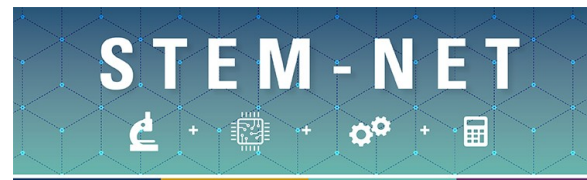


Culturally Sensitive Teaching in STEM

Moderated by:

Dr. Frank A. Gomez
Executive Director, STEM-NET
Office of the Chancellor



<https://www2.calstate.edu/impact-of-the-csu/research/stem-net>

Speakers

Heather Macias, Cal State Long Beach

Culturally Responsive Teaching: Serving the Needs and Integrating the Strengths of Historically Marginalized STEM Students

Aletha M. Harven, Stanislaus State

Culturally Responsive Teaching in STEM: Transformative Tools for Student Engagement

Melissa Navarro Martell, San Diego State

Ideological Perspectives in STEM with Latinx Students at HSIs

Cathrine Maiorca, Cal State Long Beach

Using an Equity-oriented Framework to Teach STEM

Rouhollah Aghasaleh, Humboldt State

Another STEM Teaching is Possible: Toward a Phronetic Scientific Knowledge

Ximena Cid, CSU Dominguez Hills

The Demographics of PER and How our Knowledge is Impacted by Who We Do and Do Not Study



Culturally Responsive Teaching: Serving the Needs and Integrating the Strengths of Historically Marginalized STEM Students

Culturally Responsive Teaching: Serving the Needs and Integrating the Strengths of Historically Marginalized STEM Students

Heather C. Macias— California State University, Long Beach

Preservice teachers and culturally responsive teaching: Learning to serve the needs and integrate the strengths of historically marginalized STEM students

Heather C. Macias, (Assistant) Professor

CSULB, Department of Teacher Education

heather.macias@csulb.edu



Culturally Responsive Teaching: Serving the Needs and Integrating the Strengths of Historically Marginalized STEM Students

Project Overview

The Problem:

- The “opportunity gap” (Carter & Welner, 2013)
- The Eurocentric history and tradition of science education (McKinley, Jones, & Castagno, 2008)
- Lack of BIPOC representation in STEM (McGee, 2016; Puritty et al., 2017)

The Solution:

- Preparing culturally responsive STEM teachers
- CRP science education has a more critical stance toward teaching science, constructing scientific knowledge, and using this knowledge to empower students and teachers (Moore, 2007)
- Students build STEM identities (N. Shah et al., 2013)

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Activities

Culturally Responsive Teaching: Serving the Needs and Integrating the Strengths of Historically Marginalized STEM Students

Preservice STEM teachers would...

- Learn about the culture of the community to which students belong (Gay, 2010; Ladson-Billings, 2009)
- Link students' home experiences to curriculum (Calabrese Barton, Koch, Contento, & Hagiwara, 2005; Moll et al., 1992); embed real-world problems in curriculum (Marx et al., 2004); use culturally relevant analogies (Fernandez & Middlecamp, 1999; C. D. Lee, 2003; O. Lee & Fradd, 1998; Villegas & Lucas, 2001)
- Create Funds of Knowledge presentations (Moll et al, 1992)
- Small group work with group roles that play to students' strengths; reciprocal learning strategies; open-ended problems to encourage discussion (and criticality); student choice; access students' prior knowledge

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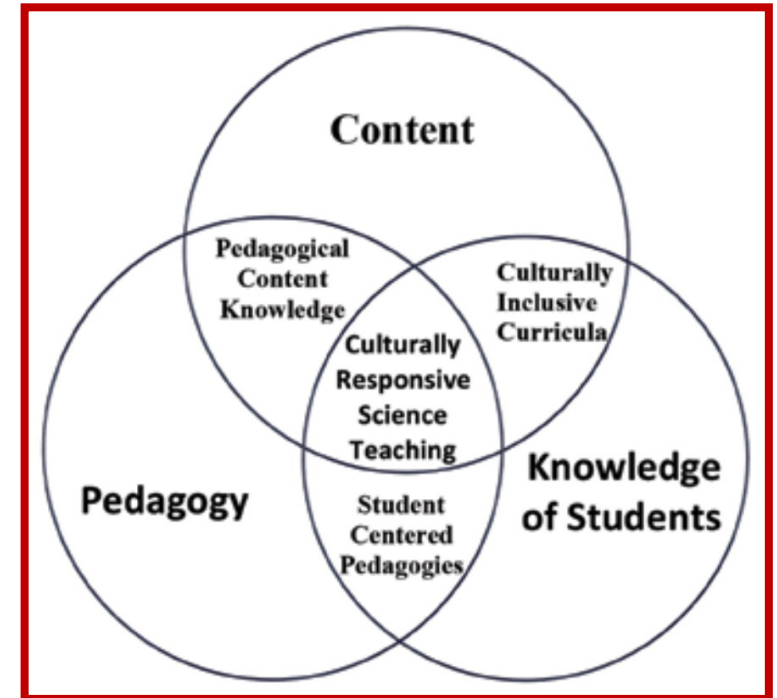


Culturally Responsive Teaching: Serving the Needs and Integrating the Strengths of Historically Marginalized STEM Students

Results

Consistent with past research, STEM credential candidates demonstrated student-centered teaching practices and beliefs:

- Adopted a student-centered perspective on learning (Ladson-Billings, 1995)
- Create caring, learning classroom communities (Johnson, 2011) to support academic discourse that is culturally congruent (Brown & Crippen, 2016b) and socioculturally aware (Mensah, 2011)
- Integrate content knowledge, pedagogical knowledge, and knowledge of students into their teaching (Horowitz et al., 2018, p. 9)



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Culturally Responsive Teaching: Serving the Needs and Integrating the Strengths of Historically Marginalized STEM Students

Lessons Learned

Preparing culturally responsive science educators requires preparing teachers who...

- Are socioculturally aware
- Consistently validate students' backgrounds
- Expand perceptions of science as it is currently taught in schools
- Build communities of learners
- Reflect on their teaching to develop a culturally responsive stance

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Culturally Responsive Teaching: Serving the Needs and Integrating the Strengths of Historically Marginalized STEM Students

Next Steps/Long-Term Plans

STEM education in higher ed:

- *Rebalancing the Equity Gap in Chemistry Education with Individualized Adaptive Learning Grant*, UC Davis, CSUSB, CSU CO, Mendocino College, & the Academic Senate for California Community Colleges
- Similar work with a team hoping to integrate CRP into a "Calculus for Life Sciences" course
- Continue to develop teacher education courses that integrate social justice into STEM-teaching at the secondary level

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Summary

Culturally Responsive Teaching: Serving the Needs and Integrating the Strengths of Historically Marginalized STEM Students

Remember:

- Culturally responsive teaching makes learning more appropriate and effective by teaching to and through the strengths of diverse students (Gay, 2000).
- “Culturally responsive teaching is less about just using racial pride as a motivator and more about mimicking students’ cultural learning styles and tools - strategies their moms, dads, grandmas, and other community folks use to teach them life skills and basic concepts long before they come to school and during out-of-school time” (Hammond, 2015, n.p.).

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Culturally Responsive Teaching in STEM: Transformative Tools for Student Engagement

Aletha M. Harven– Stanislaus State

Co-Principal Investigator
“CIENCIA”

Webinar Series

Transformative Conversations:
Promoting Equity and Inclusion in Education and Beyond



Aletha M. Harven, Associate Professor

Stanislaus State, Department of Psychology & Child Development

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Culturally Relevant Education

Teacher Practice Culturally Responsive Teaching

“While “caring about” conveys feelings of concern for one’s state of being, “caring for” is active engagement in doing something to positively affect it.”~ **Dr. Geneva Gay**



Geneva Gay, Ph.D.

Teacher Posture & Paradigm Culturally Relevant Pedagogy

“(Good teachers) create a net designed to catch all students, not a sieve” ~ **Dr. Gloria Ladson-Billings**



Gloria Ladson-Billings, Ph.D.

Culturally Relevant Education

1. Deepen knowledge on culturally relevant education

-- > Affirm students' identities; Utilize their lived experiences; Maintain high expectations, etc. (Ladson-Billings, 1992, 1995a, 1995b; Gay & Howard, 2000; Gay, 2018)

2. Deepen knowledge on students from historically underserved communities

-- > Reject deficit ideology (Harven & Soodjinda, 2016)

-- > Increase students' sense of belonging (Strayhorn, Long, Kitchen, Williams, & Stentz, 2013)

3. Shift Your Paradigm of Education & Share Power with Students

-- > Move from being "teacher-centered" to "learner-centered" (Aronson & Laughter, 2016)

-- > Share power with students (Harven, 2021)

4. Reflection-in-Action

-- > Note taking; Requesting feedback; Checkpoints; Adjusting practices (Giaimo-Ballard & Hyatt, 2012)



Trouble Shooting



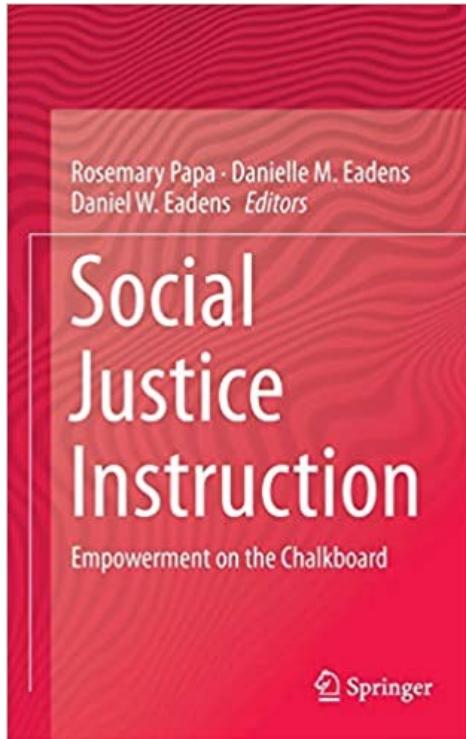
Challenges

- (1) Lack of Pedagogical Training
- (2) Structural Issues
- (3) Faculty Workload

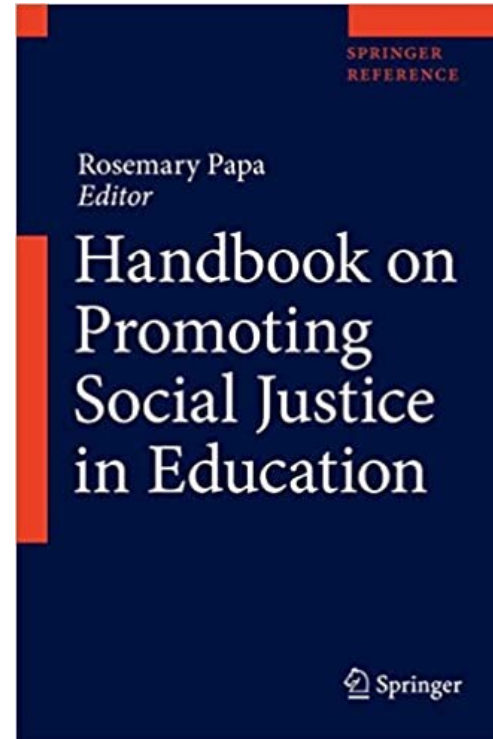
Suggestions

- (1) Engage in Individual & Collaborative Learning
- (2) Encourage Departmental Conversations & Action
- (3) Adopt Strategies for Balancing Teaching, Research & Service

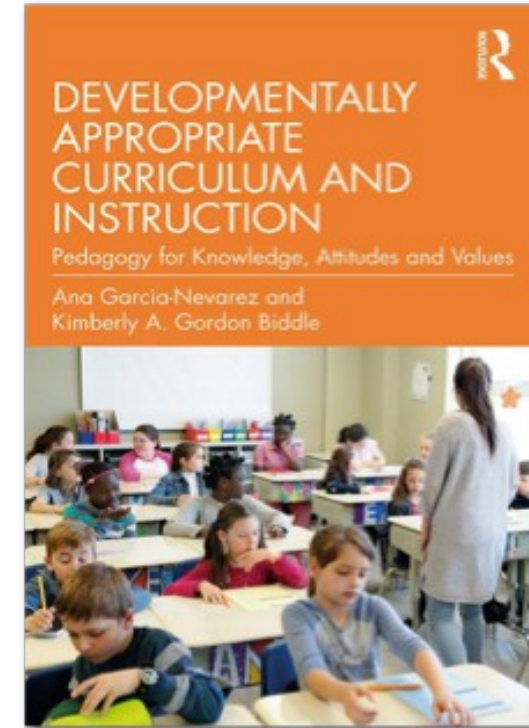
Culturally Relevant Education: Literature



2016



2020



April 2021 Release

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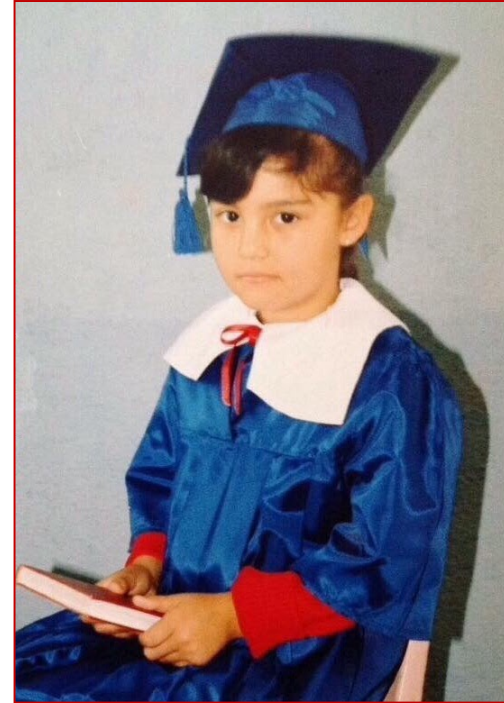
Ideological Perspectives in STEM with Latinx Students at HSIs

