Developing Pre-Service Teachers' Equity Literacy in Content Courses

IUSE Summit Workshop June 2022

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NSF

MODULE(S^2)

Mathematics Of Doing, Understanding, Learning and Educating for Secondary Schools

The University of Arizona

Eastern Michigan University

Middle Tennessee State University

University of Nebraska Lincoln

Utah State University

The Mathematics Of Doing, Understand, Learning, and Educating Secondary Schools (MODULE(S2)) project is made possible through funding from the National Science Foundation IUSE (Improving Undergraduate STEM Education) multi-institutional collaborative grant #1726707 (APLU), #1726098 (University of Arizona), #1726252 (Eastern Michigan University), #1726723 (Middle Tennessee State University), #1726744 (University of Nebraska - Lincoln), and #1726804(Utah State University).

MODULE(S²)
Mathematics Of Doing, Understanding, Learning and Educating for Secondary Schools

- What is MODULE(S2)?
- ***Equitable Teaching Practices*** as inputs for ***Equity Literacy*** development
- Engage in MODULE(S2) Tasks
- Reflect on your projects/contexts with respect to ***Equitable Teaching*** and ***Equity Literacy***

Mathematics Teacher Education-Partnership

1. Set a gold standard for secondary mathematics teacher preparation
2. Help teacher prep programs transform to meet this gold standard.

MODULE(S2) addresses this problem:

"***Math courses taken by secondary teachers often don't help them to develop math knowledge for teaching***"

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- **Algebra**
  - Relations and Functions; Number, Powers, and Logarithms; and Fields and Polynomials
- **Geometry**
  - Axiomatic Systems, Transformational Geometry, and Similarity
- **Modeling**
  - The Process and Purpose of..., Incorporating Real Data in..., and Diverse Perspectives in … Mathematical Modeling
- **Statistics**
  - Study Design and Exploratory Data Analysis, Statistical Inference, and Statistical Association

MODULE(S^2)

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6 Project Years	54 Universities in the U.S. and Canada
65 Piloting Faculty	938+ Students/Prospective Teachers

Equity-based Teaching Practices

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Going deep with mathematics	*Focus on understanding*
Leveraging multiple mathematical competencies	*draw on students' strengths*
Affirming mathematics learners' identities	*encouragement, support, promotes student participation*
Challenging spaces of marginality	*practices that embrace student competencies (group work, discussions, projects, etc.)*
Drawing on multiple resources of knowledge	*tap students' knowledge and experiences (mathematical, cultural, linguistic, peer, family, community, etc.)*

Aguirre, J., Mayfield-Ingram, K., & Martin, D. (2013). The Impact of Identity in K-8 Mathematics Learning and Teaching: Rethinking Equity-Based Practices

Prioritized Instructional Practices in MODULE(S2)

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Teaching Practices to Actively Cultivate and Sustain a Bias Free Classroom	
Practice 1	*Learning about student understanding using their explanations, justifications, and representations*
Practice 2	*Generating questions and discussion that promote students exploring conjectures and justification*

Equity Literacy Abilities

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Recognize biases, inequities, and oppressive ideologies
Respond to biases, inequities, and oppressive ideologies in the immediate term
Redress biases, inequities, and oppressive ideologies in the long term by addressing their root causes
Cultivate equitable, anti-oppressive ideologies and institutional cultures
Sustain bias-free, equitable, and anti-oppressive classrooms, schools, ideologies, and institutional cultures

Gorski, P., Equity Literacy Institute (2020), http://www.edchange.org/handouts/Equity-Literacy-Intro-Abilities.pdf

Focus: Cultural Relevance

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- What is culture?
- A broad definition: ***Culture is a summation of personal experiences that shape who we are*** (González, 2008)
- How can we leverage cultural experiences for teaching and learning mathematics?

Focus: Cultural Relevance

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- Culture—broad definition:
  Culture is a summation of personal experiences that shape who we are (González, 2008).

- How can we leverage cultural experiences for teaching and learning mathematics?

Elements of Culture on the Surface
Ethnic Appearance
Clothing
Music
Pastimes
Foods
Celebrations
Art
Language
Community Events

Focus: Cultural Relevance

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Elements of Culture on the Surface
Ethnic Appearance
Clothing
Music
Pastimes
Foods
Celebrations
Art
Language
Community Events

Elements of Culture Below the Surface
Attitudes toward time
Attitudes toward parenting
Moral beliefs
Expressing joy, sorrow, disagreement
Displaying leadership
Gender roles
Religious beliefs
Body language
Interpersonal relationships
Individualism vs. collectivism
Interdependence vs. independence
Collaboration vs. competition

The MODULES Curriculum

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- Explicit focus on equitable teaching practices
- Meaningful contexts embedded in social issues
- Mathematics and Statistics with a focus on understanding

MODULE(S2) Tasks

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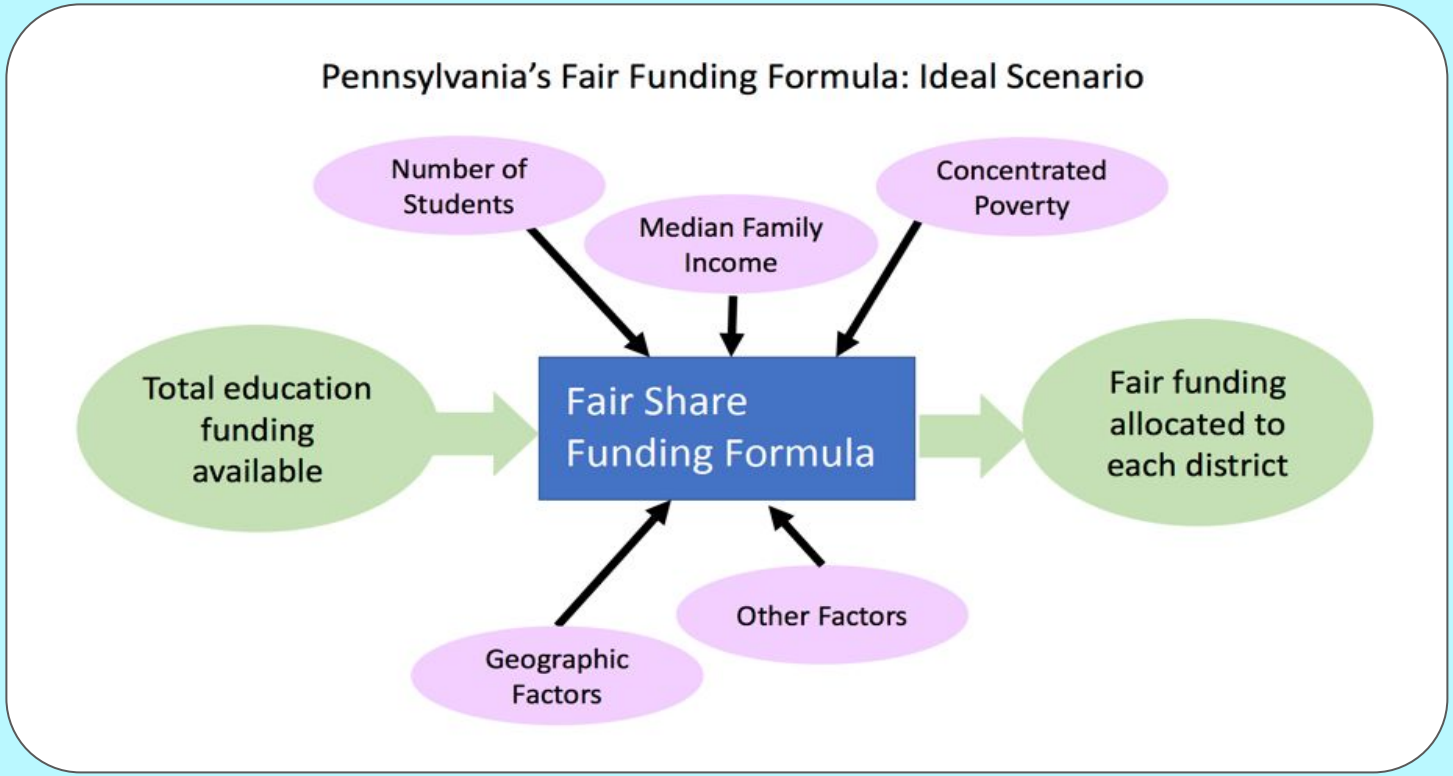
- Statistics: Exploratory Data Analysis module, lesson from approximately 3rd week of class

