MODULE(S^2)

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

www.Modules2.com

Teacher Education Curriculum Materials that Develop Statistical Knowledge for Teaching

Stephanie Casey & Andrew Ross, Eastern Michigan University

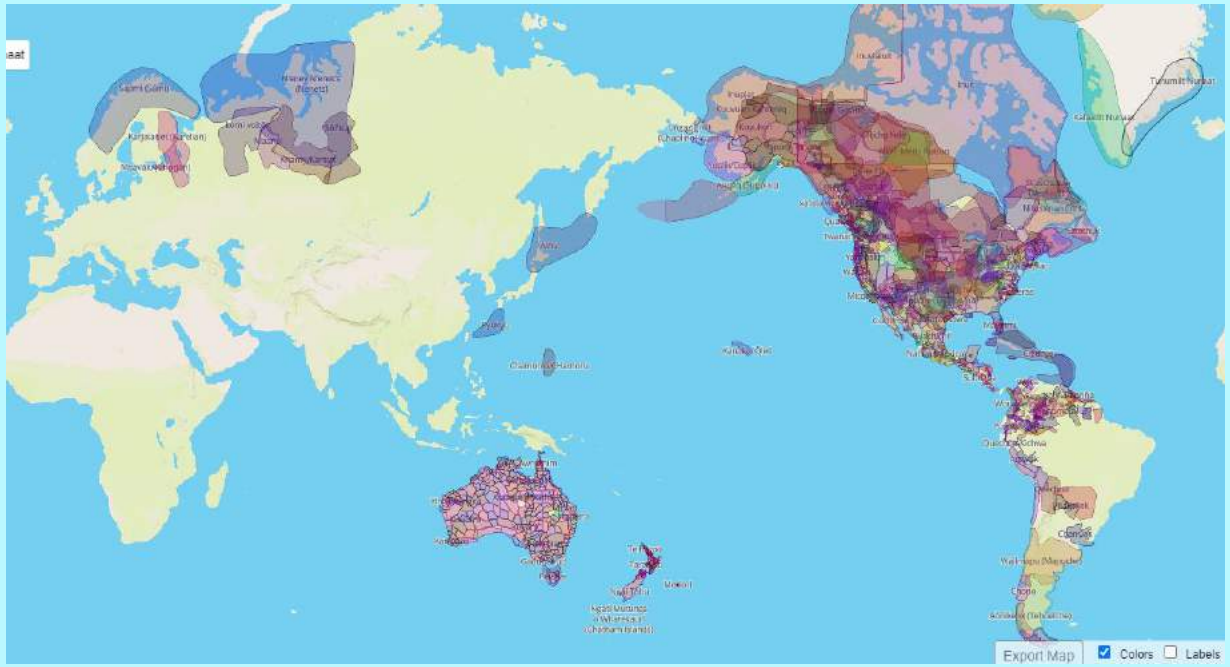
CAUSEweb Webinar 2021-02-09 2:00pm EST

APLU MTE-Partnership Mathematics Teacher Education Partnership

NSF

Land Acknowledgement

The campus of Eastern Michigan University is located on the traditional territory (ceded in the 1807 Treaty of Detroit) of the Anishinaabeg, which refers collectively to the Ojibwe, Odawa, and Potawatomi (also known as the People of the Three Fires), and was also home to the Wendat/Wyandot people. This acknowledgement is included here to honor the elders and stewards of these heritages.



https://native-land.ca/

Outline

- Background
- Sample Activity from Statistics MODULE(S^2): School Funding in Pennsylvania
- Influences and Alignment
- Examples of how we develop Statistical Knowledge for Teaching
- Call for Piloters

MODULE(S^2)

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).