Melissa A. Navarro Martell, Ph.D. – San Diego State University

Melissa A. Navarro Martell, Ph.D. Assistant Professor
San Diego State University, Department of Dual Language and English Learner Education
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Positionality

- Immigrant 10-year-old from Tijuana, México
- Academic strength in Mexico: math



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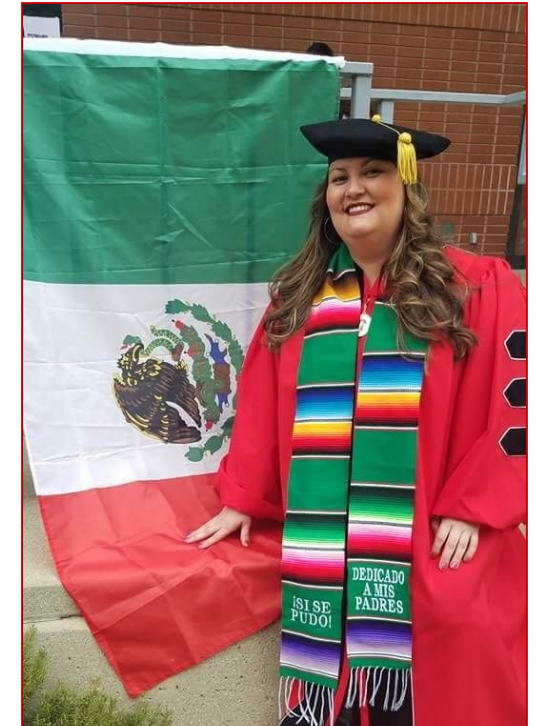
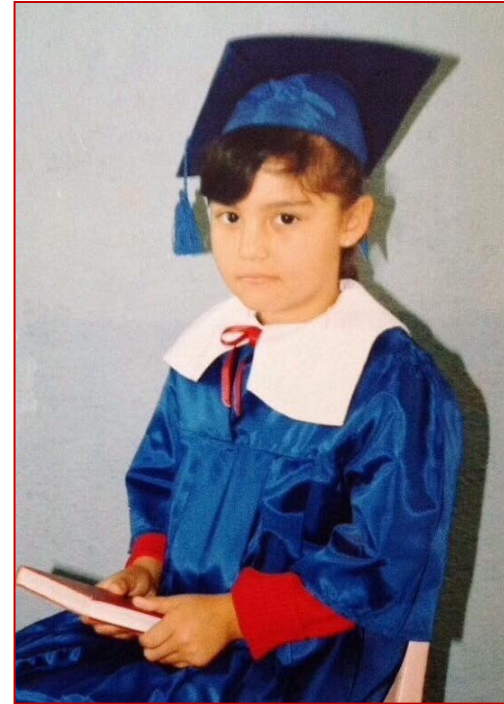
SDSU/DLE mnavarro4@sdsu.edu

Positionality

- Immigrant 10-year-old from Tijuana, México
- Academic strength in Mexico: math
- Academic strength in US: not speaking English
 - Deficit label: “ELL”
- Former bilingual elementary and middle school math & science teacher
- Ph.D. Education
- Critically conscious teacher educator and scholar: early STEM focus

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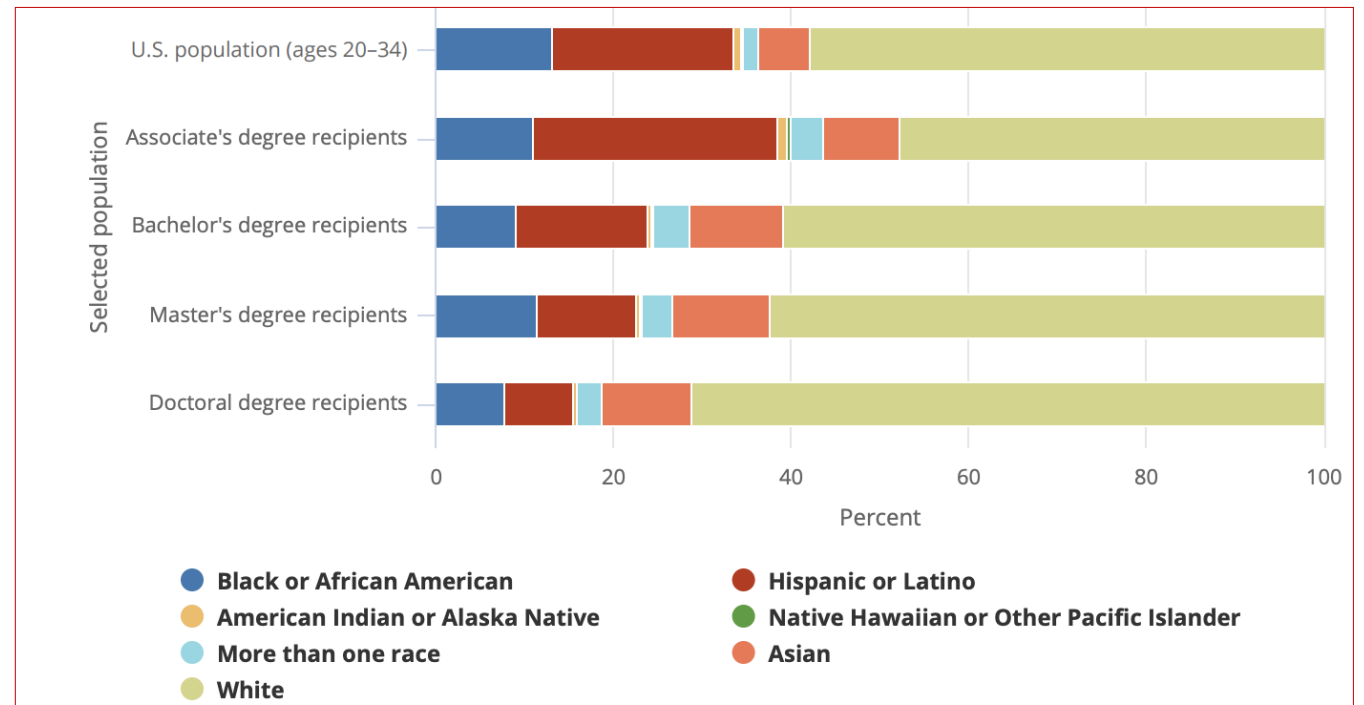
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Latinx students in STEM

Representation of racial and ethnic groups in the U.S. population and among science and engineering degree recipients: 2017

(National Science Board, 2019)



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Latinx students in STEM: Challenges

- Disparities in STEM degree attainment
- 2019-2020
 - K-12 students
 - Hispanic/Latinx = 54.9% students in California (CDE)
- Deficit perspectives/ideologies in PK-20+
- “Hispanics comprise only 8.8 percent of the teacher workforce.” (HACU, 2020)*

*(Hispanic Association of Colleges and Universities, 2020)

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Latinx students in STEM: Challenges

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 - K-12 students
 - Hispanic/Latinx = 54.9% students in California (CDE)
- Deficit perspectives/ideologies in PK-20+
- “Hispanics comprise only 8.8 percent of the teacher workforce.” (HACU, 2020)*
- “HSIs are the obvious place to target efforts to increase the number of well-prepared Hispanic STEM teachers for our nation’s children.” (HACU, 2020)
- “For **low-income students, unpaid internships are de facto inaccessible**: even college credit does not compensate for the opportunity cost of some months of earning power critical to financing education and living costs.” (HACU, 2020)
- “While one can certainly learn from teachers of a different race, ethnicity, class and gender, **having adequate role models is also an important factor in supporting aspirations to STEM careers.**” (HACU, 2020)

*(Hispanic Association of Colleges and Universities, 2020)

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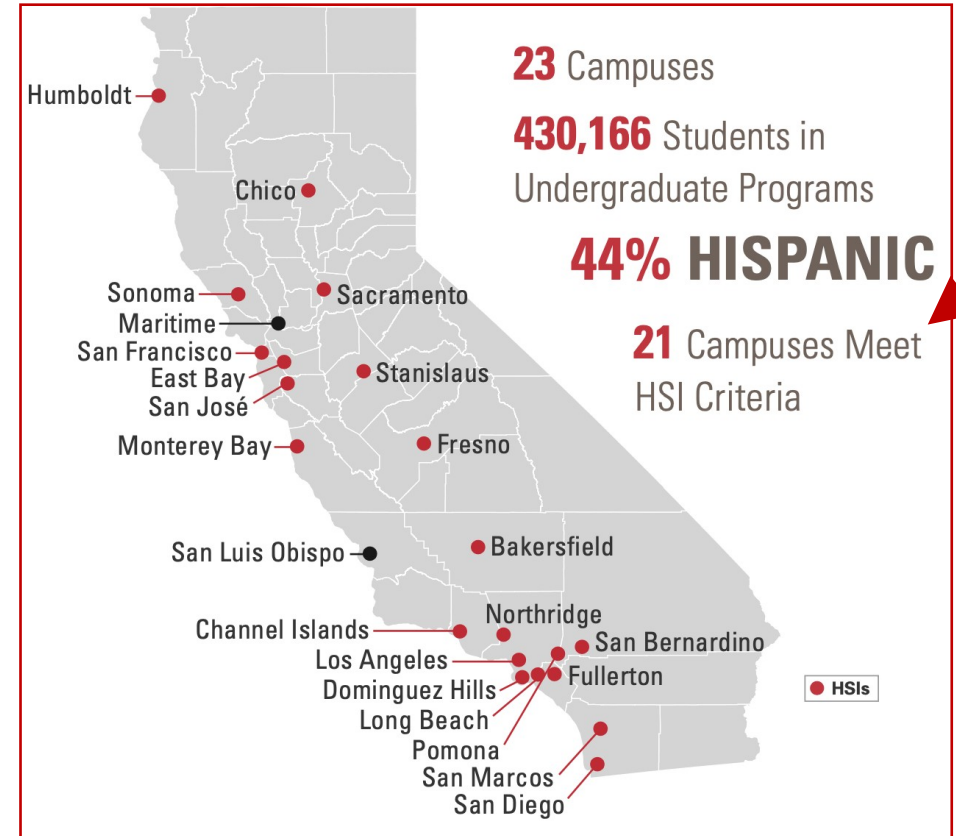
What is an HSI?

March 2020

 The California State University
EXTERNAL RELATIONS

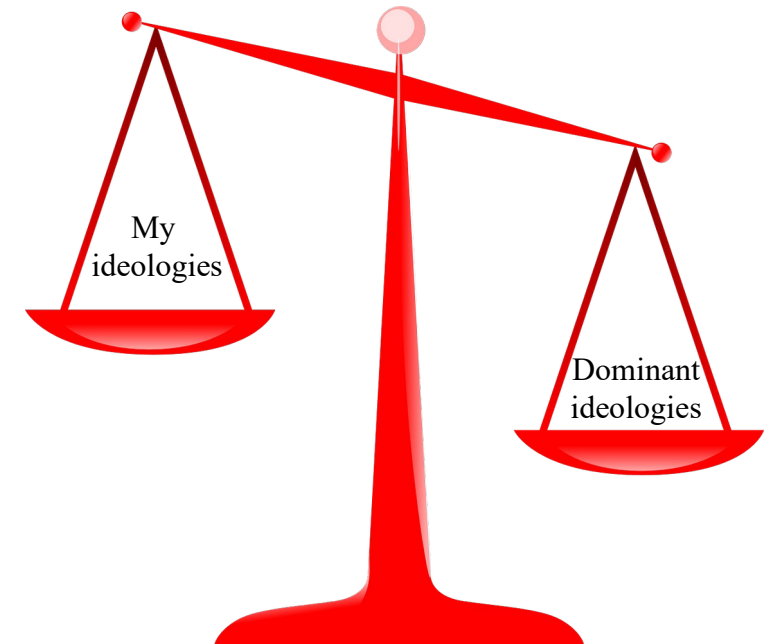
California State University's Hispanic-Serving Institutions

Hispanic serving vs. Hispanic admitting



Ideologies

- Ideological clarity: “the framework of thought constructed and held by members of a society to **justify or rationalize an existing social order**” (Bartolomé, 2008)
- “dominant ideologies are typically reflected in both the symbols and cultural practices of the **dominant culture** that **shape people’s thinking** such that they unconsciously accept the current way of doing things as **‘natural’ and ‘normal’**” (Bartolomé, 2008)
- “It is important for teachers to arrive at the realization that it is their ideology that ‘announces or denounces’ **teaching for equity and social justice**.” (Alfaro & Hernández, 2016)
- “Ideological clarity requires that teachers’ individual explanations be continually **compared and contrasted with those propagated by the dominant society**” (Alfaro & Hernández, 2016)