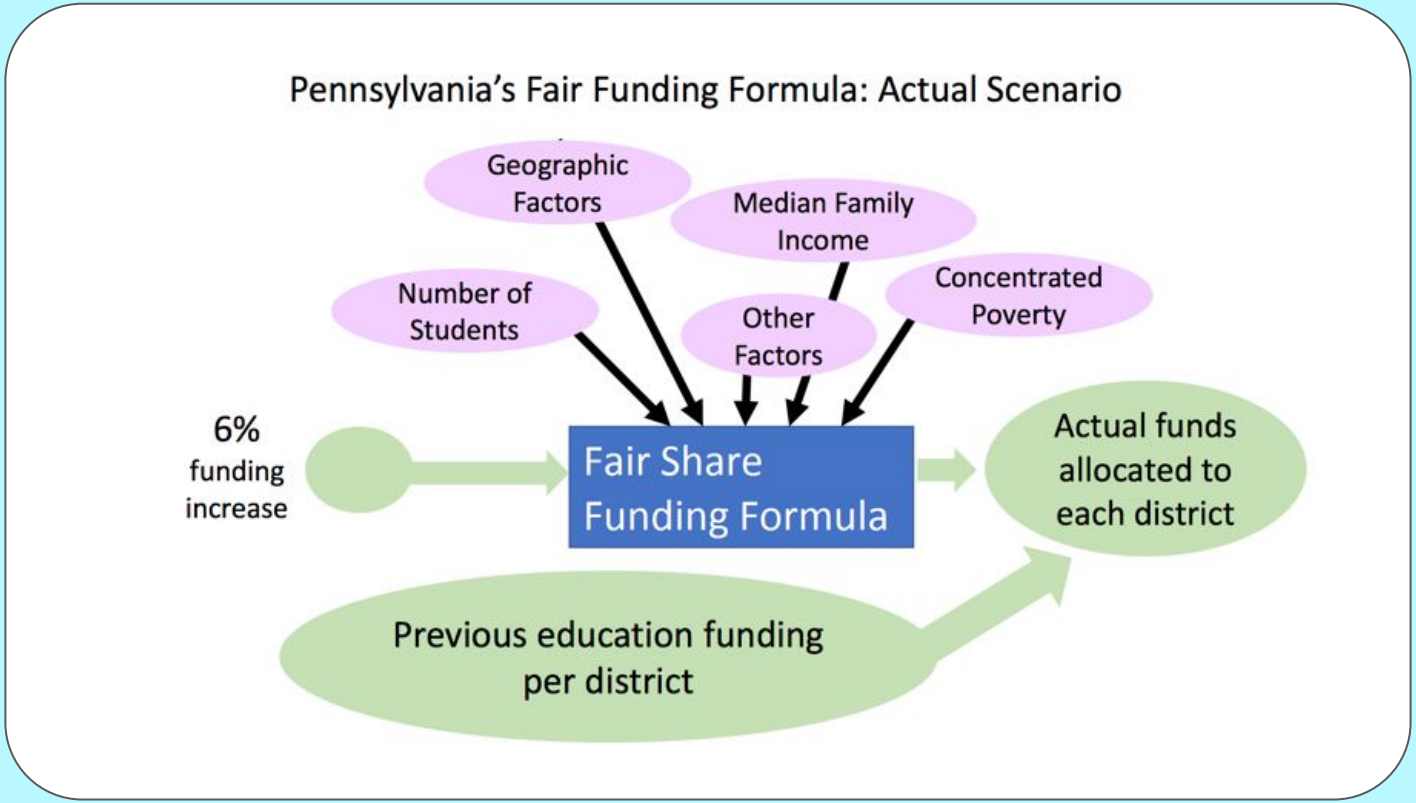
- Modeling: Diverse Perspectives on Mathematical Modeling module, first lesson

Statistical Investigation regarding PA School Funding



Mosenkis, David. (2016) Systemic Racial Bias in Latest Pennsylvania School Funding. https://powerinterfaith.org/wp-content/uploads/2016/08/PA-Racial-School-Funding-Bias-July-2016-1-1.pdf

Actual Funding Process:

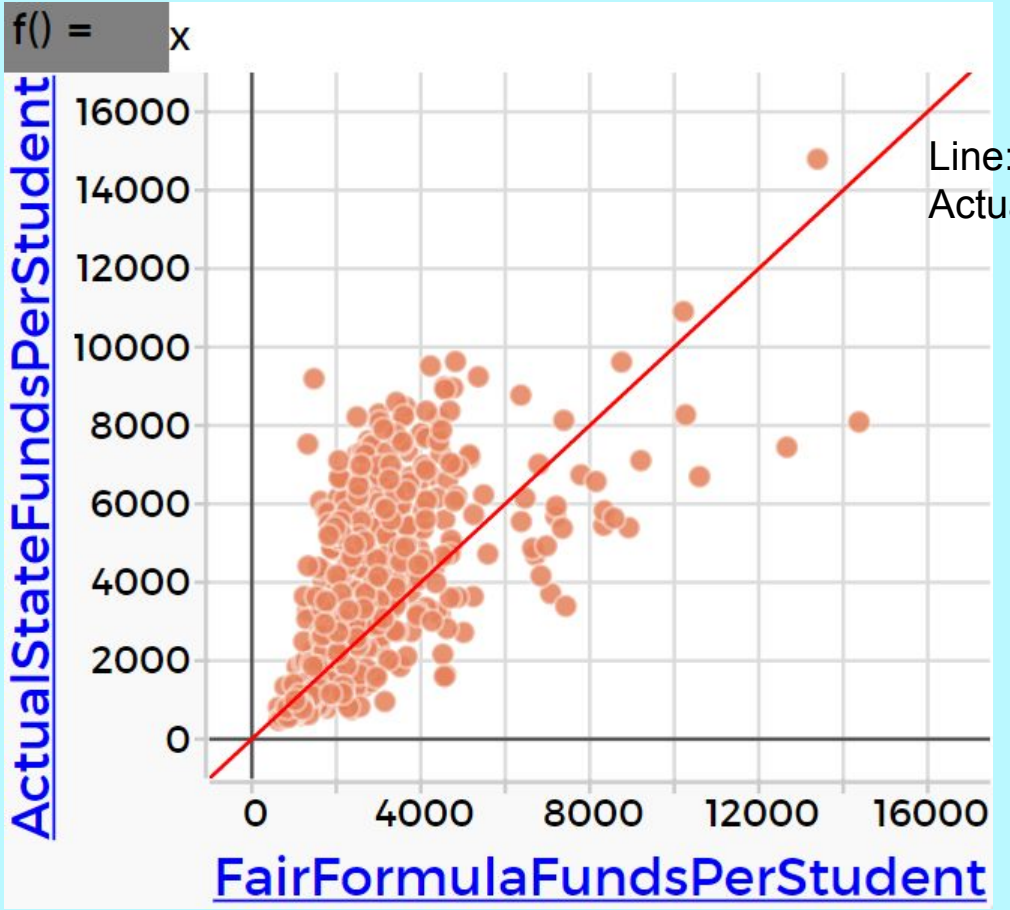


http://bit.ly/PennSchoolFunding

Video of classroom discussion

Video clip 1

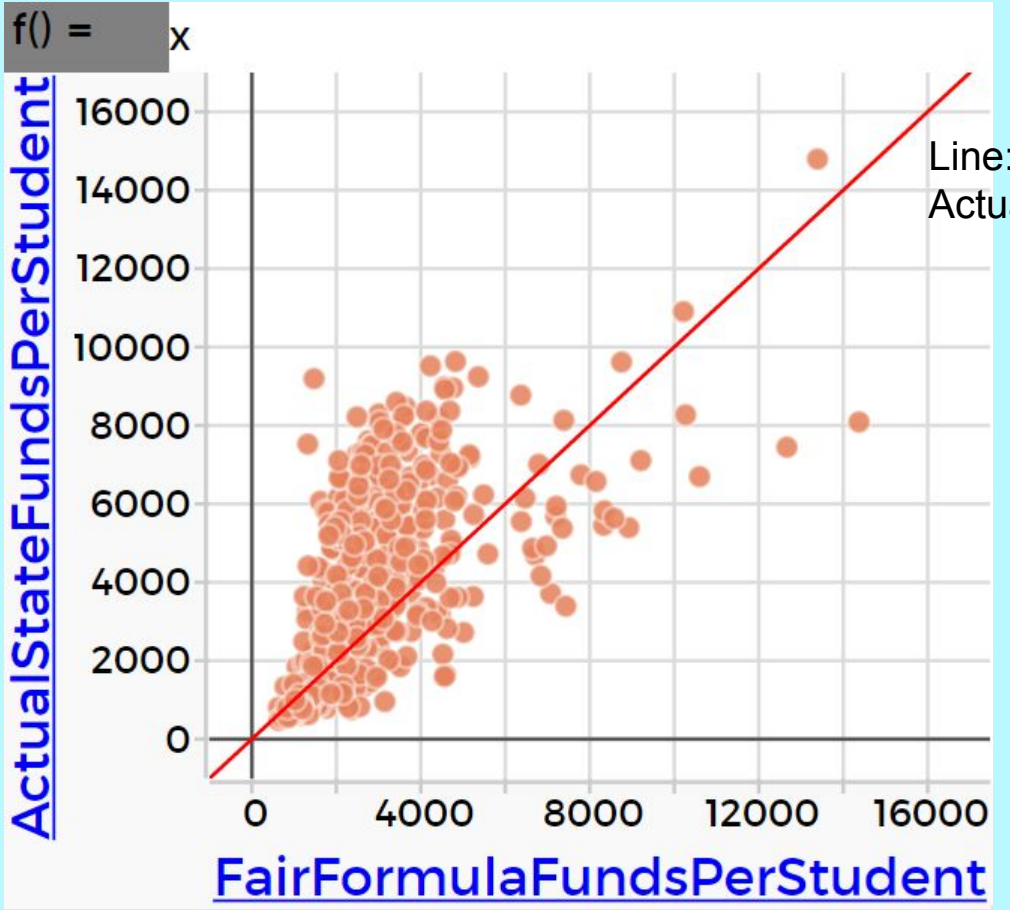
Exploratory Data Analysis



Line: f(x) = x, or
Actual Funding = Fair Formula Funding

What do you notice?
What do you wonder?

