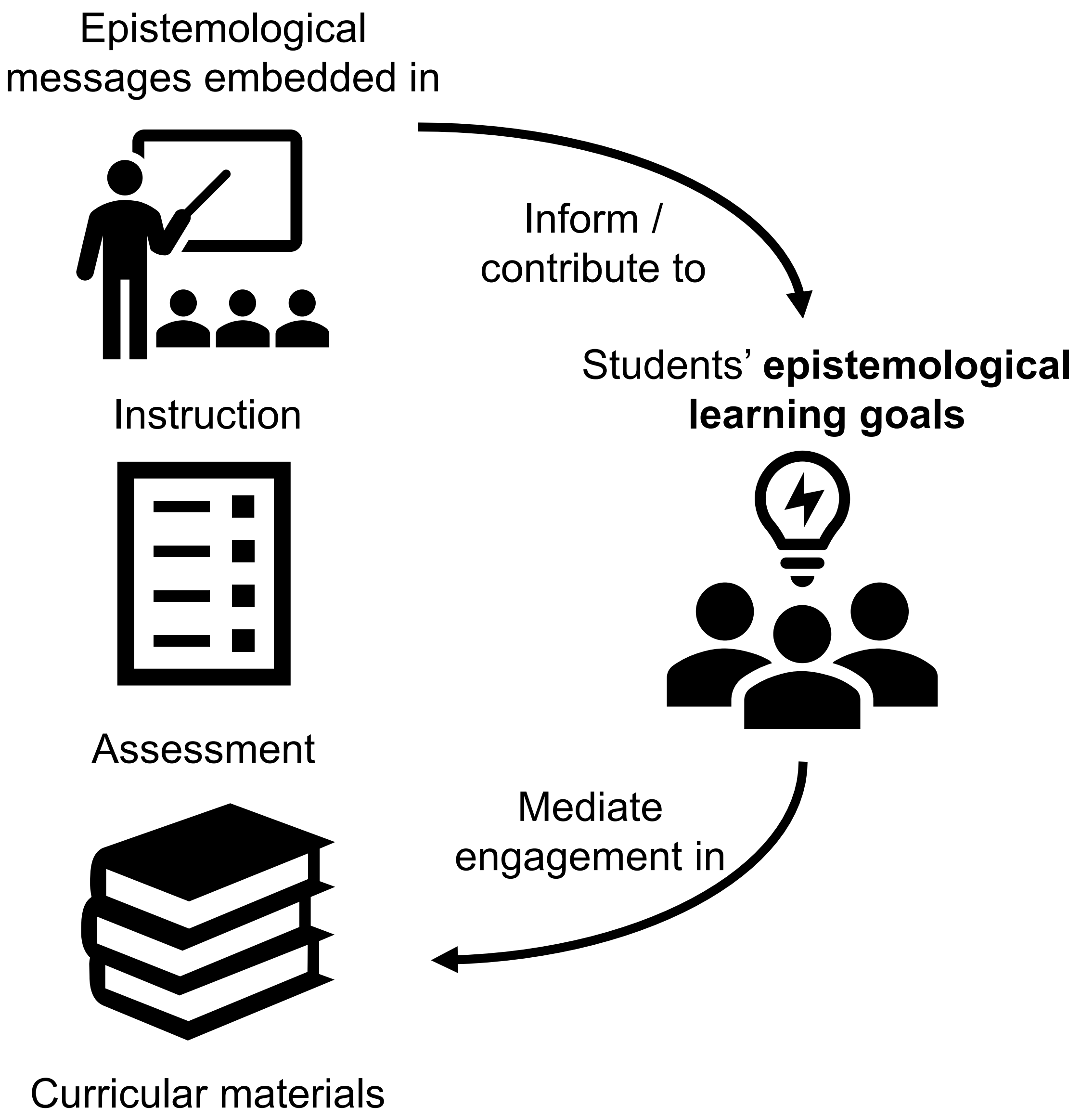

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