MODULE(S^2)

University Mathematics Curriculum Materials with an MKT focus

- Geometry
- Algebra
- Statistics
- Modeling

Statistics Writing Team

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

To facilitate connecting content with the practice of teaching, writing teams consist of…

STATISTICIAN: *Dr. Andrew Ross*, math/statistics/data science professor at Eastern Michigan University, background in operations research

MATHEMATICS TEACHER EDUCATOR: *Dr. Stephanie Casey,* mathematics teacher educator at Eastern Michigan University, former AP Statistics teacher, researcher in statistics education

GRADES 6-12 MATHEMATICS TEACHER: *Samantha Maddox*, math teacher at Jefferson High School in Georgia, former AP Statistics teacher

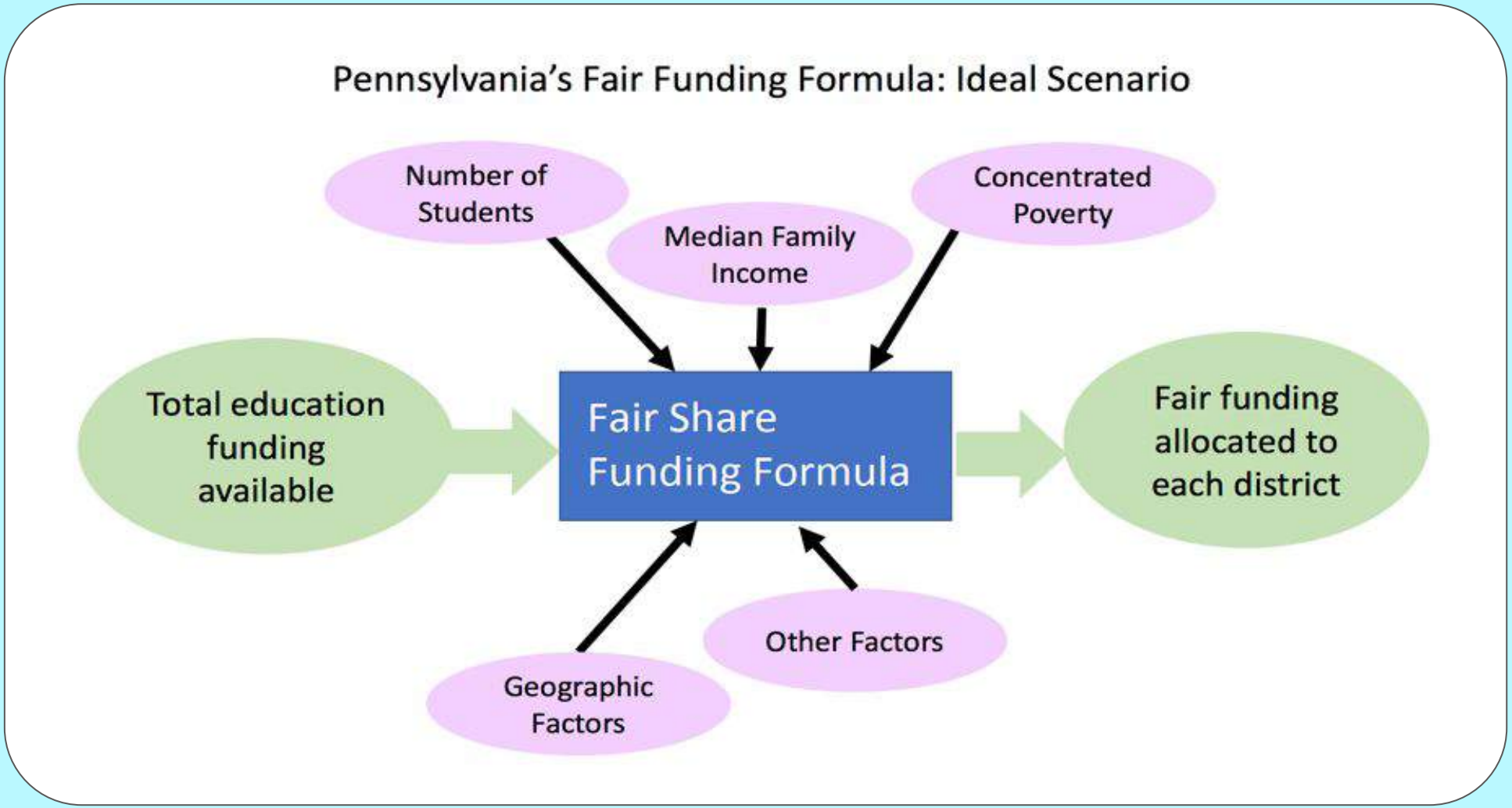
OTHER CONTRIBUTORS

Melody Wilson: graduate research assistant, former high school mathematics teacher

Statistics MODULE(S^2)