Exploratory Data Analysis



Line: f(x) = x, or
Actual Funding = Fair Formula Funding

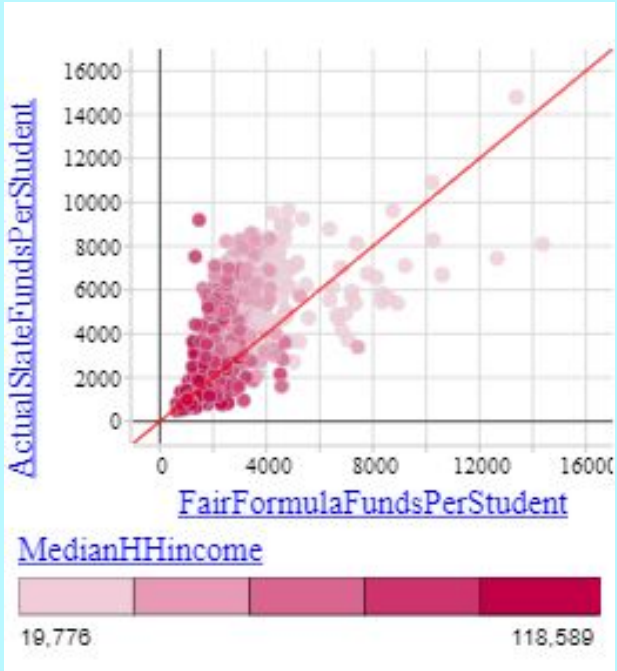
Which districts received less than the fair formula would have them receiving, and which districts got more?

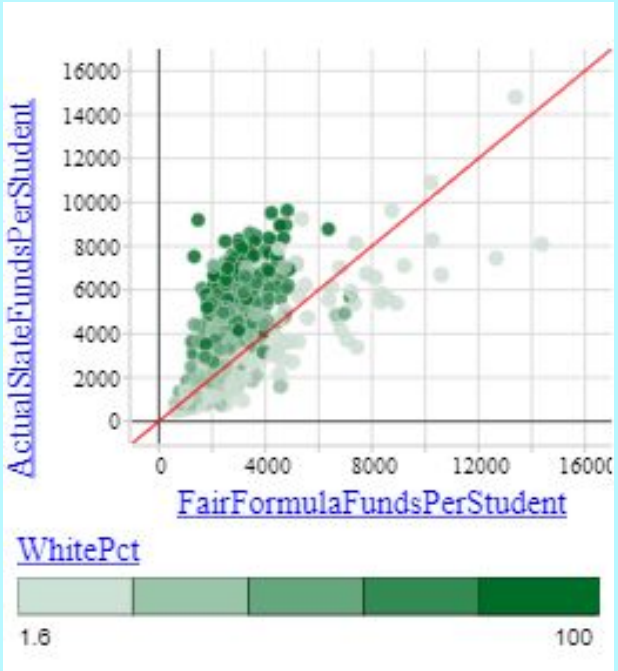
Is there a variable that best predicts which schools get less than their fair share?

Video of classroom discussion

Video clip 2

Which 3rd variable (coloring) best helps predict which schools get less than their fair share?





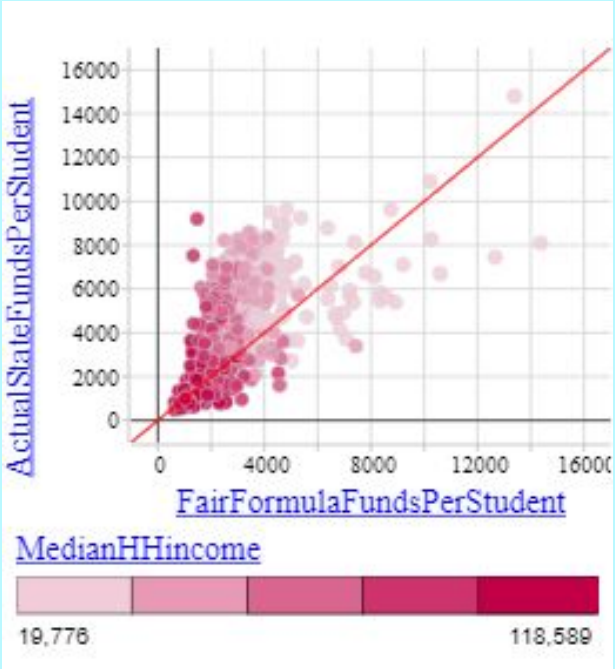
MedianHHincome: Median Household Income in the district

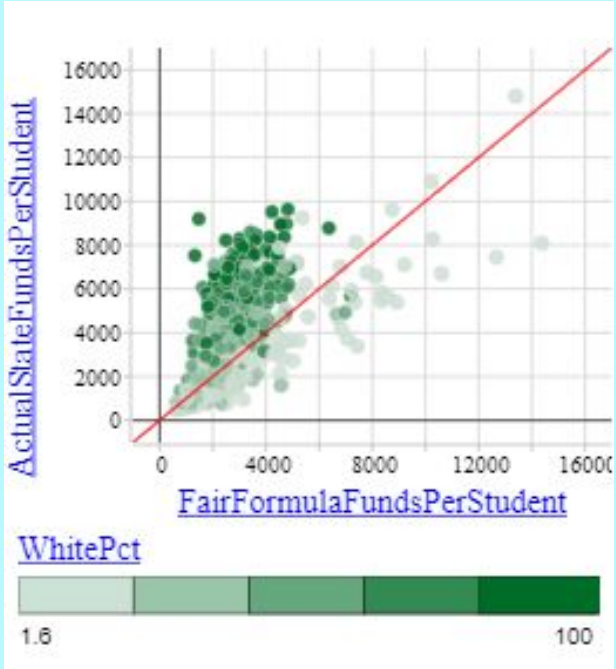
WhitePct: Percentage of White-identifying students in the district

Video of classroom discussion

Video clip 3

Which 3rd variable (coloring) best helps predict which schools get less than their fair share?





Follow-Up: *Suppose that you were writing a letter to a state government official about funding imbalances. What data-driven things would you say?*

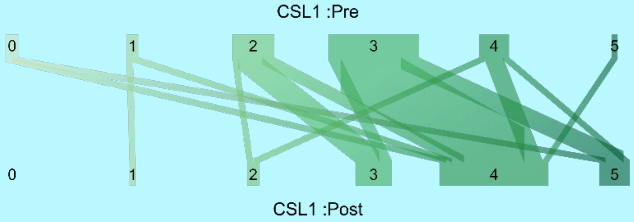
MedianHHincome: Median Household Income in the district

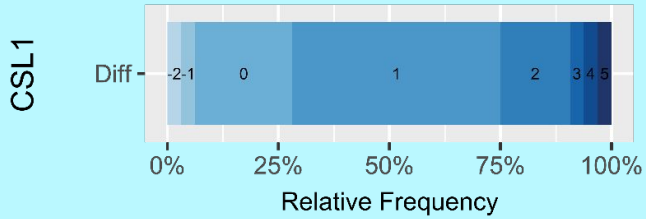
WhitePct: Percentage of White-identifying students in the district

Research results: Development of Critical Statistical Literacy

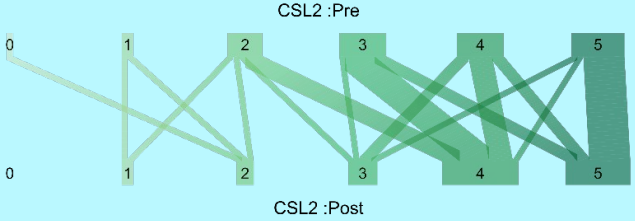
Critical statistical literacy: The practice of analytically examining and assessing sociopolitical statistical content to inform action or change.

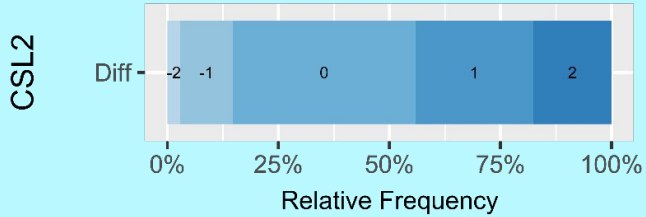
Survey Questions		
CSL1 What is your level of critical statistical literacy? [responses 0 (low) to 5 (high)]		
Question stem: How well does this statement describe you?		
CSL2 It is important to me to use critical statistical literacy skills when considering claims made regarding sociopolitical issues.	**CSL3** I am likely to apply my critical statistical literacy to sociopolitical issues that I am interested in.	**CSL4** I am likely to use activities regarding sociopolitical issues with my future students to help develop their critical statistical literacy. (Assume that you are teaching middle school/high school math students and your school setting is supportive of such work.)