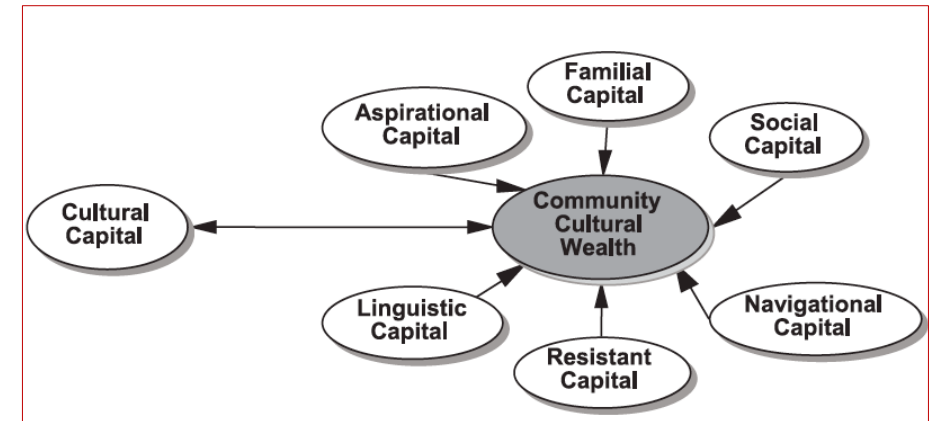


My Approach to Teaching

There are dominant ideologies accepted as the “**Truth.**”

How do I approach my work to **challenge and disrupt hegemonic ideologies?**

- Prescribing to asset-based theories
- Modeling asset-based pedagogies
 - Decolonizing science
- Designing courses that allow for students to challenge and disrupt hegemonic ideologies



(Yosso, 2005)

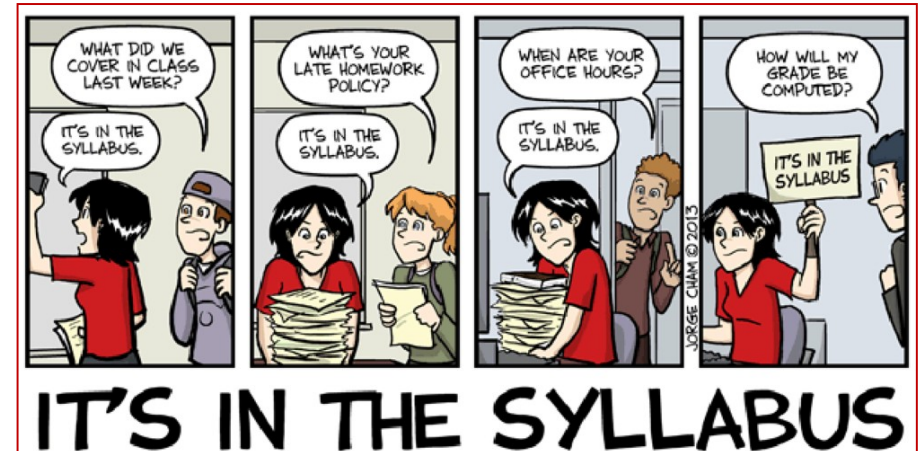
Classroom Examples

1. Course Syllabus
2. Draw a scientist
3. Textbook picture walk
4. Letter to a science teacher

1. Syllabus

Framing the Course

- How do you frame your courses?

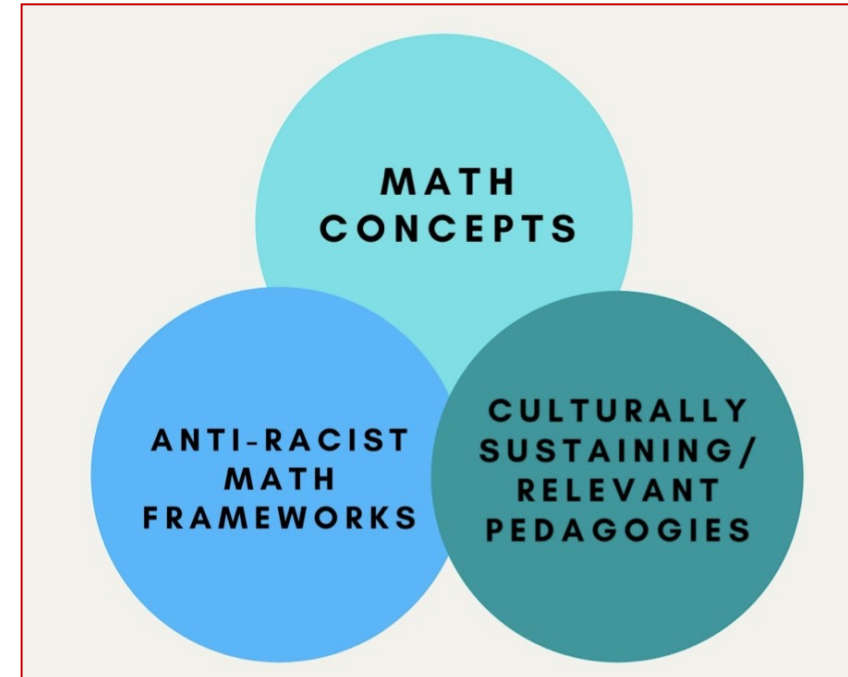


1. Syllabus



DLE 912- Teaching science
to bilingual students

Melissa A. Navarro Martell



DLE 910- Teaching mathematics
to bilingual students

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1. Syllabus

Framing the Course

- How do you frame your courses?

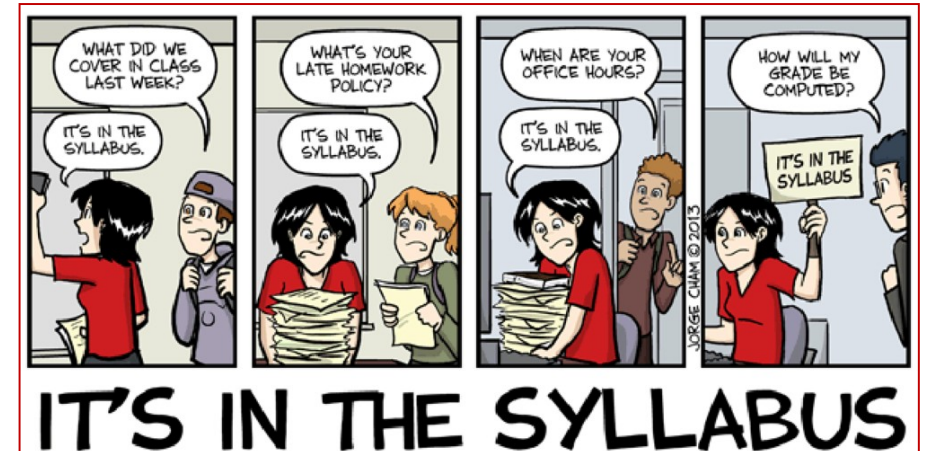
Reading Assignments

- Do your assigned readings include BIPOC* scholars?
- Do you expose your students to the authors they read?

Feedback

- Do you request student feedback throughout the semester?

* *Black, Indigenous, People of Color*

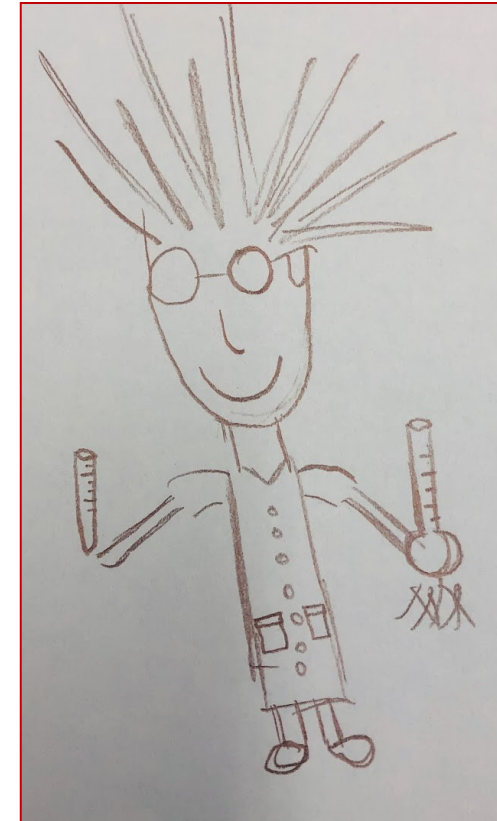
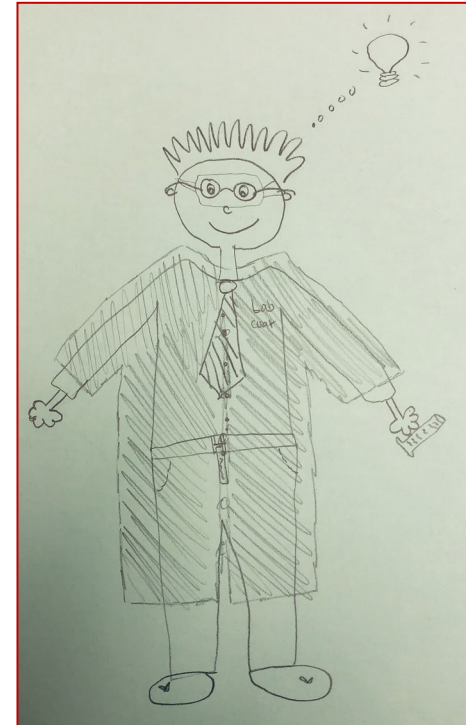
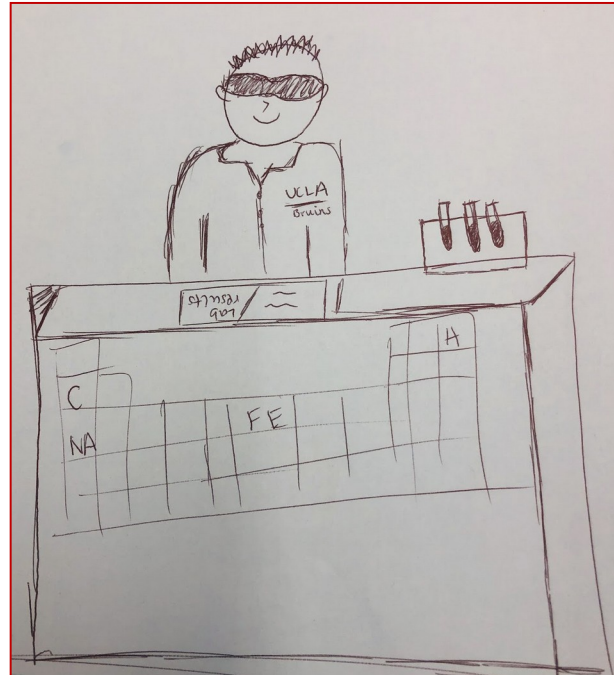
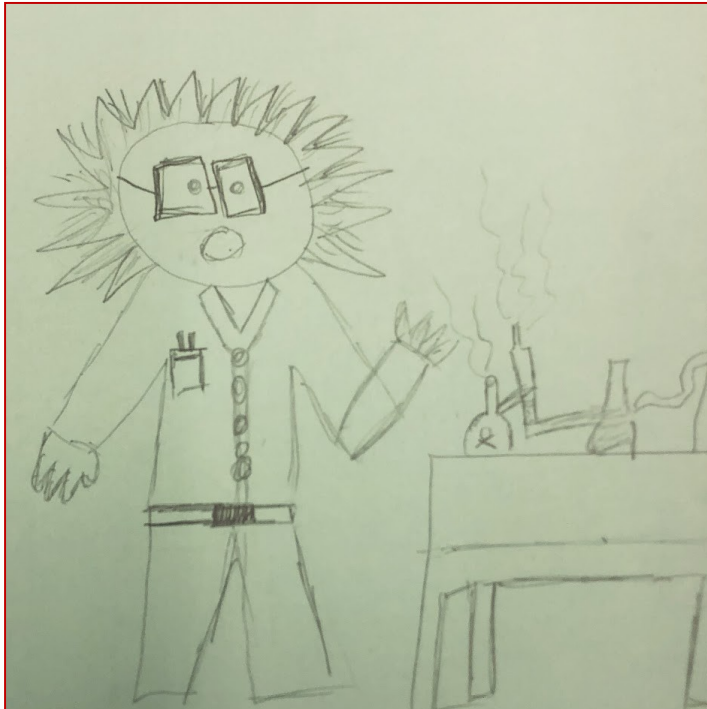


2. Draw a Scientist

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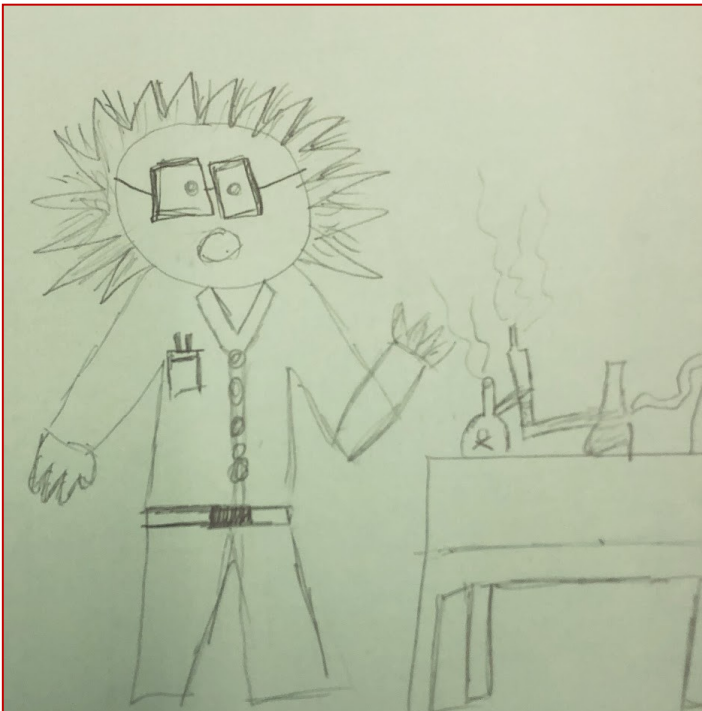
2. Draw a Scientist



