Developing Pre-Service Teachers’ Equity Literacy in Content Courses

IUSE Summit Workshop June 2022
Cynthia Anhalt, Stephanie Casey, Brynja Kohler, Jeremy Strayer

www.modules2.com
MODULE(S²)
Mathematics Of Doing, Understanding, Learning and Educating for Secondary Schools

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).
• 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”
• **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
<table>
<thead>
<tr>
<th>6</th>
<th>54</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Years</td>
<td>Universities in the U.S. and Canada</td>
</tr>
<tr>
<td>65</td>
<td>938+</td>
</tr>
<tr>
<td>Piloting Faculty</td>
<td>Students/Prospective Teachers</td>
</tr>
</tbody>
</table>
# Equity-based Teaching Practices

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

## Teaching Practices to Actively Cultivate and Sustain a Bias Free Classroom

<table>
<thead>
<tr>
<th>Practice 1</th>
<th>Learning about student understanding using their explanations, justifications, and representations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice 2</td>
<td>Generating questions and discussion that promote students exploring conjectures and justification</td>
</tr>
</tbody>
</table>
Equity Literacy Abilities

- **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

Focus: Cultural Relevance

• 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

• 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?

<table>
<thead>
<tr>
<th>Elements of Culture on the Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnic Appearance</td>
</tr>
<tr>
<td>Clothing</td>
</tr>
<tr>
<td>Music</td>
</tr>
<tr>
<td>Pastimes</td>
</tr>
<tr>
<td>Foods</td>
</tr>
<tr>
<td>Celebrations</td>
</tr>
<tr>
<td>Art</td>
</tr>
<tr>
<td>Language</td>
</tr>
<tr>
<td>Community Events</td>
</tr>
</tbody>
</table>
Focus: Cultural Relevance

- 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?

<table>
<thead>
<tr>
<th>Elements of Culture on the Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnic Appearance</td>
</tr>
<tr>
<td>Clothing</td>
</tr>
<tr>
<td>Music</td>
</tr>
<tr>
<td>Pastimes</td>
</tr>
<tr>
<td>Foods</td>
</tr>
<tr>
<td>Celebrations</td>
</tr>
<tr>
<td>Art</td>
</tr>
<tr>
<td>Language</td>
</tr>
<tr>
<td>Community Events</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elements of Culture Below the Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes toward time</td>
</tr>
<tr>
<td>Attitudes toward parenting</td>
</tr>
<tr>
<td>Moral beliefs</td>
</tr>
<tr>
<td>Expressing joy, sorrow, disagreement</td>
</tr>
<tr>
<td>Displaying leadership</td>
</tr>
<tr>
<td>Gender roles</td>
</tr>
<tr>
<td>Religious beliefs</td>
</tr>
<tr>
<td>Body language</td>
</tr>
<tr>
<td>Interpersonal relationships</td>
</tr>
<tr>
<td>Individualism vs. collectivism</td>
</tr>
<tr>
<td>Interdependence vs. independence</td>
</tr>
<tr>
<td>Collaboration vs. competition</td>
</tr>
</tbody>
</table>
The MODULES Curriculum

- Explicit focus on equitable teaching practices
- Meaningful contexts embedded in social issues
- Mathematics and Statistics with a focus on understanding
MODULE(S2) Tasks

- 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

Actual Funding Process:

Pennsylvania’s Fair Funding Formula: Actual Scenario

- Geographic Factors
- Median Family Income
- Number of Students
- Concentrated Poverty
- Other Factors

6% funding increase

Fair Share Funding Formula

Actual funds allocated to each district

Previous education funding per district

http://bit.ly/PennSchoolFunding
Video of classroom discussion

Video clip 1
Exploratory Data Analysis

What do you notice?
What do you wonder?

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

<table>
<thead>
<tr>
<th>Survey Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CSL1</strong> What is your level of critical statistical literacy? [responses 0 (low) to 5 (high)]</td>
</tr>
<tr>
<td><strong>Question stem</strong>: How well does this statement describe you?</td>
</tr>
<tr>
<td><strong>CSL2</strong> It is important to me to use critical statistical literacy skills when considering claims made regarding sociopolitical issues.</td>
</tr>
<tr>
<td><strong>CSL3</strong> I am likely to apply my critical statistical literacy to sociopolitical issues that I am interested in.</td>
</tr>
<tr>
<td><strong>CSL4</strong> 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.)</td>
</tr>
</tbody>
</table>
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

\[(350+200) \times 300/2 = 82500\]

\[(100+200) \times 250/2 = 37500\]

\[(82500 - 37500)/82500 = 56.67\% \text{ part has reduced}\]
Example PT Modeling Work

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

Computations:

Original Land Area (1851)

Shrunken Area (1876)

Area = Rectangle + trapezoid1 + trapezoid 2 - (ellipse) + triangle 1 + triangle 2

Area = (Rectangle - (right angle + ellipse)) + right angle triangle 2 + ellipse 2
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. (b) 1876 map with curve approximations. View with graph at https://www.desmos. View this graph at https://www.desmos.com/calculator/8l1rfoc0uu

calculator/bprhwv0qr
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)
“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 is 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

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

- Abilities to recognize, respond, redress biases, inequities, and oppressive ideologies in immediate and long term by addressing root causes
- Abilities to cultivate & sustain bias-free, equitable, and anti-oppressive ideologies in teacher education, classrooms, & schools

Interrogation of SJ through MM and SA

- Interrogation, contextualization, and reflection of SJ issues through mathematical modeling and statistical analysis

Equity Literacy Development

- Promote student understanding using their explanations, conjectures, justifications, and representations.
- Draw on students’ mathematical and cultural strengths, knowledge, and experiences.
Reflection Prompts

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

Equitable Teaching Practices

- Abilities to recognize, respond, redress biases, inequities, and oppressive ideologies in immediate and long term by addressing root causes
- Abilities to cultivate & sustain bias-free, equitable, and anti-oppressive ideologies in teacher education, classrooms, & schools

Interrogation of SJ through MM and SA

- Interrogation, contextualization, and reflection of SJ issues through mathematical modeling and statistical analysis

Equity Literacy Development

- Promote student understanding using their explanations, conjectures, justifications, and representations.
- Draw on students’ mathematical and cultural strengths, knowledge, and experiences.
Impacts on Instructors’ Teaching Practice

Interviewee Context:

- Math course for prospective teachers
- Functions and Modeling (2000 level)
- Used Algebra and Modeling MODULE(S2)
Find more information and request to be connected with our materials at:

www.modules2.com
We would love to continue this conversation with you!

Please, reach out.

Cynthia O. Anhalt
canhalt@math.arizona.edu

Stephanie Casey
scasey1@emich.edu

Brynja Kohler
brynja.kohler@usu.edu

Jeremy Strayer
jeremy.strayer@mtsu.edu