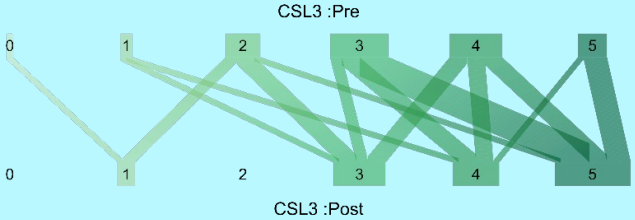


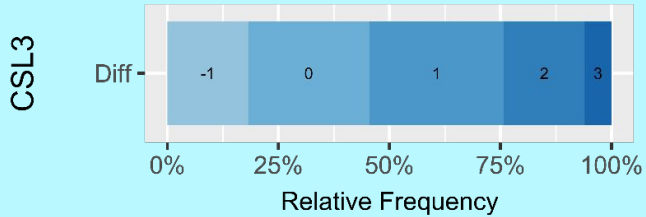
Level of CSL



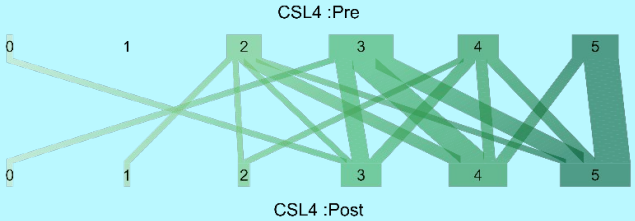


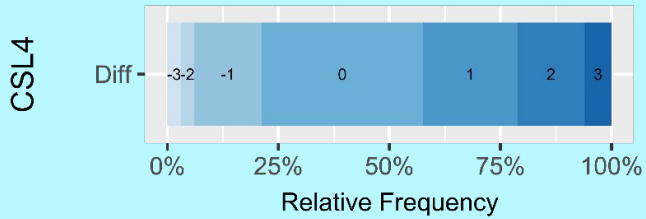
Use CSL when considering claims





Apply CSL





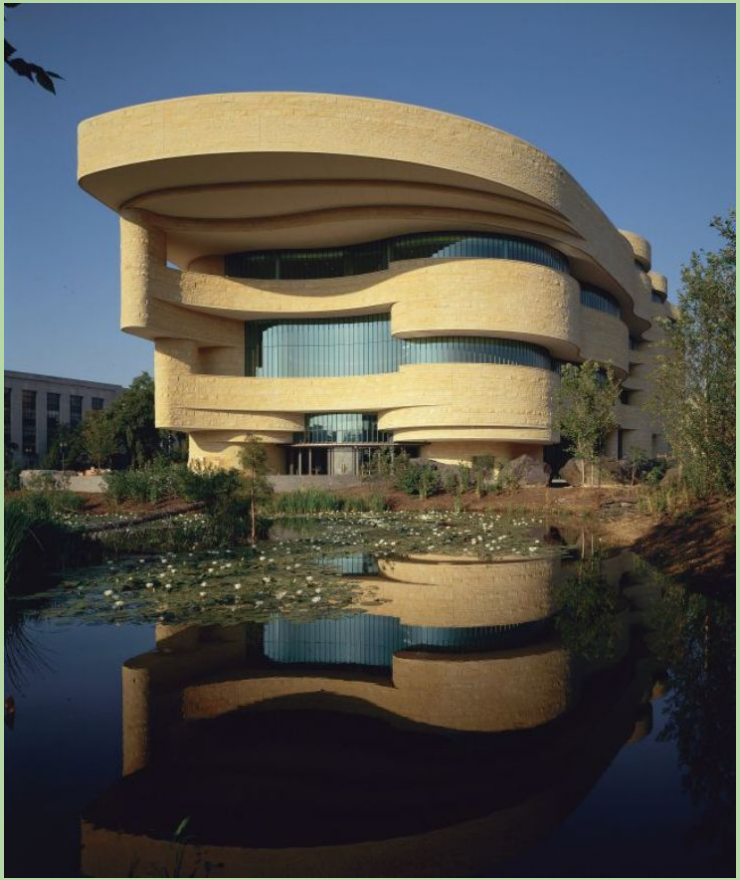
Use activities to help students develop CSL

“What did you learn about equity and social justice as a result of this course?”

Rafael: “A lot of students are disadvantaged in their ability to succeed in school due to misconceptions and stereotypes placed against them. Due to teachers expecting less of these students, they have a more difficult time being as successful as other students.”

Maria: “...it was helpful to learn about the misconceptions that people hold and look at the data to find out the truth and think about the real causes...”

Mathematical Modeling: Introduction of the task



The Mathematical Modeling Task

Based on the two maps of the Great Sioux Reservation in 1851 and 1876, develop a procedure that can be used to approximate the area of the Great Sioux Reservation and use it to calculate the percentage in area reduction between 1851 and 1876.

- Describe your method for estimating the area based on the map images.
- Estimate the accuracy of your solution and describe changes you would make to improve the accuracy.
- Develop an improved procedure based on your initial solution.

Your Approaches

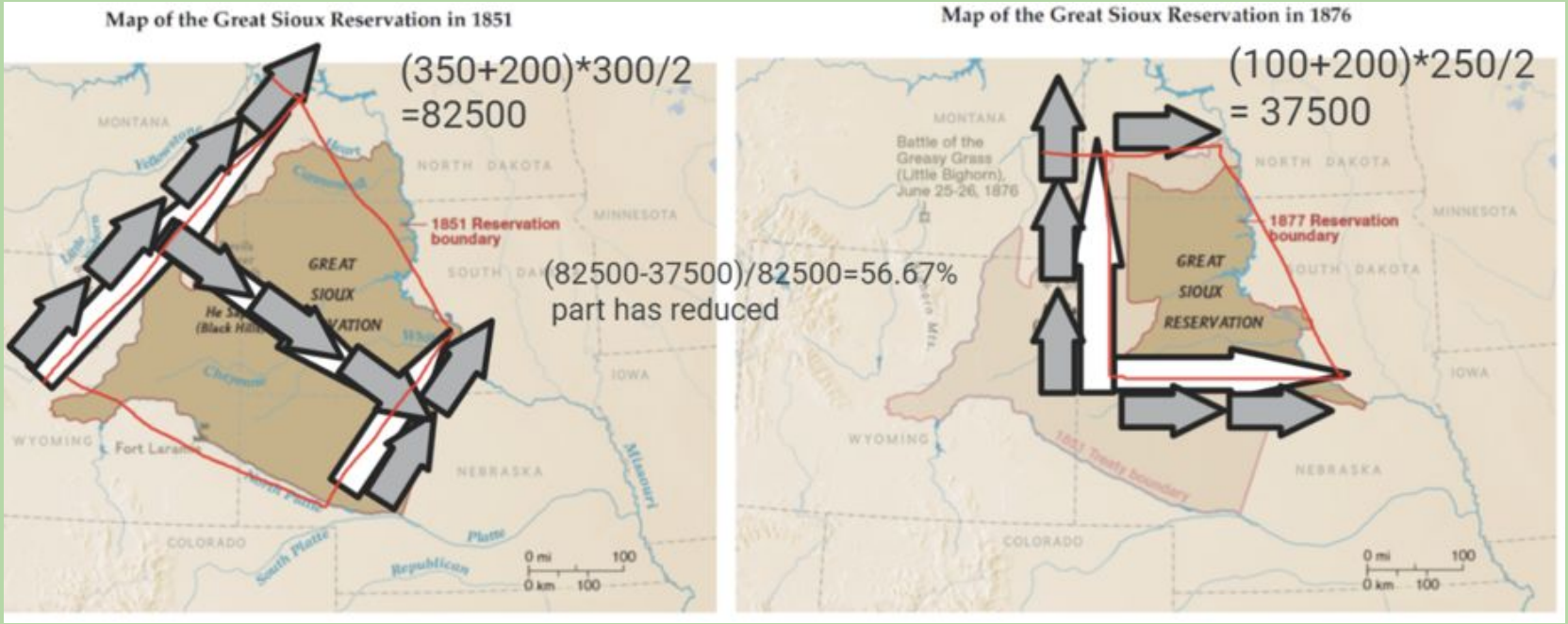
What mathematical approaches would you use to address the problem?

- Learning about student understanding using their explanations, justifications, and representations

- Generating questions and discussion that promote students exploring conjectures and justification