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2. Draw a Scientist



- Mad scientist
- Lab coat
- Working in labs
- Gender: male
- Working in isolation
- Goggles

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SAN DIEGO STATE
UNIVERSITY

~* on Kumeyaay land *~

Ideological Perspectives in STEM with Latinx Students at HSIs

2. Google: Famous Scientists

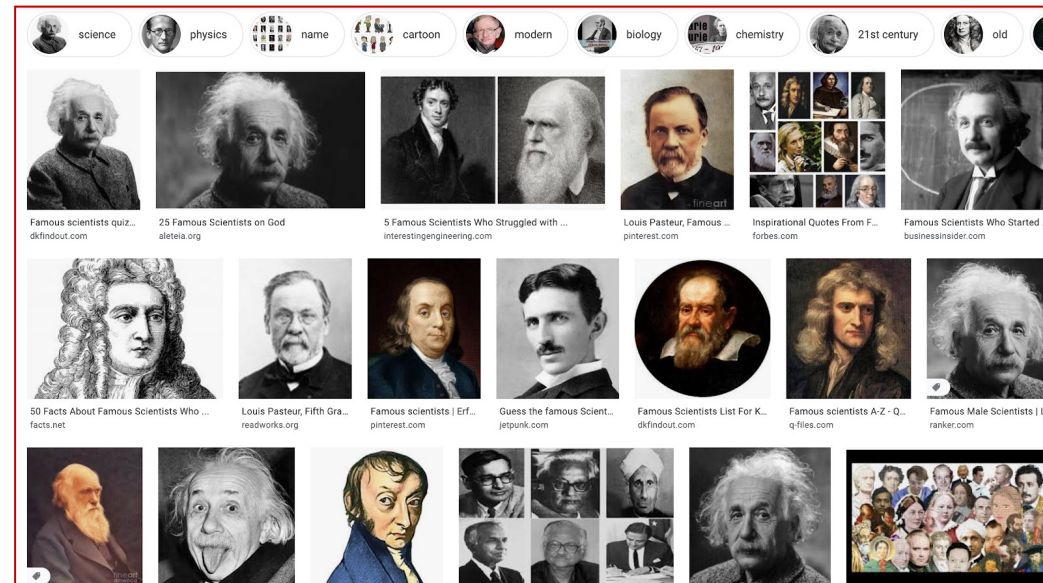
- What ideologies are depicted here?

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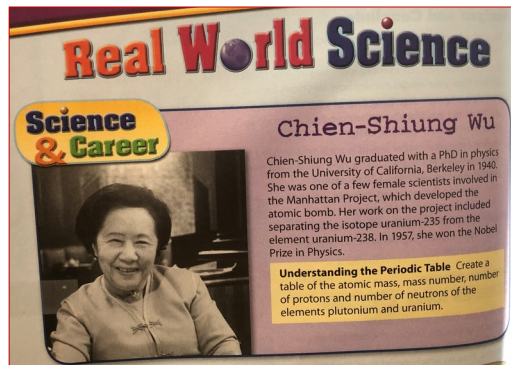
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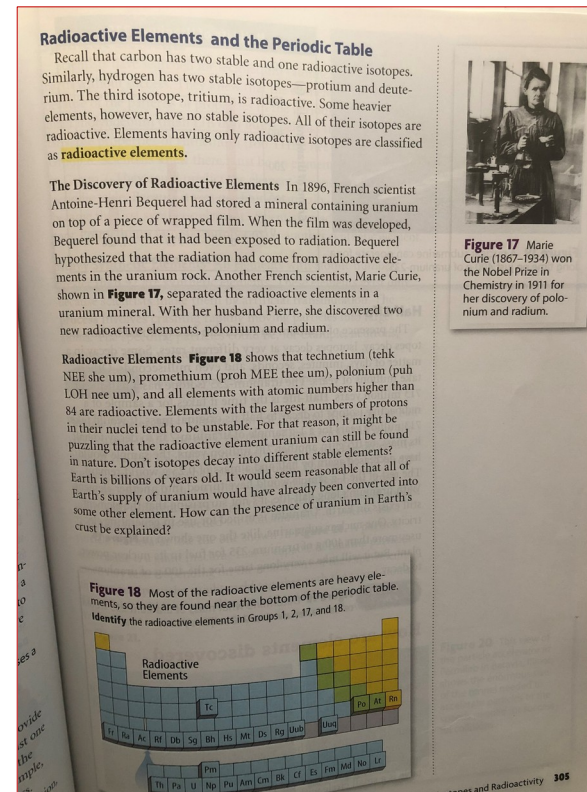


3. Textbooks: Picture Walk

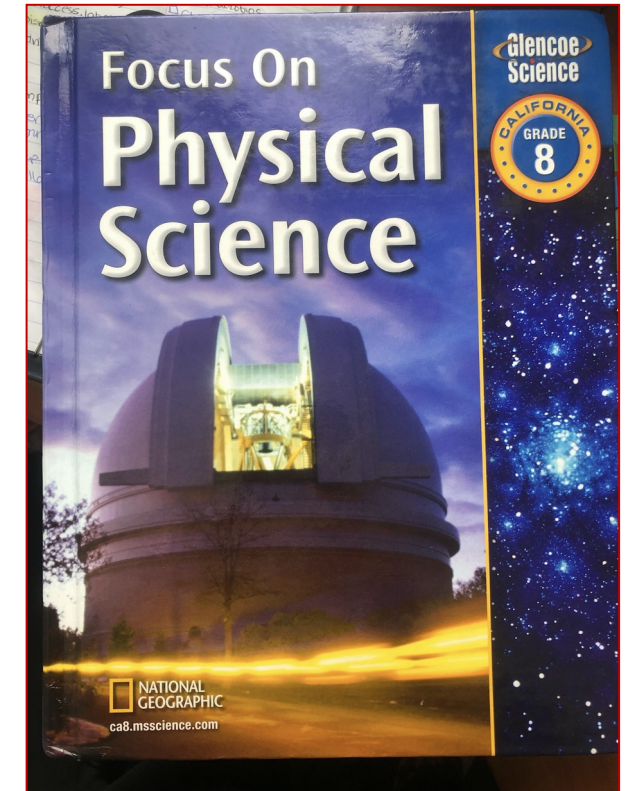
- 13 male scientist representations
- 6 female representations
 - Marie Curie
 - Chien-Shiung Wu



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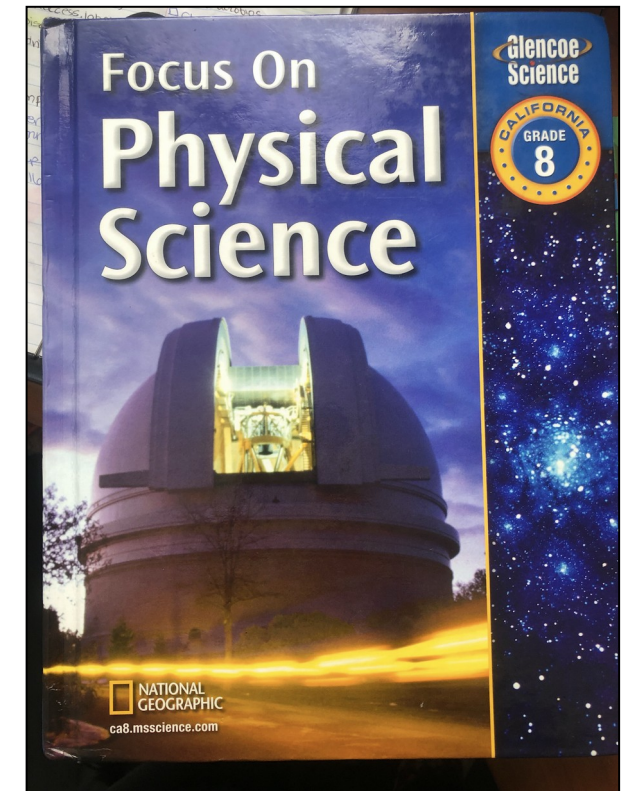
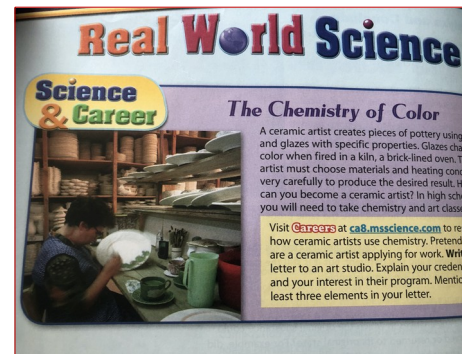


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3. Textbooks: Picture Walk

- 13 male scientist representations
- 6 female representations
 - Marie Curie
 - Chien-Shiung Wu



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4. Letter to a Science Teacher

- 2-part assignment
 1. Letter to a former science teacher
 2. Letter to their future self as science teachers

Melissa A. Navarro Martell

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Name: _____

Letter to a science teacher

Part 11

Letter

The purpose of this assignment is for you to write a letter to yourself, now as the science teacher, and how you envision yourself in your classroom. What are three teaching practices you learned in this class that you can commit to, and implement, with your students during your first year as a teacher of science? Make sure to support your teaching practices with evidence from your readings and state why those are the best choices.

NOTE: Do not forget the parts of the letter: heading, greeting, body, closing and signature

Evaluation

	1	2	3
Format	Includes at least 1 part of the letter stated in the NOTE	Includes at least 3 parts of the letter stated in the NOTE	Includes all 5 parts of the letter stated in the NOTE
Strategies	Includes 1 strategy and with supporting evidence from readings.	Includes 2 strategies and with supporting evidence from readings.	Includes 3 strategies and with supporting evidence from readings.



4. Letter to a Science Teacher

- “...I remember that the majority of the time I couldn’t connect with the subject due to the terminology, language...”
- “I didn’t have a spark of curiosity because I never knew what to do.”
- “At times, we were just given packets and depending on how well we did, we had the opportunity to do the group project. At times, Bill Nye The Science Guy was our teacher for half of the class, and we were expected to follow some of his experiments. Some of the students were bilingual...and needed extra support, like myself, and we were not given focused guidance”

Dear former science teachers,

I hope this letter finds all of you well, safe and healthy. As I take my teaching credential courses, I reflect back on how you were all able to provide me with neutral experiences in my science classes and wished I would’ve had less oral presentations since we were a large group of students and contributed very little. As a future science teacher, I want for my students to have an inclusive, creative/hands on learning environment, work collaboratively so they can develop conceptual understandings of topics and be able to make connections to current events and everyday phenomena.

In my science classes, I remember that the majority of the time I couldn’t connect with the subject due to the terminology, language and reflecting on what I had learned. I didn’t have a spark of curiosity because I never knew what to do. At times, we were just given packets and depending how well we did, we had the opportunity to do the group project. At times, Bill Nye The Science Guy was our teacher for half of the class and we were expected to follow some of his experiments. Some of the students were bilingual or multilingual learners and needed extra support, like myself, and we were not given focused, personalized guidance. On the other hand, some of the science experiments that I did enjoy was making ice cream from scratch because it was very fun and enjoyable, dissecting a frog and heart because I had never done that before, and planting our very own flower and measuring how much it grew. I do appreciate how some of you took the time to create your own Periodic Table Song but it was somehow impossible for us to learn it since we didn’t find it enjoyable rather stressed.

As I reflect on my science experiences, it’s essentially important that we are inclusive, create activities that are hands on, and allow students to work collaboratively. It is in my belief that all 3 practices are effective when teaching science. For example, we must keep all students in mind and be inclusive of their prior knowledge and experience and use that as an asset in order to create science activities they will understand and be a part of. When demonstrating an experiment, I would love for it to be hands on and for students to put in practice their 6 senses and be able to manipulate objects so they can gain knowledge and understanding, especially to those students who learn better visually. By allowing students to work collaboratively they are able to develop their conceptual frameworks and learn to problem solve as they gather their personal ideas and from other students when they are discussing. I plan on implementing these practices in my future science class so every student can be curious, explore and apply these skills in their everyday lives.

Sincerely,

Melissa A. Navarro Martell

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4. Letter to a Science Teacher

- 3 strategies
 - Summarize
 - Commitment to science classroom
- APA citations
- Parts of a formal letter
 - Introduction
 - 3 paragraphs per strategy
 - Conclusion, closing, signature

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Ideological Perspectives in STEM with Latinx Students at HSIs

14 de mayo del 2019

Querida Ms. Real,

Espero que te encuentres bien y que hayas tenido una experiencia escolar llena de aprendizaje para que te sientas más preparada como maestra de ciencias de primaria. Mi visión para mi futuro salón es crear un salón de clase que infunda orgullo desde el día en que los estudiantes entran, independientemente de su cultura, identidad racial o identidad religiosa. Espero proporcionarles a los estudiantes las herramientas necesarias que puedan aplicar a otras disciplinas y dominios en su vida. Quiero recordarte de tres estrategias para implementar en tu salón que pueden beneficiar a tus estudiantes.