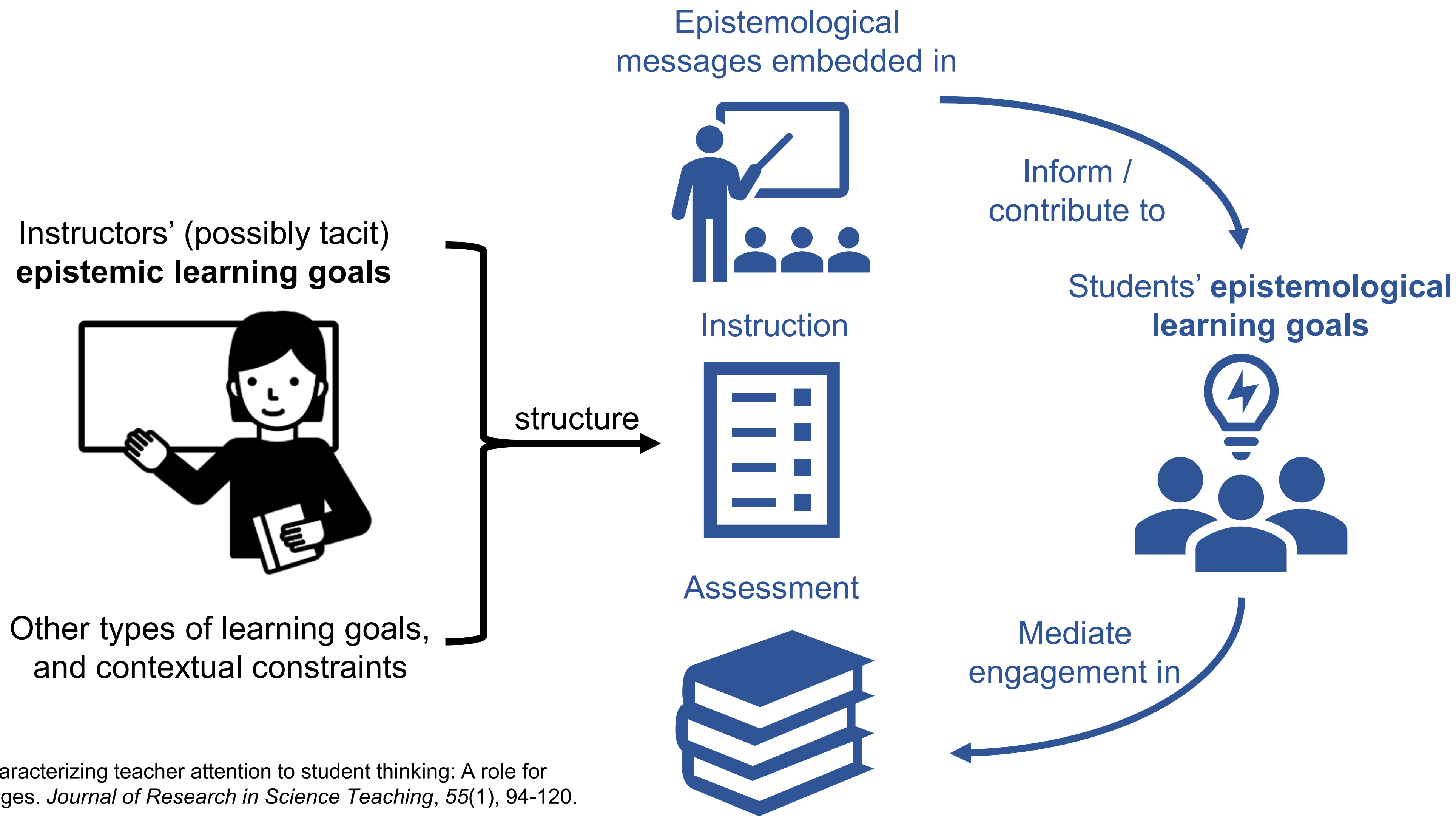

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