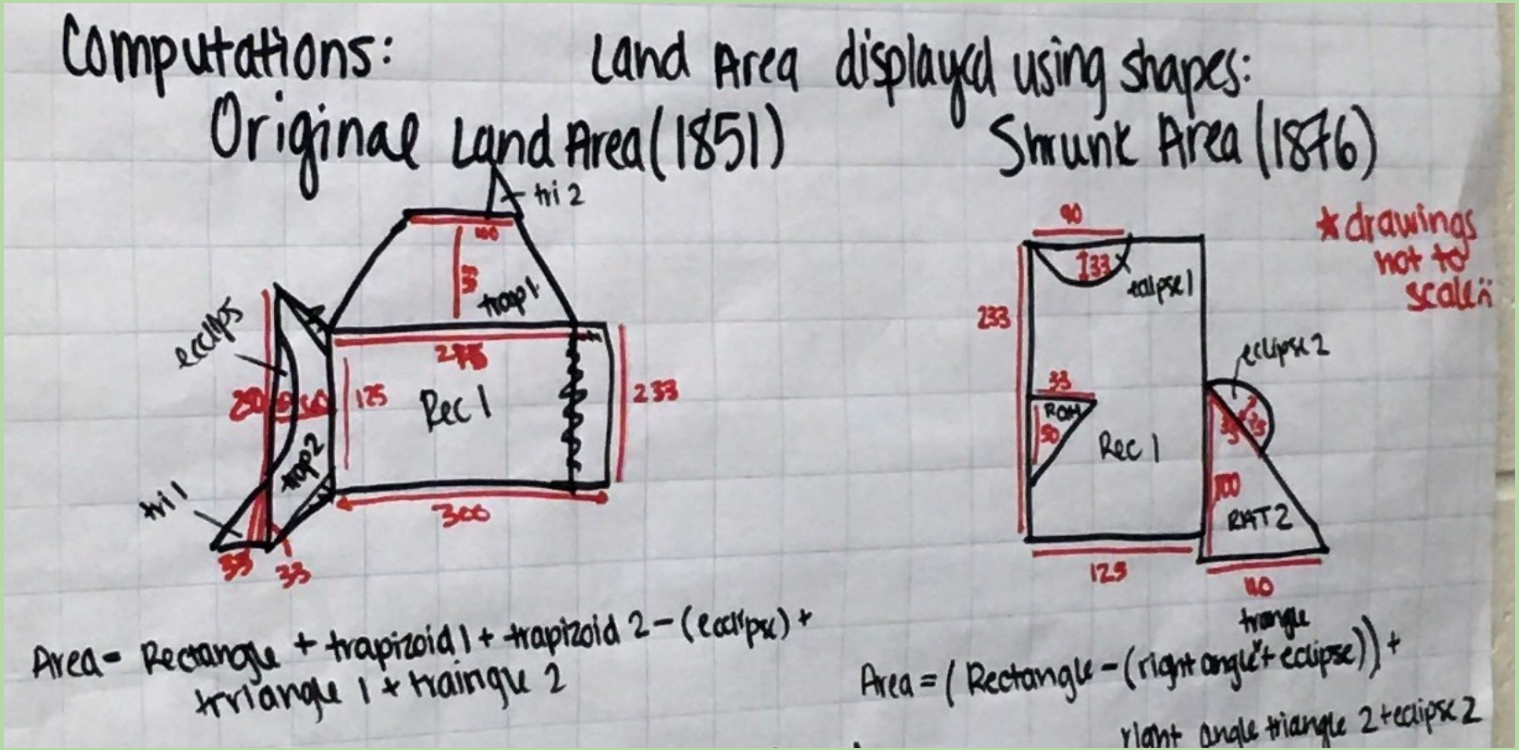
Example PT Modeling Work

Using the scale on the map, approximated areas with trapezoids



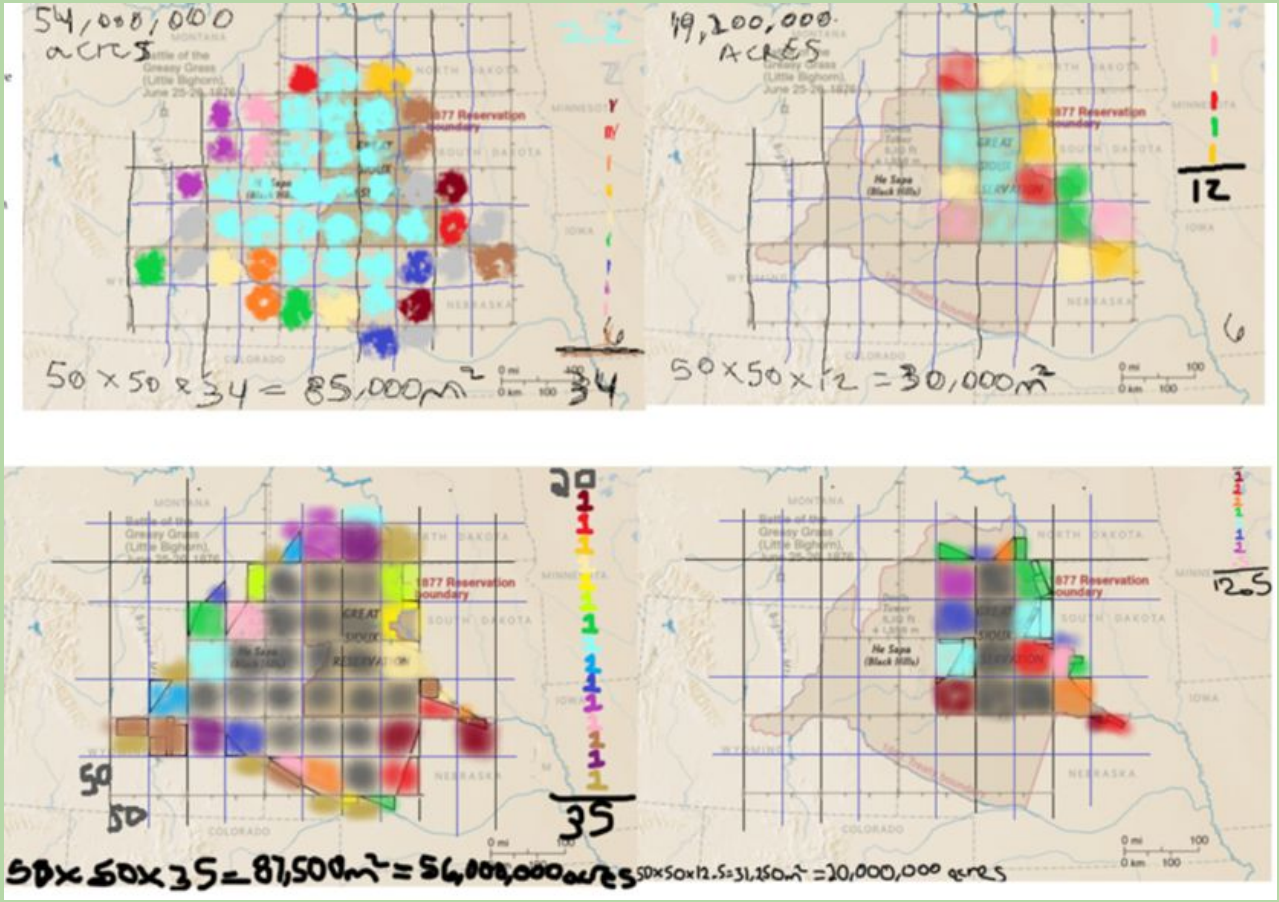
Example PT Modeling Work

Using area of composite shapes, estimated the area of reservation lands



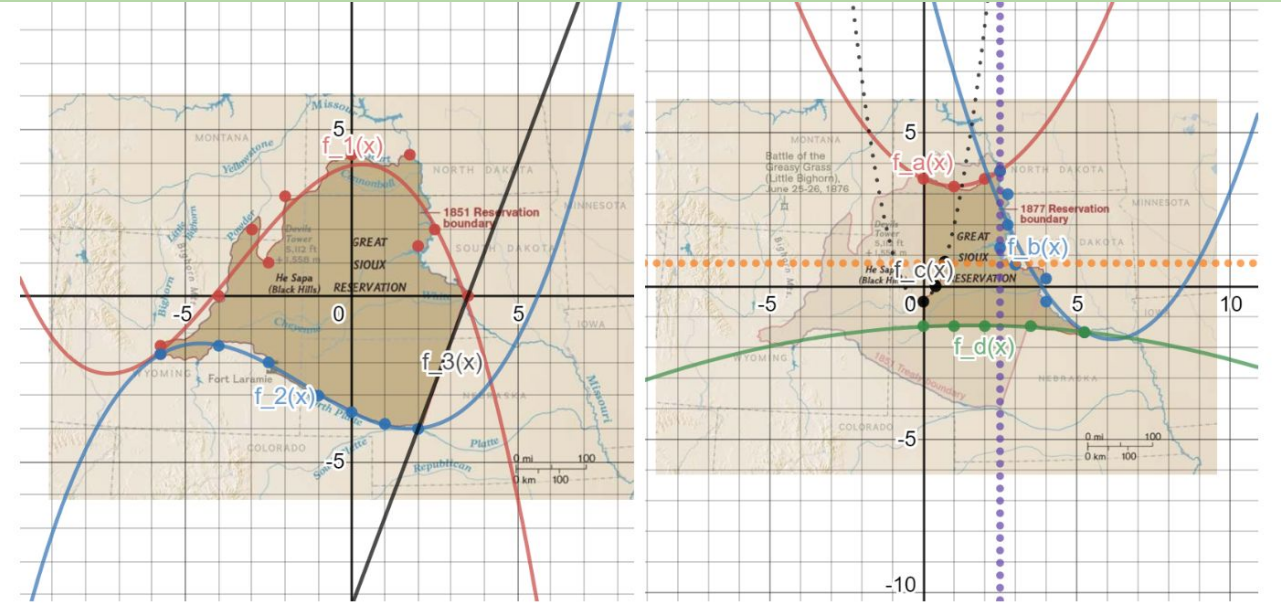
Example PT Modeling Work

Grid overlay on the land and estimated area by square acres: approximately 64% reduction in land



Example PT Modeling Work

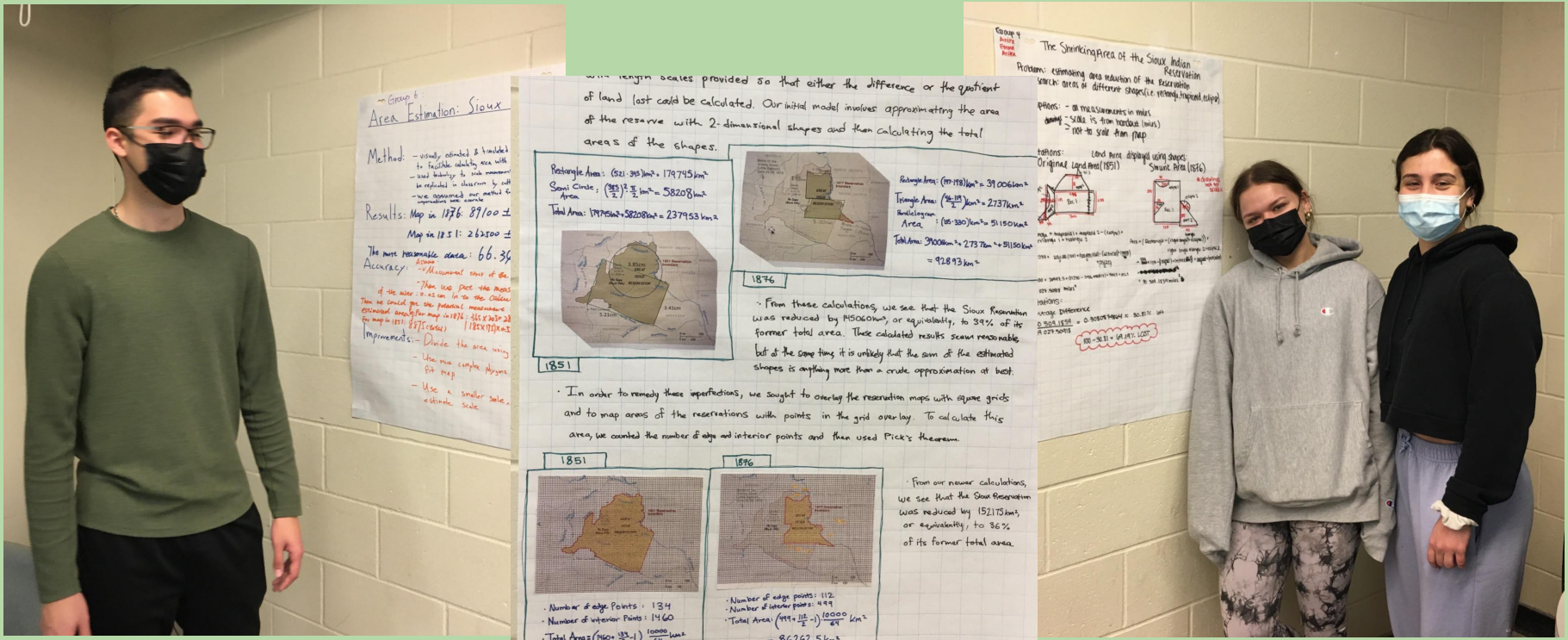
Functions to model the boundaries of the land and integrals for area