La primera estrategia de enseñanza es desafiar las ideologías dominantes. De acuerdo al artículo, *¿Cuya cultura tiene capital? Una discusión crítica de la teoría de la raza sobre la riqueza cultural de la comunidad*, hay instituciones educativas que se construyen a partir de una ideología de privilegios para los blancos que se niega a reconocer que hay un grupo subordinado que recibe oportunidades desiguales e injustas (Yosso, 2005, p. 3). Como maestra, asegúrate de que estes conciente de la manera en que presentas información y de los recursos que les ofreces a tus estudiantes. Recuerda que muchos de los libros de texto de ciencia actuales presentan información selectiva que apoya a una ideología que crea a grupos superiores y grupos marginales de personas. Además, asegúrate de tomar en cuenta que no todos los estudiantes han sido expuestos a la ciencia, así que debes de encontrar maneras de hacer tus lecciones más significativas e relatables para los estudiantes. A la misma vez, debes de tomar el tiempo para conocer a tus estudiantes para que puedas incorporar sus intereses en las lecciones y determinar cómo factores como el estado socioeconómico pueden afectar el aprendizaje de los estudiantes.

La segunda estrategia es agrupar a los estudiantes en grupos de niveles de inglés mixtos para limitar las barreras del lenguaje. De acuerdo al artículo, *La ciencia para los ELL: repensando nuestro enfoque*, en estos grupos mixtos habrá estudiantes que dominan el inglés y estudiantes que todavía no lo dominan para que los estudiantes que hablan inglés con fluidez modelen un vocabulario adecuado (Medina-Jerez, 2007, p. 54). Mi meta es desarrollar instrucción que es accesible para todos los estudiantes de niveles académicos variables y de desarrollo del lenguaje diferente. Desde una perspectiva de justicia social, es necesario que los estudiantes nunca sientan que hablar más de un idioma es una desventaja. Al contrario, aparte de enseñar ciencia, quiero enseñarles a mis estudiantes lo importante que es valorar su identidad y cultura.

La tercera estrategia de enseñanza para mi futura clase de ciencia es incluir los siguientes cuatro niveles de instrucción: confirmación, estructurando, guiado y abierto. De acuerdo al artículo titulado, *Los muchos niveles de indagación*, los maestro/as pueden controlar la pregunta de

HACU: Rethinking Policy and Practice for STEM Education: New Hispanic Perspectives

Policy Recommendation:

Among the many policy recommendations that could be made, the single most important one to the participation of Hispanics in STEM education is increasing funding support to Hispanic-Serving Institutions. Targeting those institutions where Hispanics are enrolled in large numbers with support for effective articulation programs, stronger laboratory STEM classes, enhanced STEM faculty research opportunities, more and more effective collaborations with research institutions (both universities and laboratories) is critical.

Practice Recommendation:

Expanding undergraduate research opportunities for Hispanic STEM students at HSIs is necessary. To do this will require more active collaboration from other institutions, research universities, national laboratories, non-profit and for-profit corporations that depend on research and development for their livelihood. It can (and probably must) take a number of forms: collaborative research grants, summer research and internship experiences for students, summer and collaborative research opportunities for HSI STEM faculty, cooperative education programs, etc.

Hispanic Association of Colleges and Universities

Melissa A. Navarro Martell

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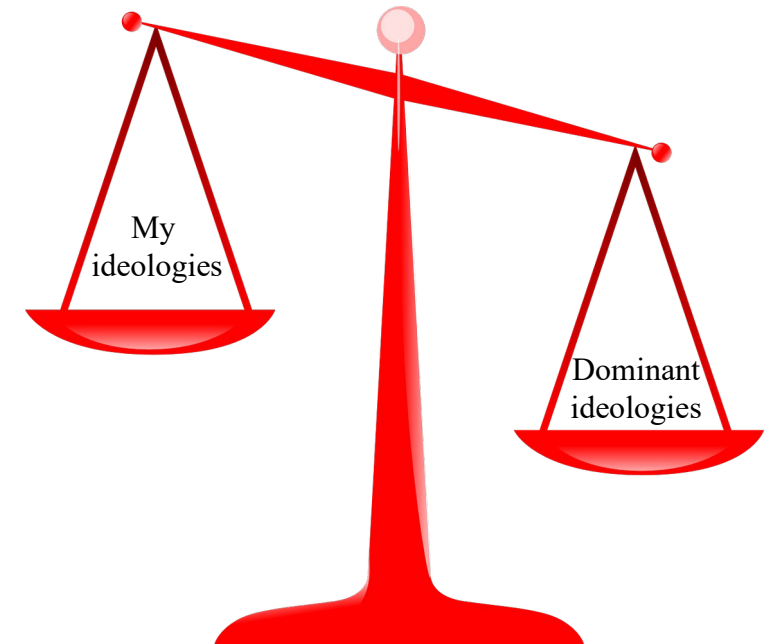
Summary

- Latinx students already come in with ideologies about their persistence in STEM
- We have the ability to embrace all students in our learning spaces
- We can be inclusive in how we design our courses, departments, programs
- It's ok to ask students what they need to be successful in our courses, departments, programs
- **What are the ideologies that operate in your own classrooms?**
- **Have you thought about decolonizing your syllabus?**

Melissa A. Navarro Martell

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Ideological Perspectives in STEM with Latinx Students at HSIs



Using an Equity-Oriented STEM Literacy Framework to Teach STEM

Cathrine Maiorca, PhD – California State University, Long Beach

Collaborators: Christa Jackson, PhD- Iowa State University; Margaret Mohr-Schroeder, PhD – University of Kentucky; Sarah Bush, PhD – University of Central Florida; Thomas Roberts, PhD – Bowling Green State University; Caitlyn Yost – University of Kentucky; Abigail Fowler – University of Kentucky

Cathrine Maiorca, Assistant Professor

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Overview

- Integrated K-12 Science, Technology, Engineering, and Mathematics (STEM) makes STEM subjects more meaningful (NRC, 2011)
- Increases students' engagement and interest (Cotabish et al., 2013; Moore, Guzey, & Brown, 2014), and raises student achievement (Barker & Ansorge, 2007; Becker & Park, 2011; Dickerson et al., 2014; Rehmat, 2015; Sullivan, 2008; Venville et al., 2012)
- Given the importance of these outcomes of integrated STEM, it is imperative that each and every student has access to integrated STEM learning experiences, especially minoritized students in STEM and the STEM disciplines.

Conceptual Framework

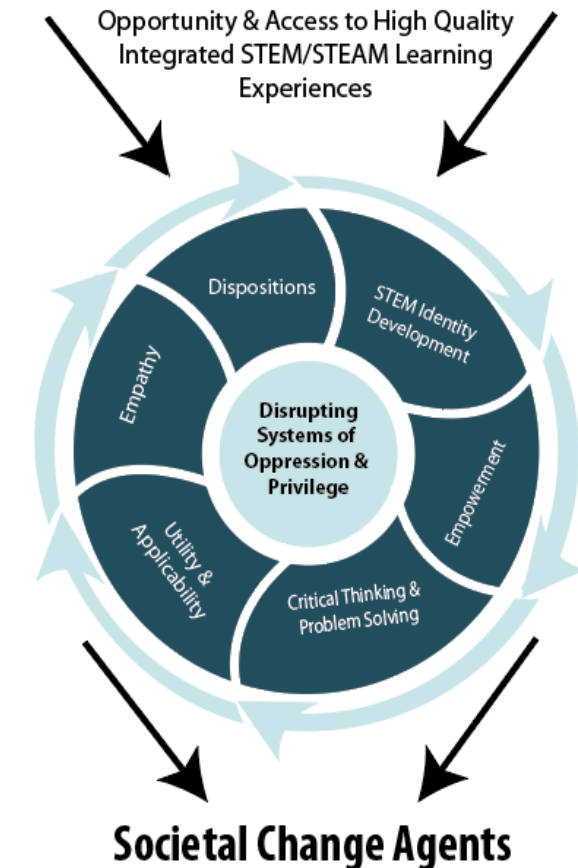
- **Opportunity and access**
 - High quality integrated STEM learning experiences
 - Inquiry based approaches
- **Utility and applicability**
 - Value in personal lives
 - Needed in society

Cathrine Maiorca

Long Beach/Teacher Education

Using an Equity- Oriented STEM Literacy Framework to Teach STEM

Equity-Oriented STEM Literacy Framework



(Jackson et al., under review, p. 11)
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Conceptual Framework

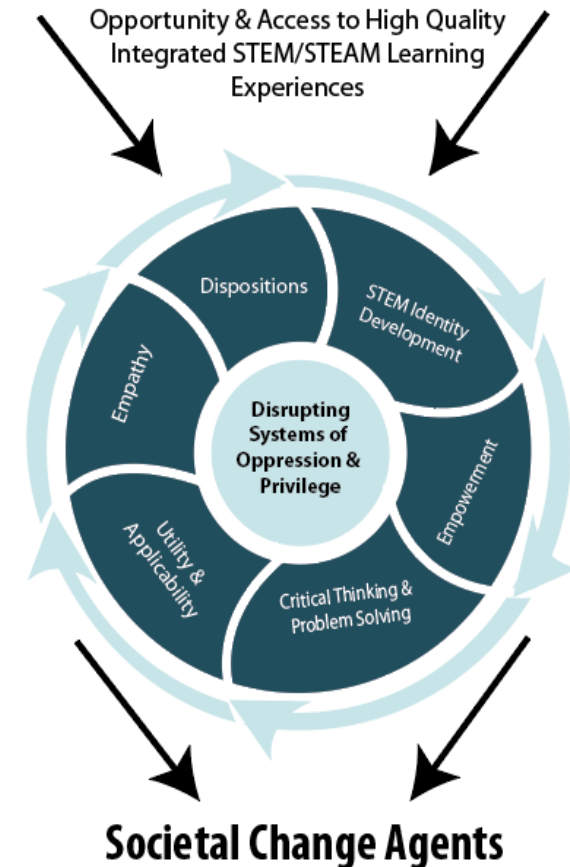
- **Empathy**
 - Bridge for students who perceived barriers in past
 - Empathetic problem solving provided the most transformative learning experiences
- **Dispositions**
 - Productive STEM dispositions include seeing STEM as “sensible, useful, and worthwhile” (Kilpatrick et al., 2001, p. 116).

Cathrine Maiorca

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Using an Equity- Oriented STEM Literacy Framework to Teach STEM

Equity-Oriented STEM Literacy Framework



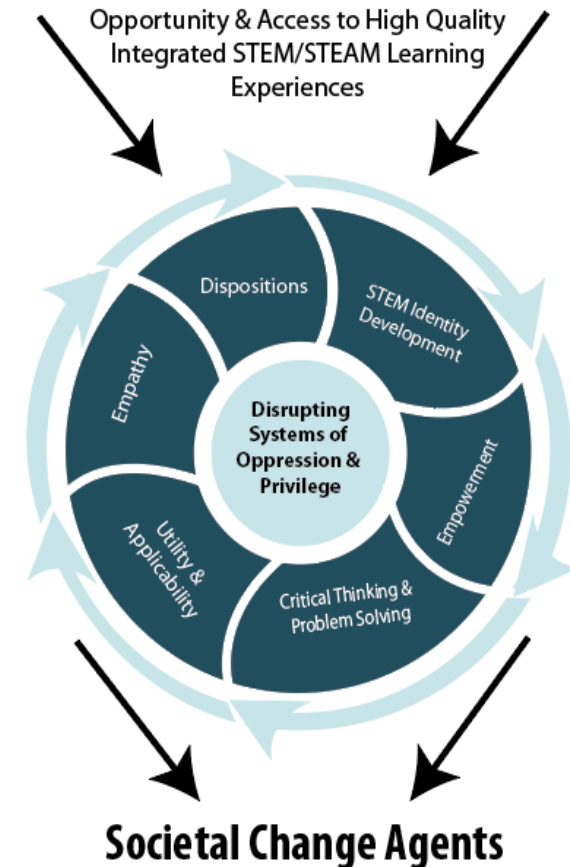
(Jackson et al., under review, p. 11)
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Conceptual Framework

- **STEM identity**
 - Students develop more positive STEM identities as they see the utility and application of STEM in the world around them.
- **Empowerment**
 - Incorporating CRP can show students that STEM can be a part of their everyday lives, and not something that is challenging or atypical in the Black and Latinx communities

Using an Equity- Oriented STEM Literacy Framework to Teach STEM

Equity-Oriented STEM Literacy Framework



(Jackson et al., under review, p. 11)
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Conceptual Framework

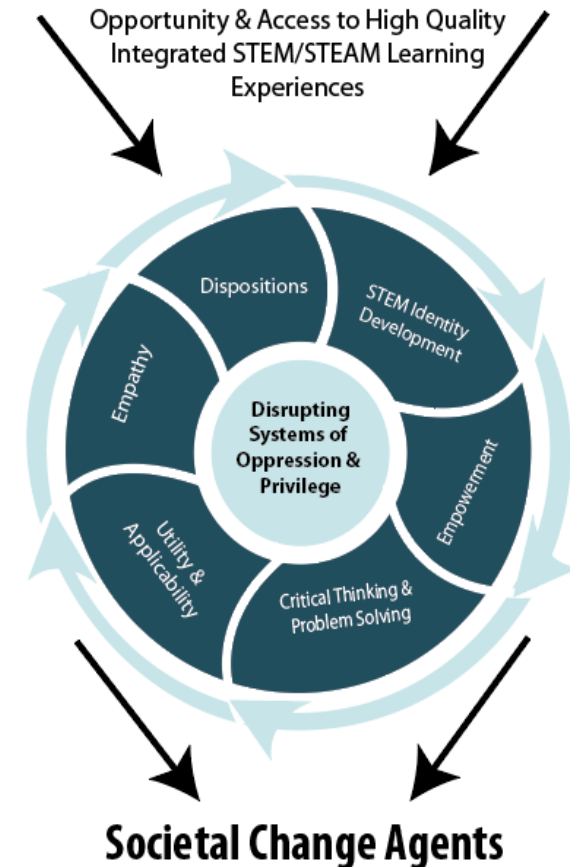
- **Societal Change agents**
 - change agents in society in which they live
 - using knowledge, skills, and dispositions associated with STEM area
- **Disrupt systems of oppression**
 - solve real world issues
 - challenges in the community