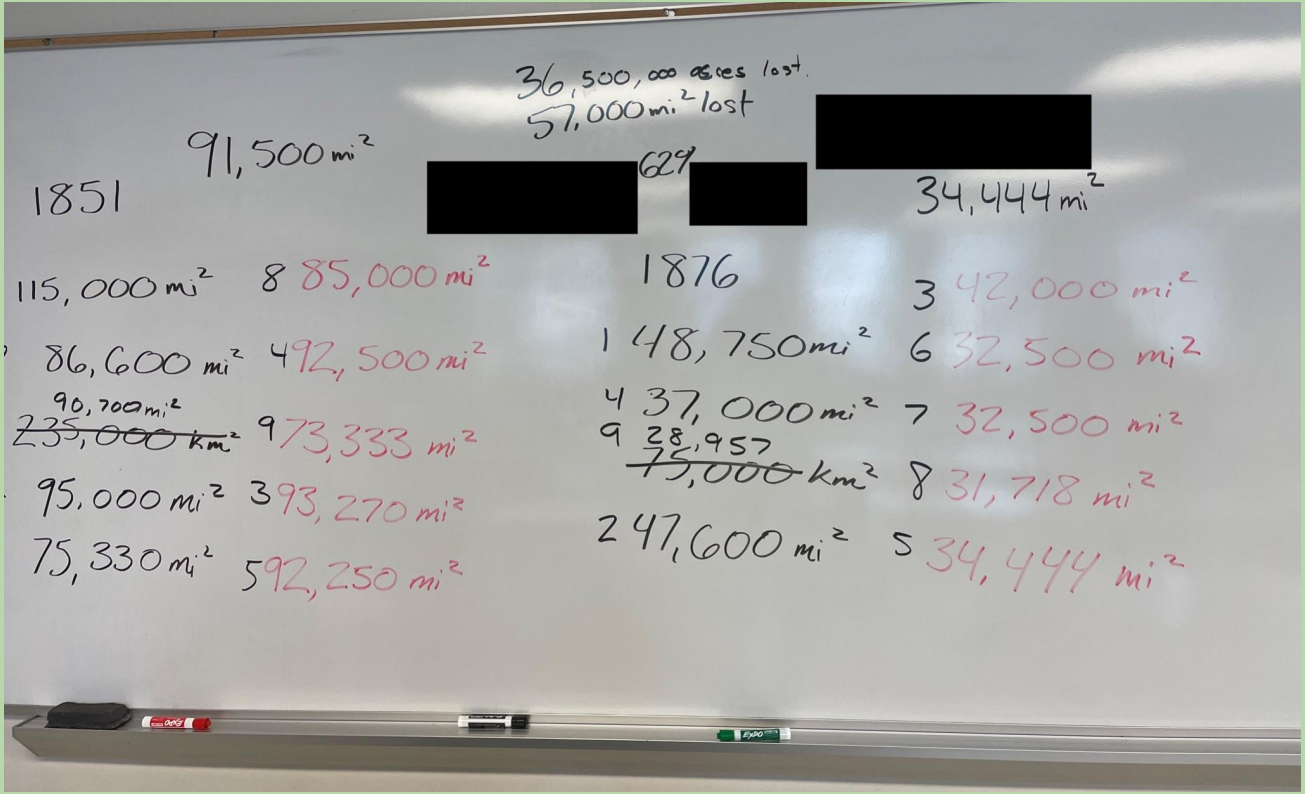
(a) 1851 map with curve approximations. View with graph at https://www.desmos.com/calculator/8l1rfoc0uu

(b) 1876 map with curve approximations. View this graph at https://www.desmos.com/calculator/bprhwvg0qr

Gallery Walk to discuss approaches and results



Audio of classroom discussion



Simulation of Practice Assignment

Discuss the mathematical approaches:

- How would you facilitate a discussion so that students describe the **benefits, drawbacks, and similarities of multiple approaches**?
- Suppose that the groups calculate a wide range of percentages for the shrinkage of reservation land from 1851 to 1876, how would you facilitate a discussion to **explain the variance in results**?

Contextualize the mathematical results:

- How would you structure the discussion on the **social justice issue** of shrinking reservation land in addition to the mathematical objectives of this task. What are the implications of the results?
- Regardless of the methods for determining areas, what do the model results mean? What have you learned about the **social and political history** in the US and **current treatment** of indigenous populations?
- Address the purpose and utility of applying mathematics to address societal issues.

(Simulations of Practice, Grossman et al., 2009)

PT Example Response in Designing a Discussion on Mathematical Approaches

*"**Problems like these can be solved using many different paths and approaches. A teacher needs to encourage the students to look at the ways to do it other than how they solved the problem.** I would give the students the option to either answer the questions relating to benefits, drawbacks, and similarities for one approach first and then the other approach, …" (PT1)*

- **Openness to multiple solutions paths**
- **Focus on process, rather than correct/incorrect solutions**
- **Consider listening to student ideas and provide options.**
- **Encourage students to consider alternate solutions paths.**

PT Example Response in Contextualization of Mathematical Results

The purpose of applying mathematics to address societal issues it to draw awareness and create an understanding into the minds of the students. ***It is one thing to go through a history or government class and just be given the facts and percentages,*** *but when giving the problem to the students and them having to go through the work and research for themselves to come up with the same answers given to them elsewhere, students will gain a deeper understanding of the situation. (PT5)*

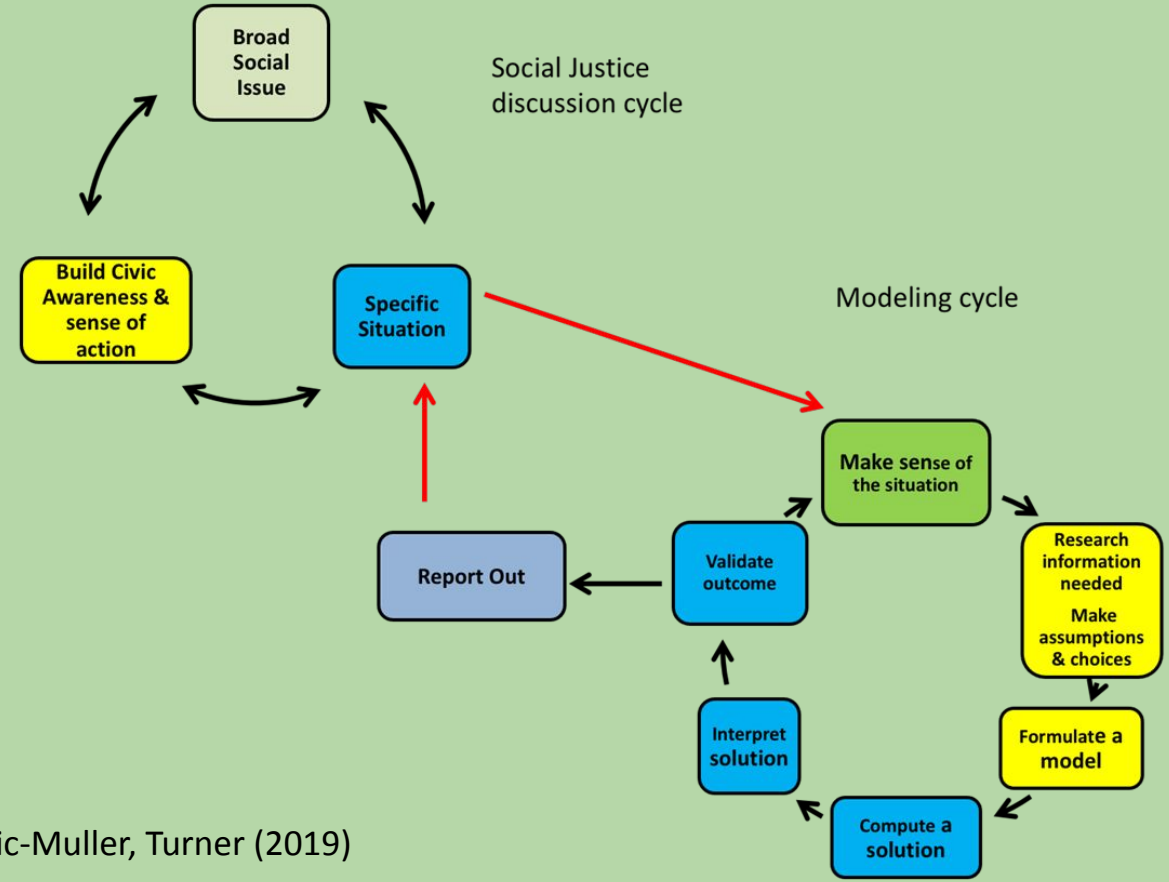
- **Reject the idea of students just being recipient of facts**
- **Value placed on students going through the process of calculating**
- **Allow students to evaluate the meaning of the results, especially in examining critical social issues.**

Implications and Conclusions

• While exploring critical social issues, PTs metacognitively engaged in the modeling process and participated in discussions and reflections.	• Through a SoP, PTs engaged as learners of mathematics, connecting content to a context, and pedagogy in considering student thinking.
• This study informs teacher education programs on the use of SoP and their role in developing mathematical knowledge for teaching.	• Goal: To prepare teachers to be cognitively and critically reflective practitioners and question social injustices through mathematics.

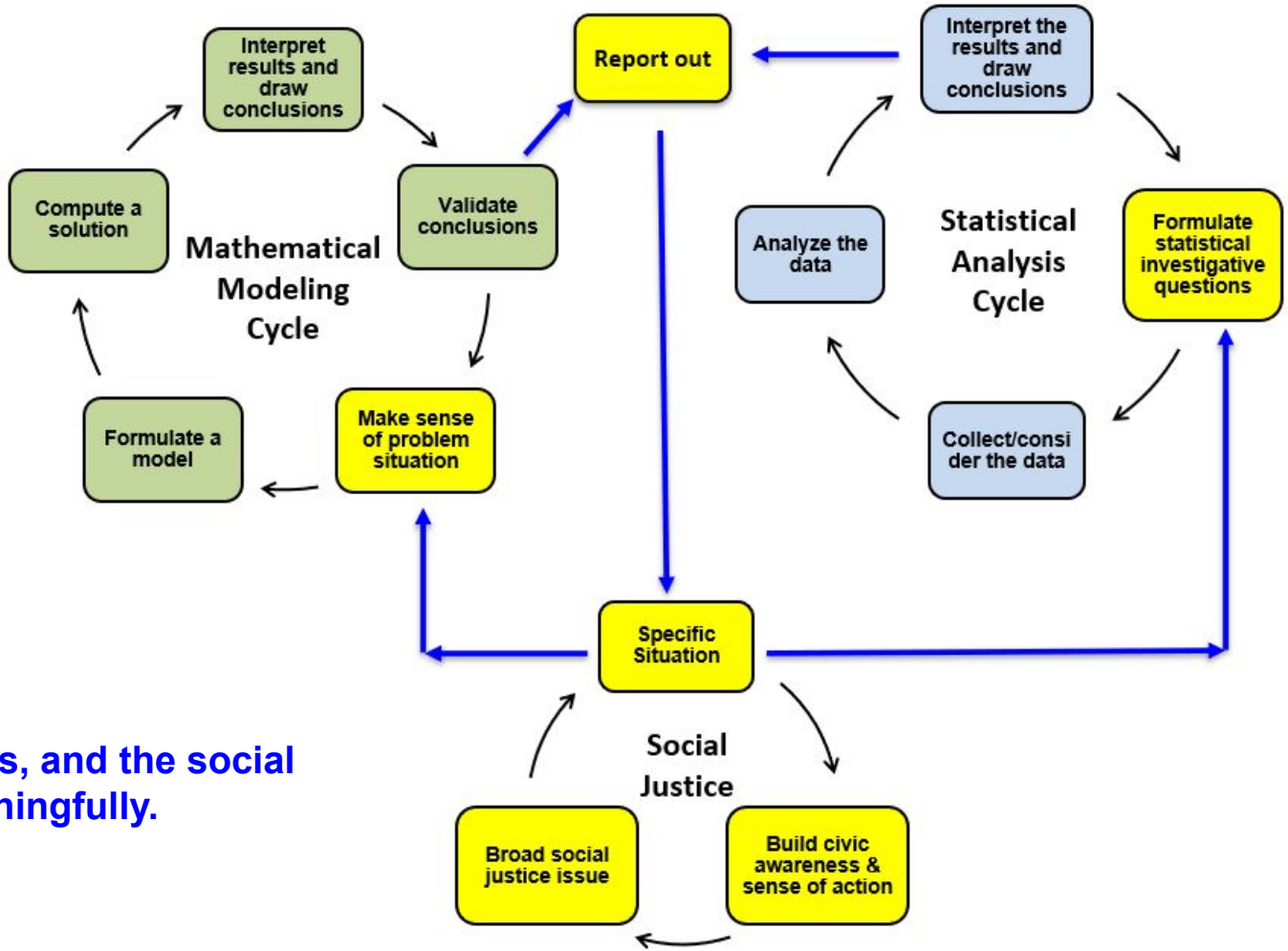
The Interaction of Mathematical Modeling and Critical Social Issues

- Promotes the use of mathematics to analyze critical social issues.
- Both the mathematics and the social issue are treated meaningfully.



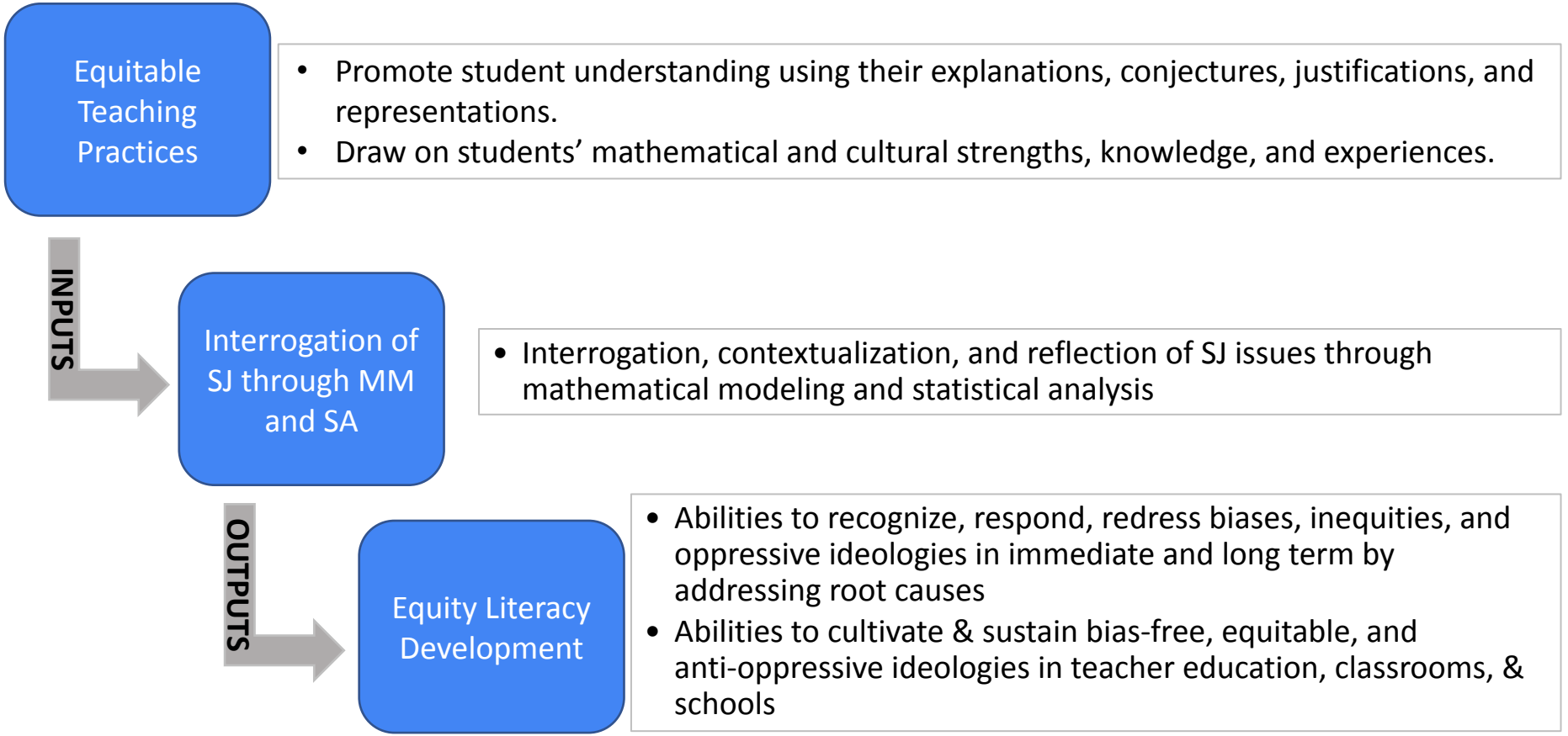
Aguirre, Anhalt, Cortez, Simic-Muller, Turner (2019)

Interaction between Interrogation of Social Justice and Mathematical Modeling or Statistical Analysis



Mathematics, statistics, and the social issue are treated meaningfully.