Cathrine Maiorca

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Using an Equity- Oriented STEM Literacy Framework to Teach STEM

Equity-Oriented STEM Literacy Framework

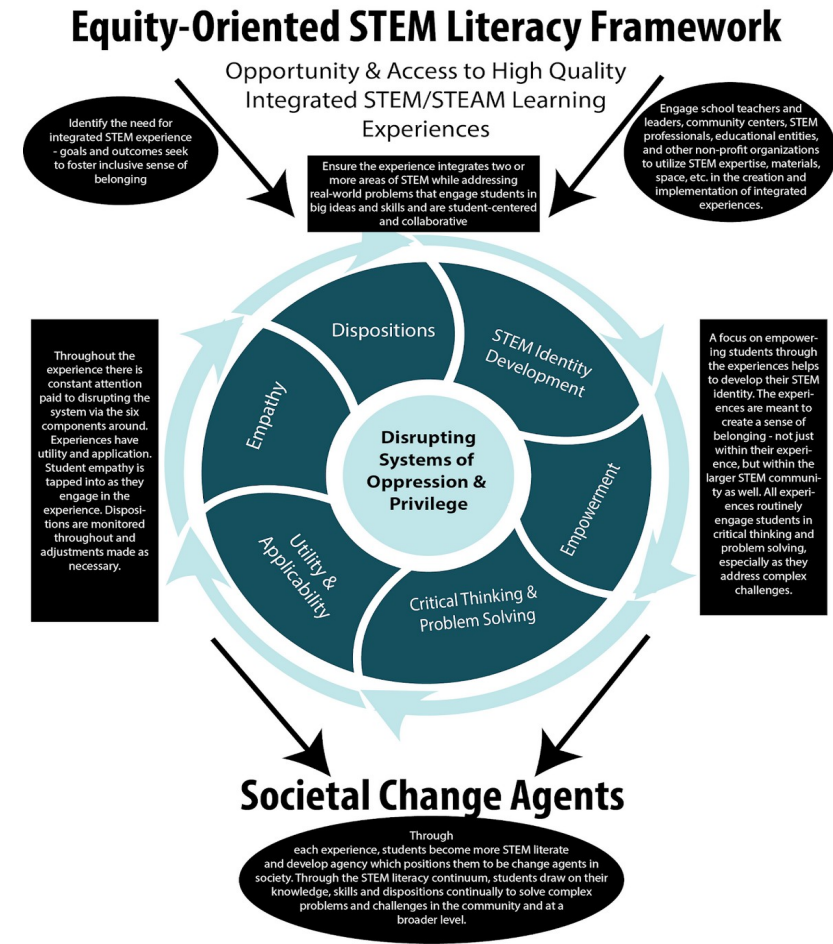


(Jackson et al., under review, p. 27)
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Using an Equity- Oriented STEM Literacy Framework to Teach STEM

Implications for Teaching and Practice

- Rich, integrated STEM learning experiences
- Each component of framework is addressed
- Leaving out one component of the framework risks further disadvantaging minoritized populations



(Jackson et al., under review,)

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Land of the Wiyot People

Another STEM Teaching is Possible: Toward a Phronetic Scientific Knowledge

Another STEM Teaching is Possible: Toward a Phronetic Scientific Knowledge

Rouhollah Aghasaleh, Ph.D. – Humboldt State University

* All political views in this presentation, if any, are my personal opinion and do NOT represent Humboldt State University or the California State University System perspective.

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Another STEM Teaching is Possible: Toward a Phronetic Scientific Knowledge

Overview: Conventional Justice-oriented Pedagogy

- Critical Pedagogy (Freire, 1968/ 1970): oppression, banking concept of education, praxis, conscientization (Giroux, Apple, McLaren)
- Multicultural Education (Banks & Banks, 1989; Nieto, 1992): content integration, basic, process, for all
- Culturally Relevant Pedagogy (Ladson-Billings, 1994): Educators as Dreamkeepers, student competence, cultural competence, socio-political consciousness
- Culturally Responsive Instruction (Gay, 2000): cultural knowledge, prior experience, frames of reference, performance style
- Culturally and Linguistically Responsiveness (Hollie, 2012): validate, affirm, build, bridge
- Culturally Sustaining Pedagogy (Paris & Alim, 2014): cultural pluralism, humanity, identity, history, language, family/ community



Another STEM Teaching is Possible: Toward a Phronetic Scientific Knowledge

Paradigm: Ontology, Epistemology, Methodology

- **Ontology:** BEING– What is the nature of reality?
 - Idealism, Realism, Constructivism, **Humanism**
- **Epistemology:** KNOWLEDGE– What is the relationship between the knower and the known?
 - Feminist Standpoint Epistemology, Critical Theory, **Empiricism**
- **Methodology:** INQUIRY– How should the knowledge be found/ generated?
 - Interpretivism, Phenomenology, Emancipatory, Deconstruction, **Scientific-based Research**



Land of the Wiyot People

Another STEM Teaching is Possible: Toward a Phronetic Scientific Knowledge

Ontological Turn

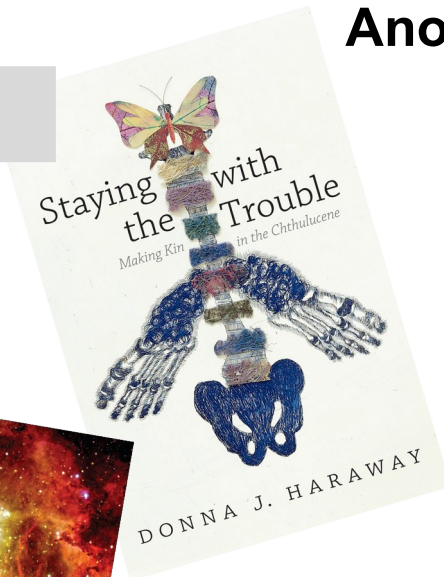
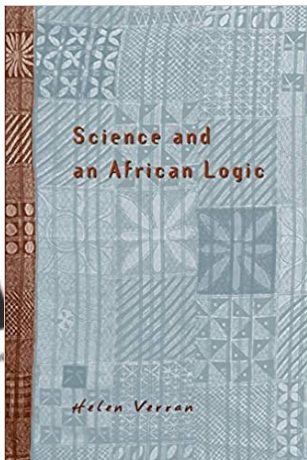
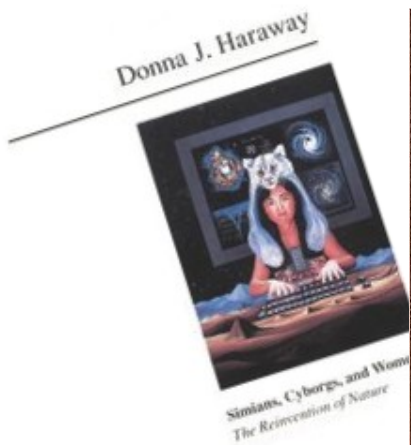
- Wicked Problems of Capitalocene/ Anthropecene:
“dualism-busting assemblage[s] of the Capitalocene” (Sharma 2020, p.7)
 - Environmental Crisis: Global problem with local solutions → Glocalization
 - COVID-19 : natureculture (Haraway, 2007)
 - Global racism, xenophobia, heterosexism
 - Wealth Inequality
- Paradigm Shift (Kuhn, 1970): Normal Science/ Incrementalism failure
- New ethico-onto-epistemologies (Barad, 2007): Post-Enlightment, Non-Western, Non-Modern Science



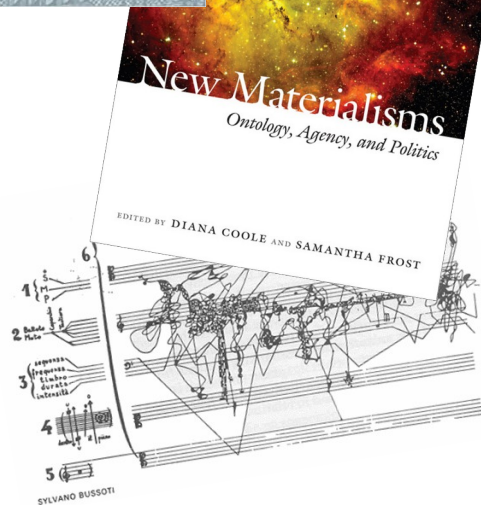
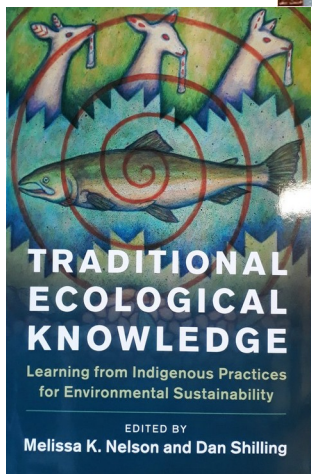
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Phronetic Ontology

Another STEM Teaching is Possible: Toward a Phronetic Scientific Knowledge

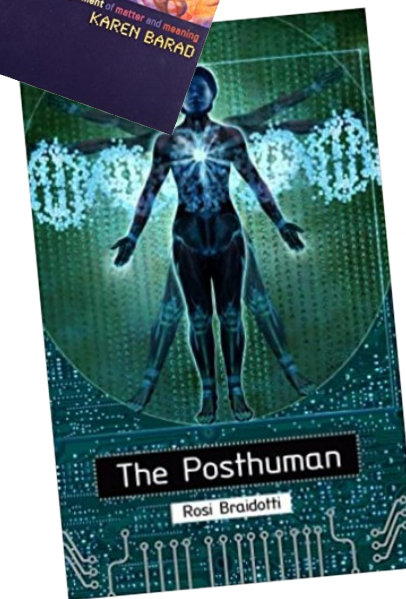


Isabelle Stengers
Another Science is Possible
A Manifesto for Slow Science



Agential realism is not a manifesto, it does not take for granted that all is or will or can be made manifest. On the contrary, it is a call, a plea, a provocation, a cry, a passionate yearning for an appreciation of, attention to the tissue of ethicality that runs through the world.

— Karen Barad —



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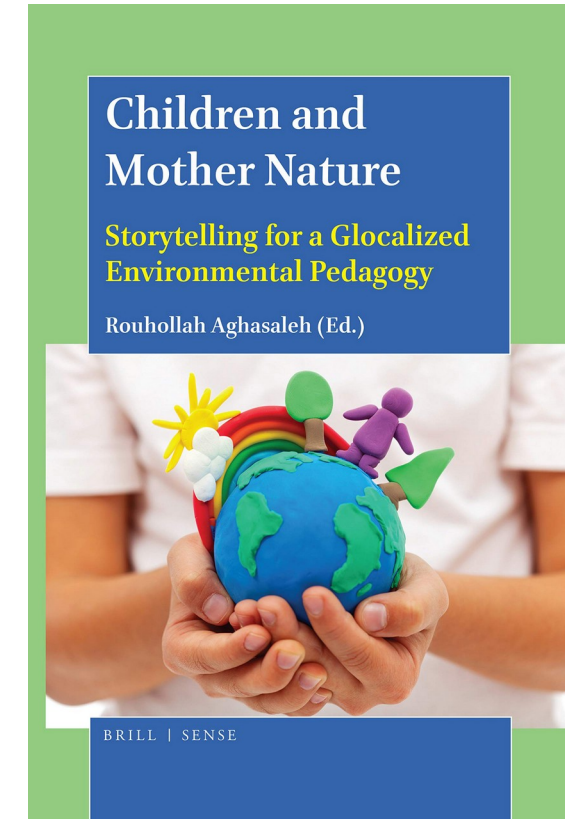


Land of the Wiyot People

Another STEM Teaching is Possible: Toward a Phronetic Scientific Knowledge

Implications for STEM Education

- How do students and communities (especially the minoritized) benefit from “new” ontologies?
 - Disrupt the deficit-based approach and send a message to communities that their home culture and indigenous ways of problem solving are valued and recognizable as science as a response to an old question by feminist scholars: Whose Science? Whose Knowledge? (Harding, 1991).



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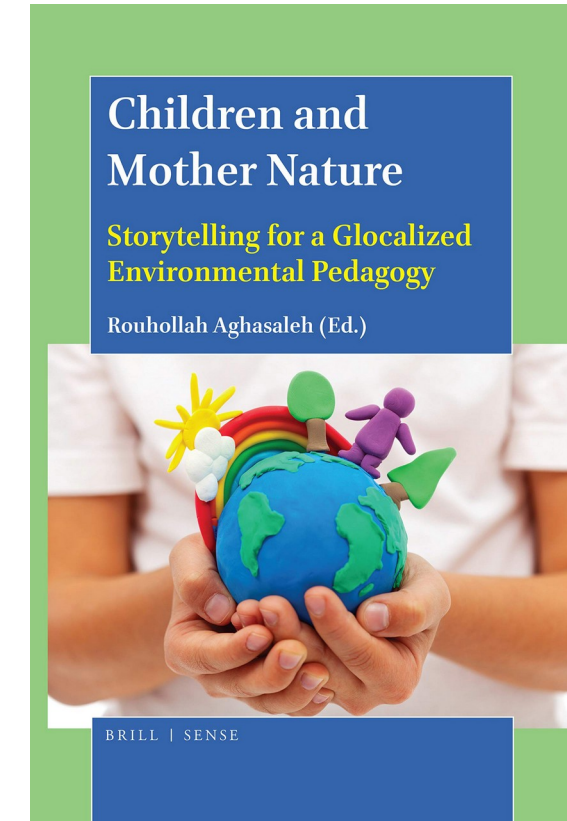


Land of the Wiyot People

Another STEM Teaching is Possible: Toward a Phronetic Scientific Knowledge

Implications for STEM Education

- How does Science benefit from “new” ontologies?
 - Given that wicked problems are marked by value laden moral predicaments that are impervious to both *episteme* and *technē*, it is clear that if we are to survive the *Capitalocene* we need to collectively position phronesis as a primary end goal of science.



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Another STEM Teaching is Possible: Toward a Phronetic Scientific Knowledge

Summary

- It is crucial for science educators to address issues of equity, representation, identity, and justice beyond instructional methods and consider ethico-onto-epistemologies (Barad, 1995) which are informed by critical, feminist, Indigenous, interpretive, linguistic, cultural, legitimation crisis, ethical, slow science, agential realist, post-structural, post-colonial, de-colonial, post-humanist, anti-oppressive, standpoint epistemology, new materialist, race and ethnic turns and theories in science studies as alternative ways to conceptualize research and teaching in science, technology engineering, and math (STEM).

**The Demographics of PER and How our Knowledge is
Impacted by Who We Do or Do Not Study**

Ximena Cid, Ph.D. – CSU Dominguez Hills

*Collaborators: Steve Kanim, Ph.D. New Mexico State (emeritus physics
faculty)*

Ximena Cid, Associate Professor

CSUDH, Department of Physics

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Who takes Physics in the US?

- Student enrollment*
 - High School: 1,376,000 (2013)
 - Two-Year Colleges (TYC): 215,000 (2010-2011)
 - Four-year Institutions (Undergrad): 450,000 (2011)
 - Graduate Institutions: 15,812 (2014)

*All data taken from
American Institute of Physics (AIP) website

Project Overview

- The goal of our study was to assess the demographics of Physics Education Research (PER) studies.
 - Both myself and my colleague Steve Kanim were questioning whether or not our ideas of best practices, curriculum development, or expert-like thinking was biased or influenced by sample bias.
 - We hypothesized that PER studies were over generalizing who was supposed to benefit from study results within PER and by extension STEM Education overall.
- We decided to review all PER publication in three prominent journals between 1970 and 2015: American Journal of Physics (AJP), Physical Review-Physics Education Research (PRPER) and The Physics Teacher (TPT)
 - We looked at the populations that were studied and if the sample was not disclosed we assumed the sample populations were taken from home campuses.

The Demographics of PER and How our Knowledge is Impacted by Who We Do and Do Not Study

Who PER Studies

Examined all papers starting from 1970 - 2015

	<i>PRPER</i>	<i>AJP</i>	<i>TPT</i>	Total
Papers: Total	342	372	317	1,031
Papers: Included	179	159	79	417

Student Population	N from <i>PRPER</i>	N from <i>AJP</i>	N from <i>TPT</i>	N Total
K-9	10	193	0	203
High School	674	1,590	19,275	21,539
Two-year College	380	321	0	701
Teacher Prep	938	1,598	260	2,796
Disadvantaged	0	69	0	69
Conceptual	615	2,597	469	3,681
Honors	405	924	0	1,329
Algebra-based	8,341	23,718	4,607	36,666
Calculus-based	56,991	109,218	13,487	179,696
Upper level	4,600	3,108	3	7,711
Other	145	3,061	60	3,266
Total	73,099	146,397	38,161	257,657

The Demographics of PER and How our Knowledge is Impacted by Who We Do and Do Not Study

Who PER Studies

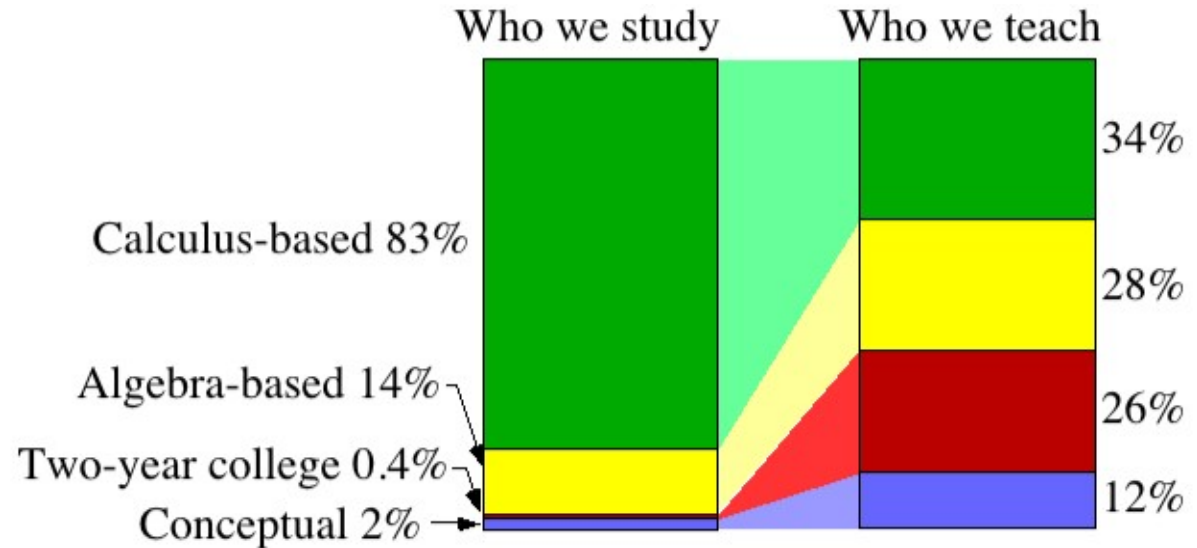
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The Demographics of PER and How our Knowledge is Impacted by Who We Do and Do Not Study

Who PER Studies

- We oversample calculus-based courses at Undergrad institutions and know virtually nothing about TYC

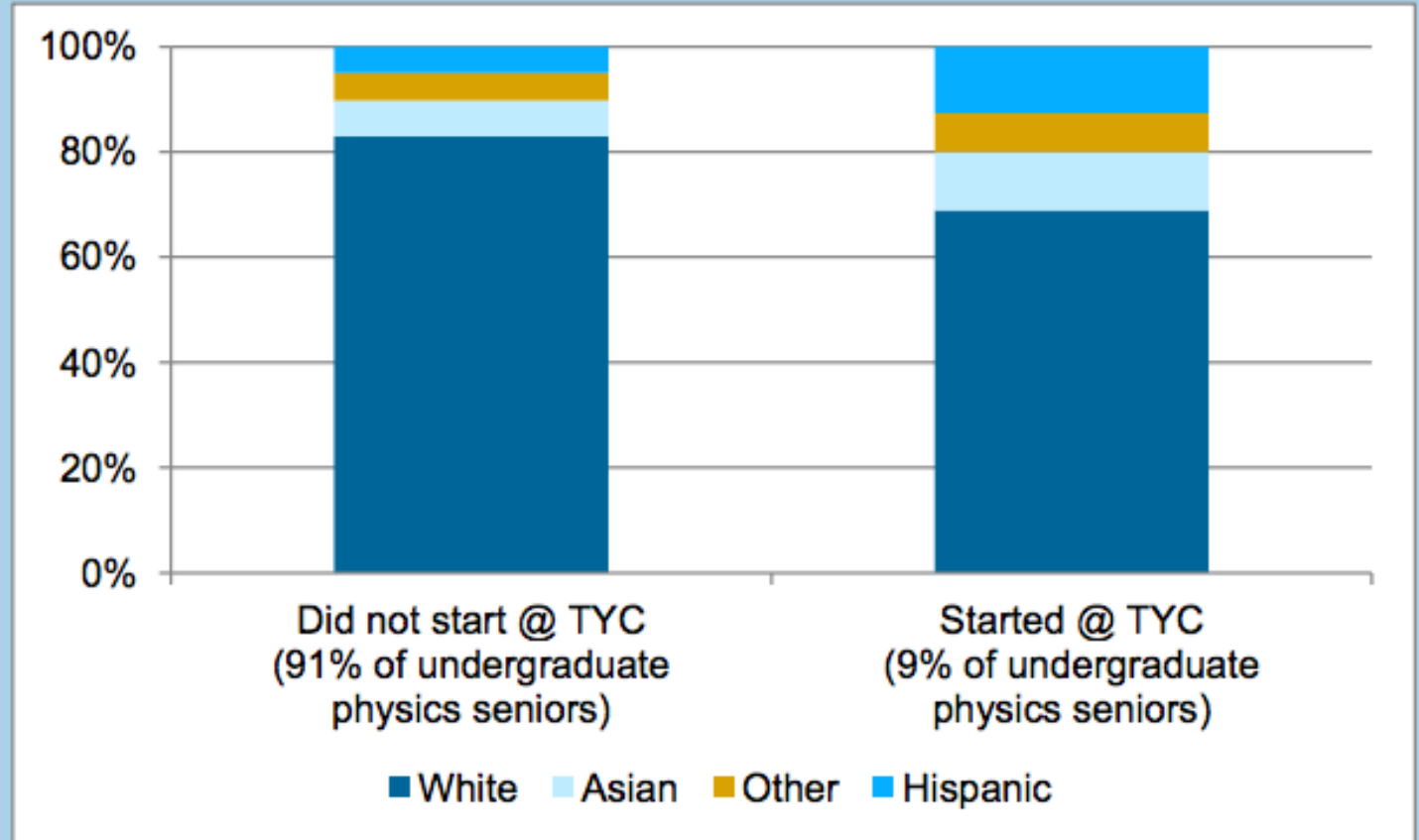


(215,000 students take physics at TYC)

Who PER Studies

TYC students enrolled in physics are more racially diverse than Undergrad institutions

Racial Diversity among Undergraduate Physics Seniors 2007 Survey of Seniors in Degree-Granting Departments



Note: The "Other" category includes African Americans. We did not receive enough responses from students in this group to analyze it separately.

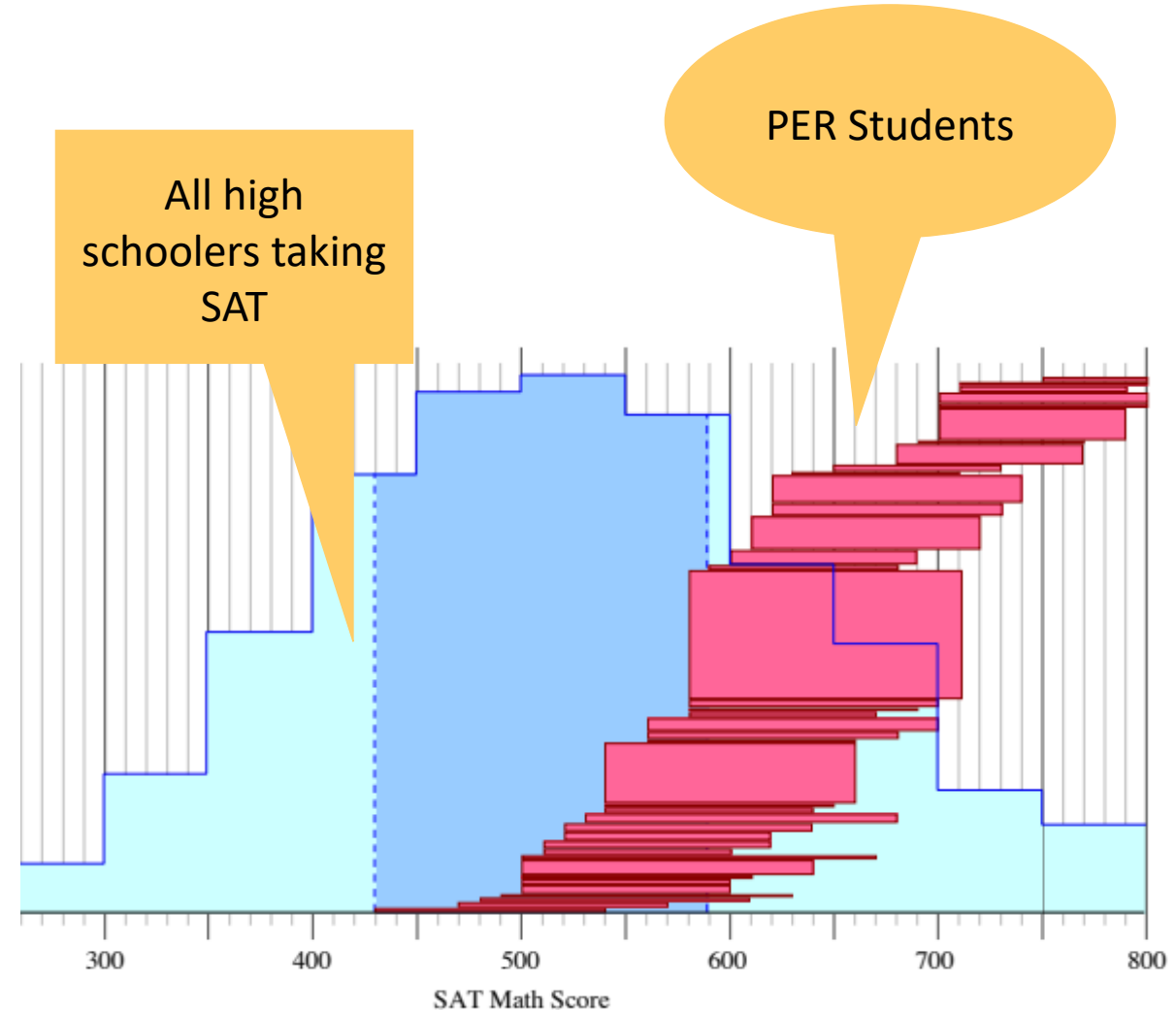
<http://www.aip.org/statistics>

The Demographics of PER and How our Knowledge is Impacted by Who We Do and Do Not Study