Equity Literacy Development



Reflection Prompts

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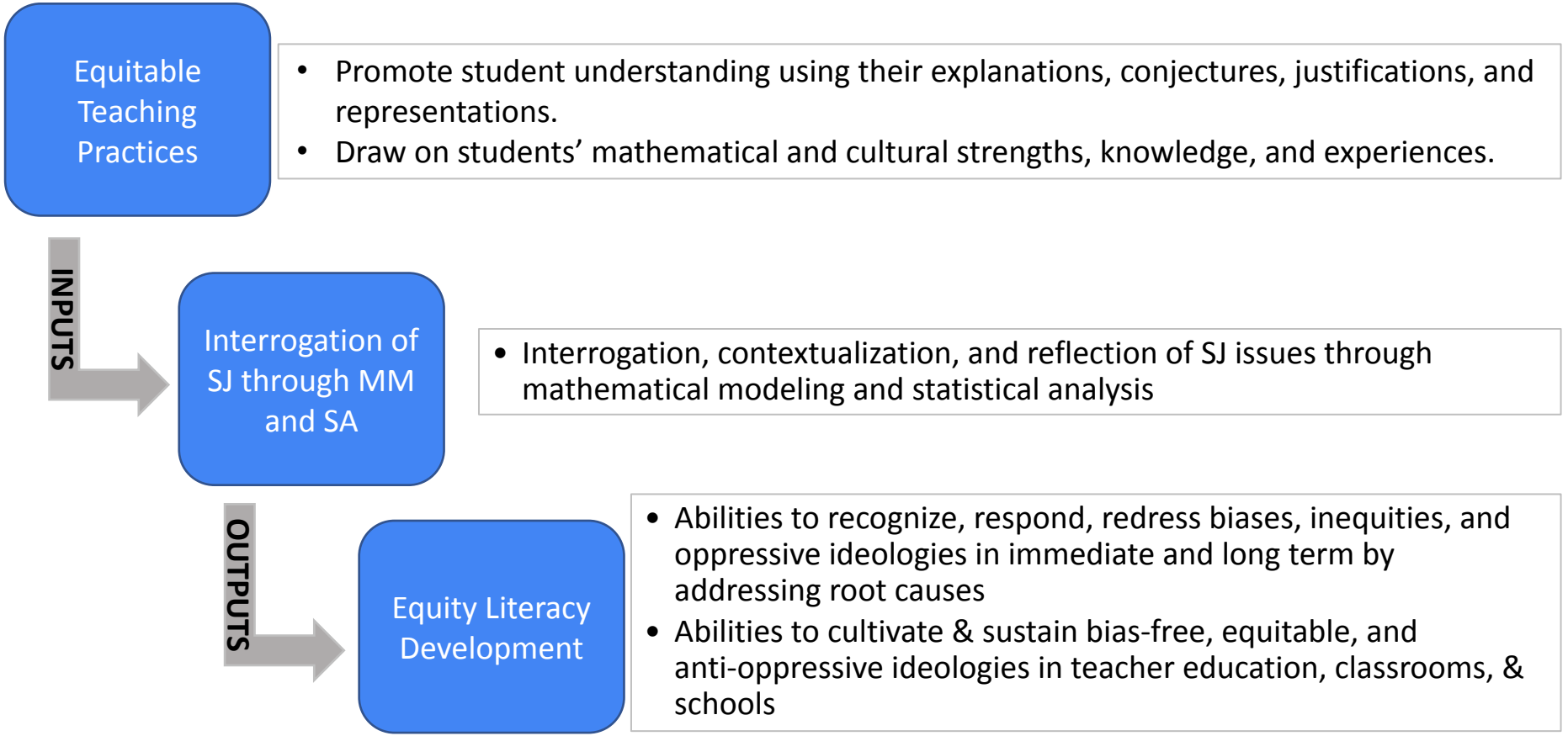
In your settings…

- *What strategies can be used to adopt **equitable teaching practices**?*

- *What strategies can be used to advance the development of **equity literacy** with students?*

Reflection on Equity Literacy Development



Impacts on Instructors' Teaching Practice

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Mathematics Of Doing, Understanding, Learning and Educating for Secondary Schools

Interviewee Context:

- Math course for prospective teachers
- Functions and Modeling (2000 level)
- Used Algebra and Modeling MODULE(S2)

MODULE(S²)

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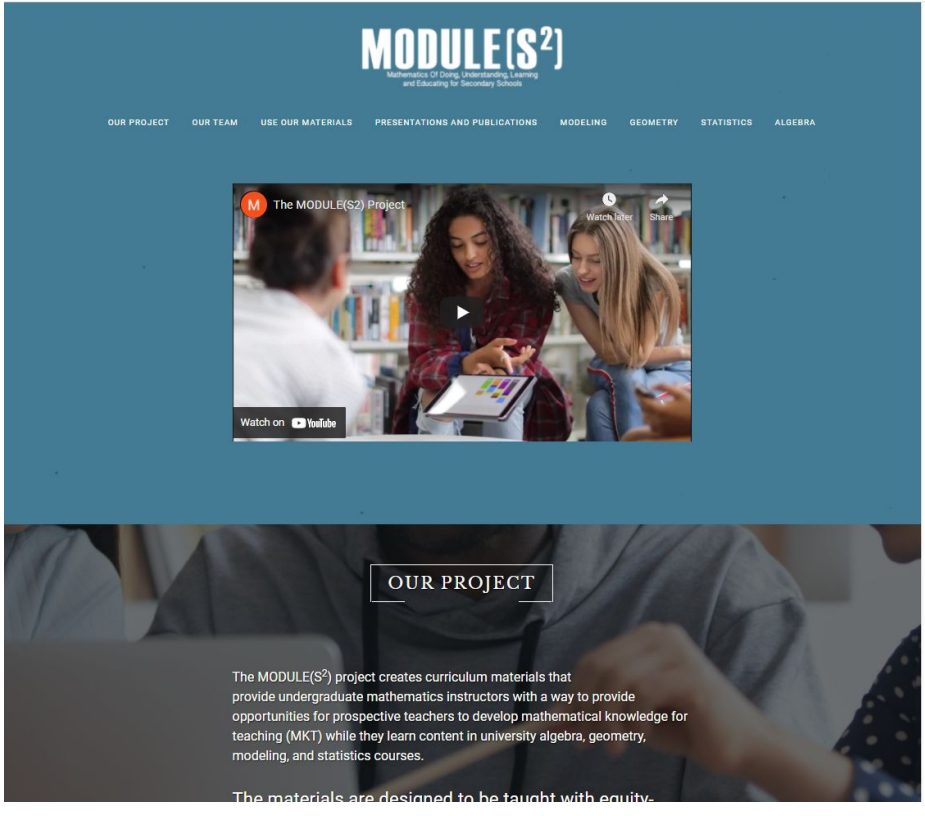

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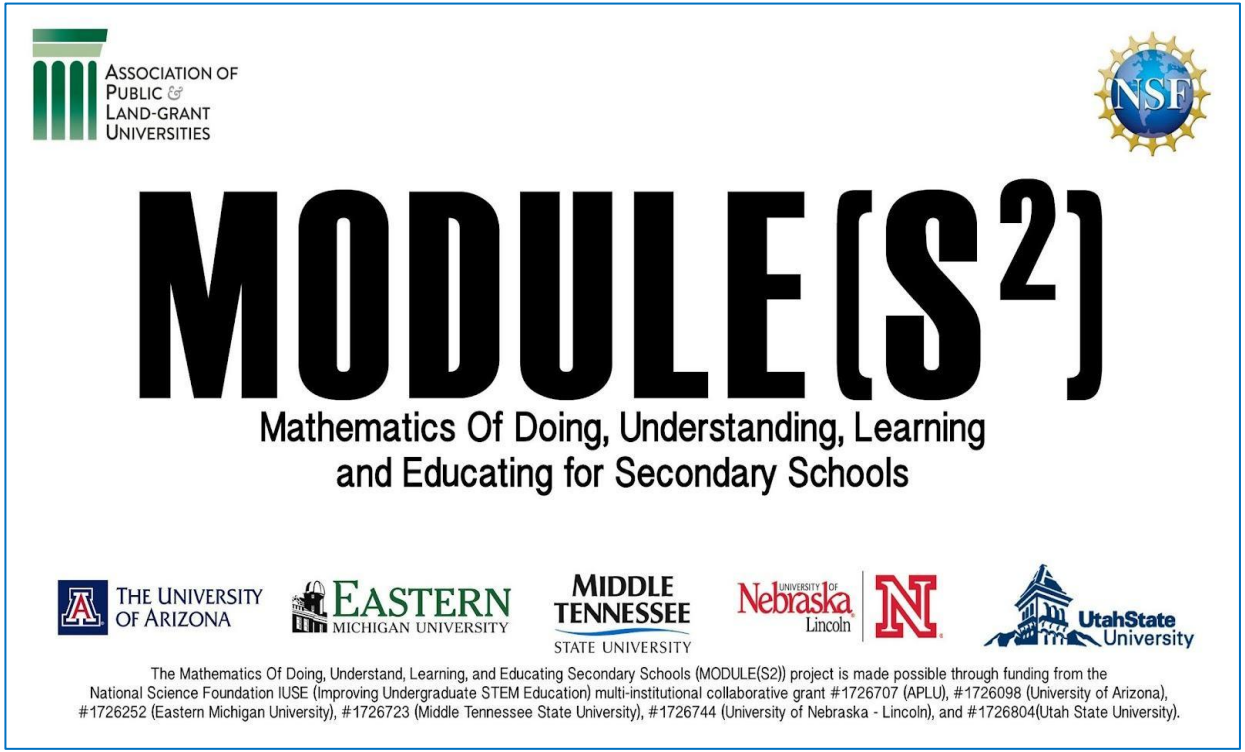
Please, reach out.



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