Who PER Studies: Normalized

- Students in PER literature come from institutions with SAT-Math scores shifted above the general population
- **Implications:** Students sampled are from more well prepared (mathematically) populations

Source: July 2016, <https://bigfuture.collegeboard.org/college-search>



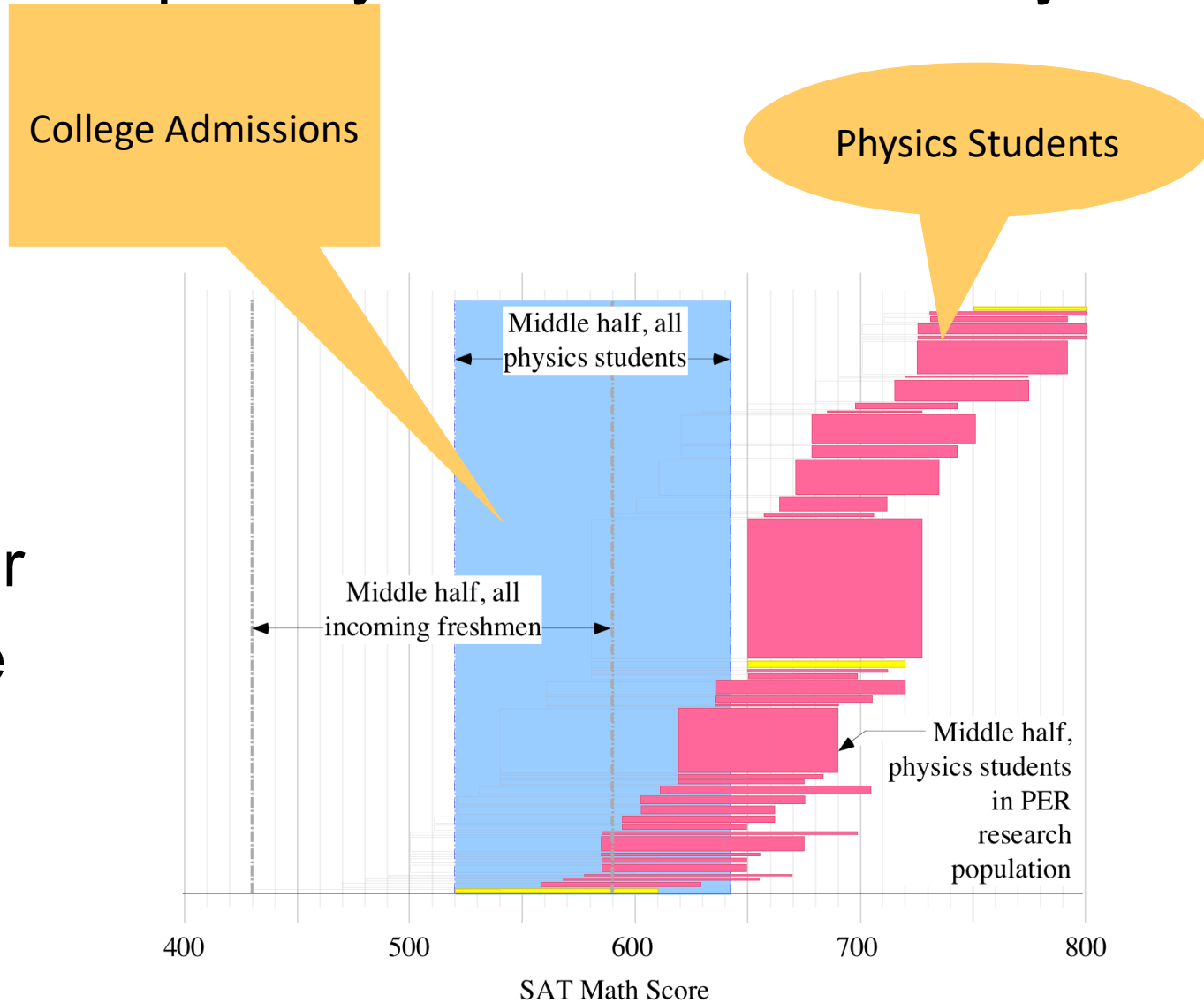
The Demographics of PER and How our Knowledge is Impacted by Who We Do and Do Not Study

Who PER Studies:

Physics Students vs. Gen population

- When taking into account that physics students likely have higher SAT Math Scores, populations are expected to be more skewed.

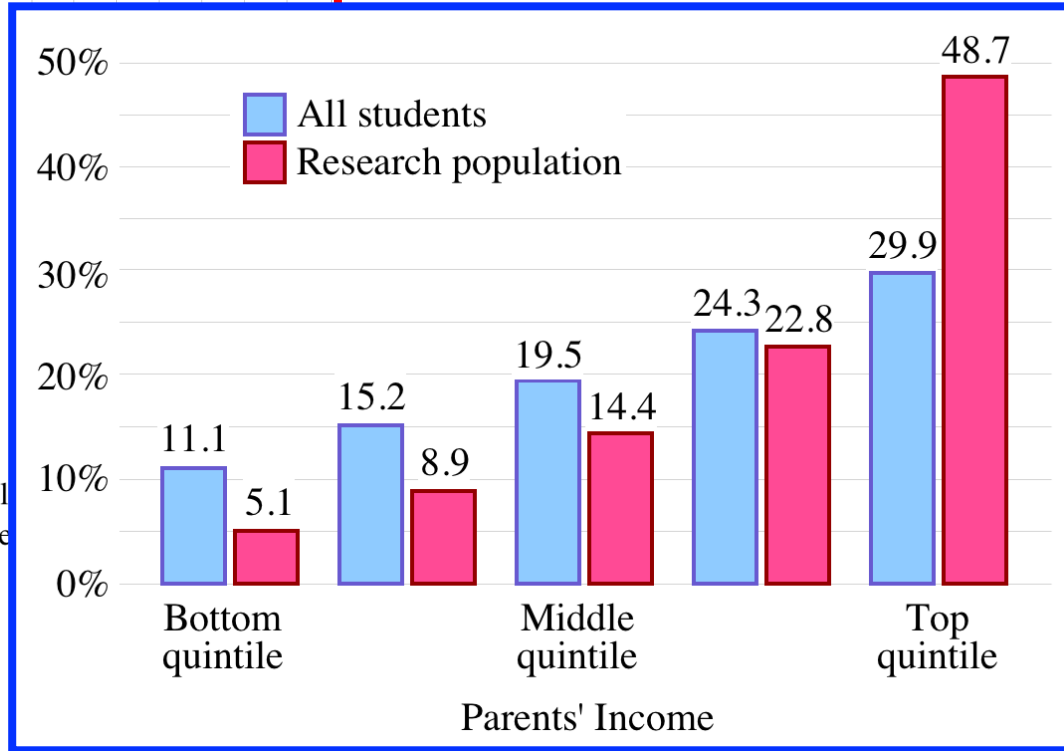
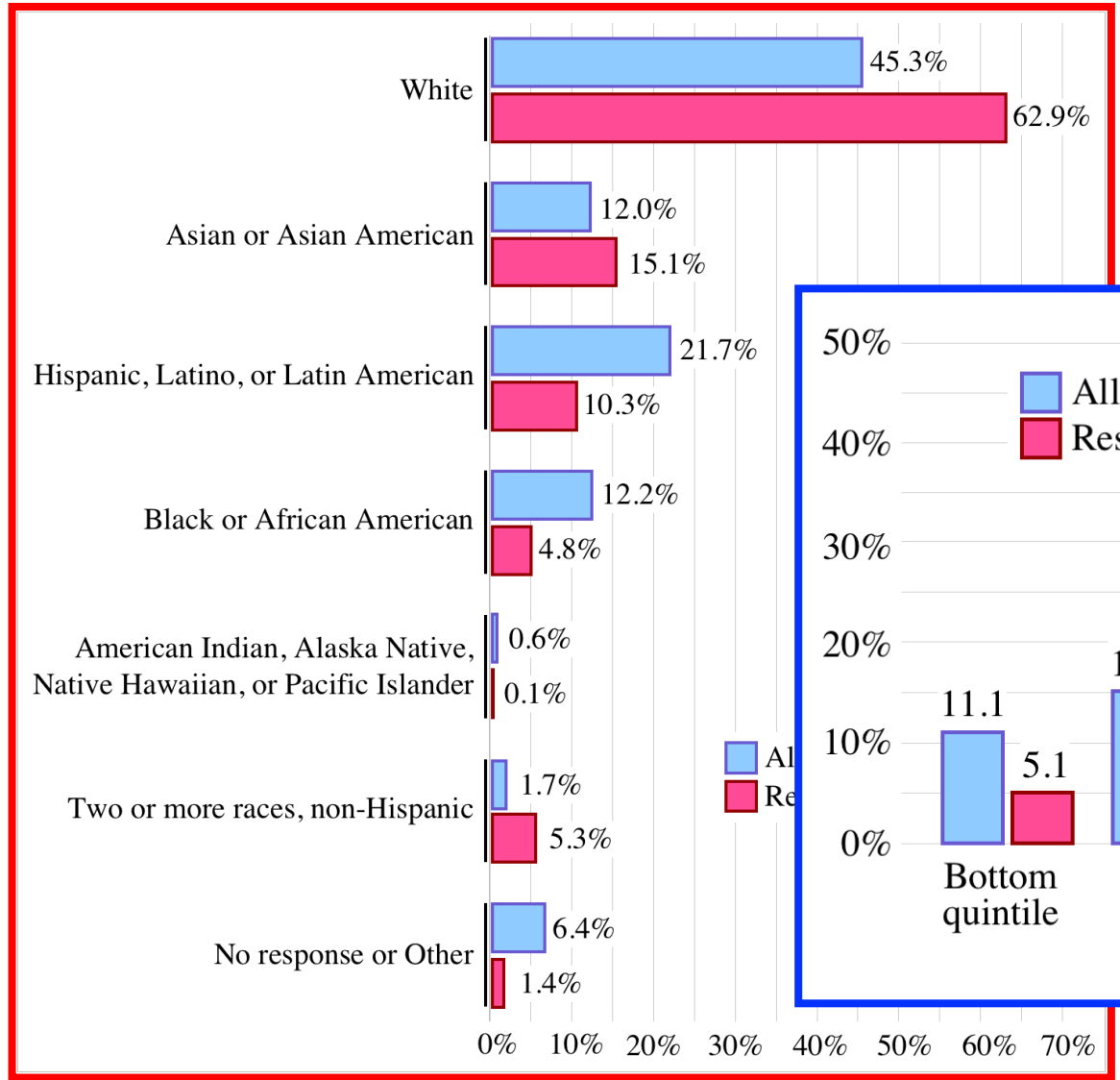
Source: July 2016,
<https://bigfuture.collegeboard.org/college-search>



Who PER studies:

Predominantly white and wealthy

<http://www.equality-of-opportunity.org/data/>



Summary

- Our sample populations are homogenous
 - Demographic data is presented as a statement
 - Deficit model: This population is lacking some physics characteristic from the “norm” population
- **Implications:**
 - There is a lack of understanding of what variables are important or impactful for students who are not represented in the samples studied

Conclusion

- PER is exclusive not inclusive.
 - We study white and well-prepared students.
- Concerns: Convenient sampling
 - How generalizable are PER major findings?
 - How transferable is PER curriculum amongst institutions?
 - We are leaders in Discipline-based Education Researcher (DBER)
 - but are we good leaders?

Questions & Answers

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Next Steps/Closing Remarks

Dr. Frank A. Gomez
Executive Director, STEM-NET
Office of the Chancellor



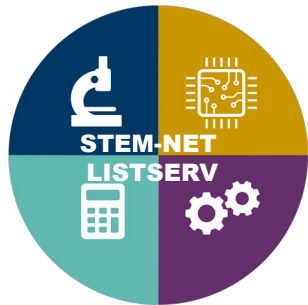
<https://www2.calstate.edu/impact-of-the-csu/research/stem-net>



Webcast Feedback Survey

Please take a few moments to tell us about your webcast experience

<https://forms.gle/szpdNPFaioah1e7i8>



Join our CSU STEM-NET Community listserv

csustemnet@lists.calstate.edu



Begin a Conversation with Colleagues and Join our Private CSU STEM-NET Facebook Group

<https://www.facebook.com/groups/2629611737269292>

Save the Dates

STEM-NET Virtual Research Café 10.0

- March 19th 11AM-12PM
Registration Link: <https://tinyurl.com/4lukz28t>

STEM-NET April Webcast

- Transportation Research in the CSU: April 15th, 10AM- 12PM
Registration Link: **Coming Soon**