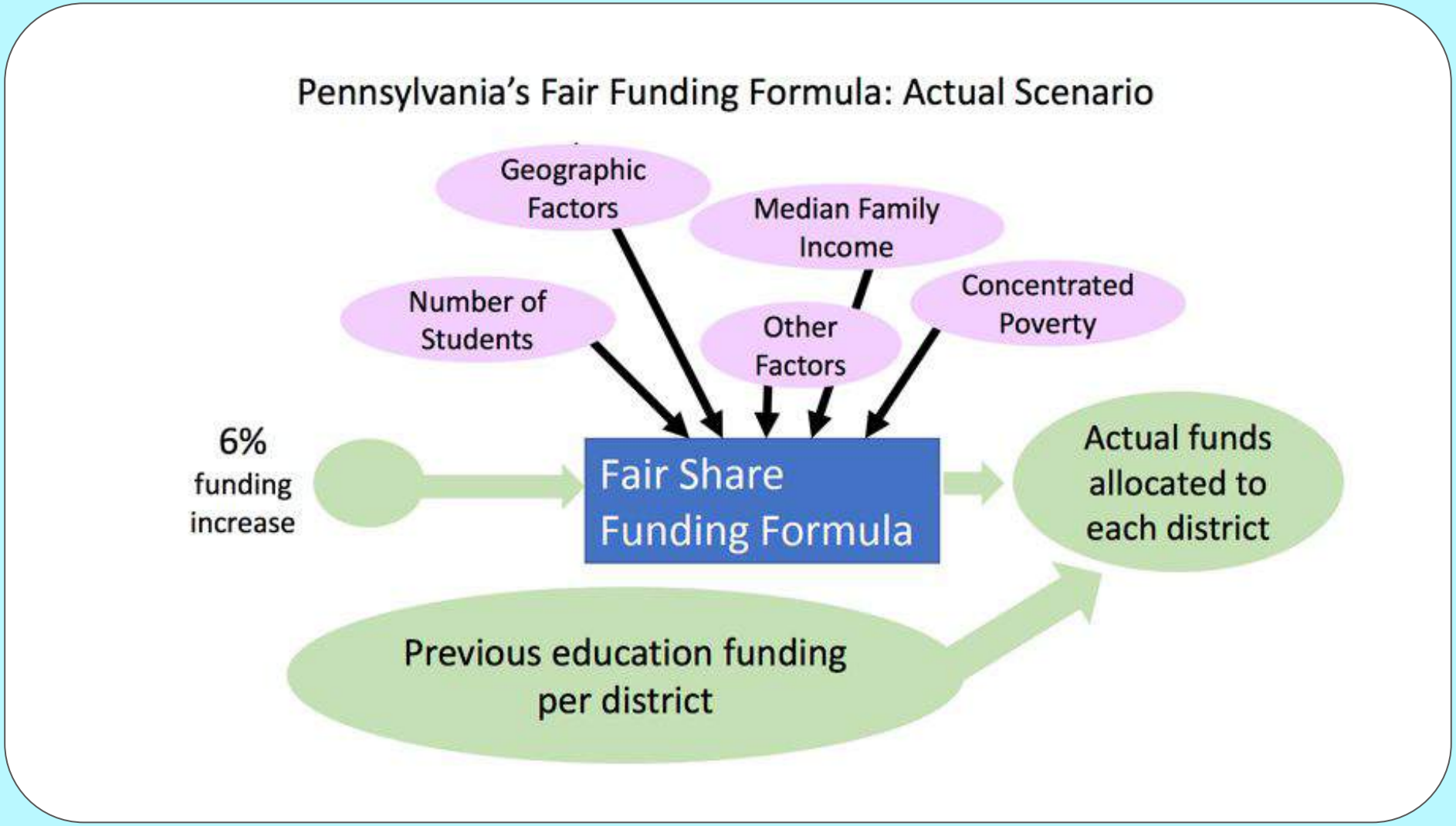
- **Statistics & Data literacy in K-12 education**: Higher need and expectations
- **Preservice Teachers**: Feel least prepared to teach statistics and demonstrate weak content understanding (Lovett & Lee, 2017; 2018)
- **Teacher Education**: Greater emphasis on learning based on practices of teaching & equity literacy (AMTE *SPTM*, 2017); very limited resources for statistics teacher education

Let's Try An Activity From Our Materials



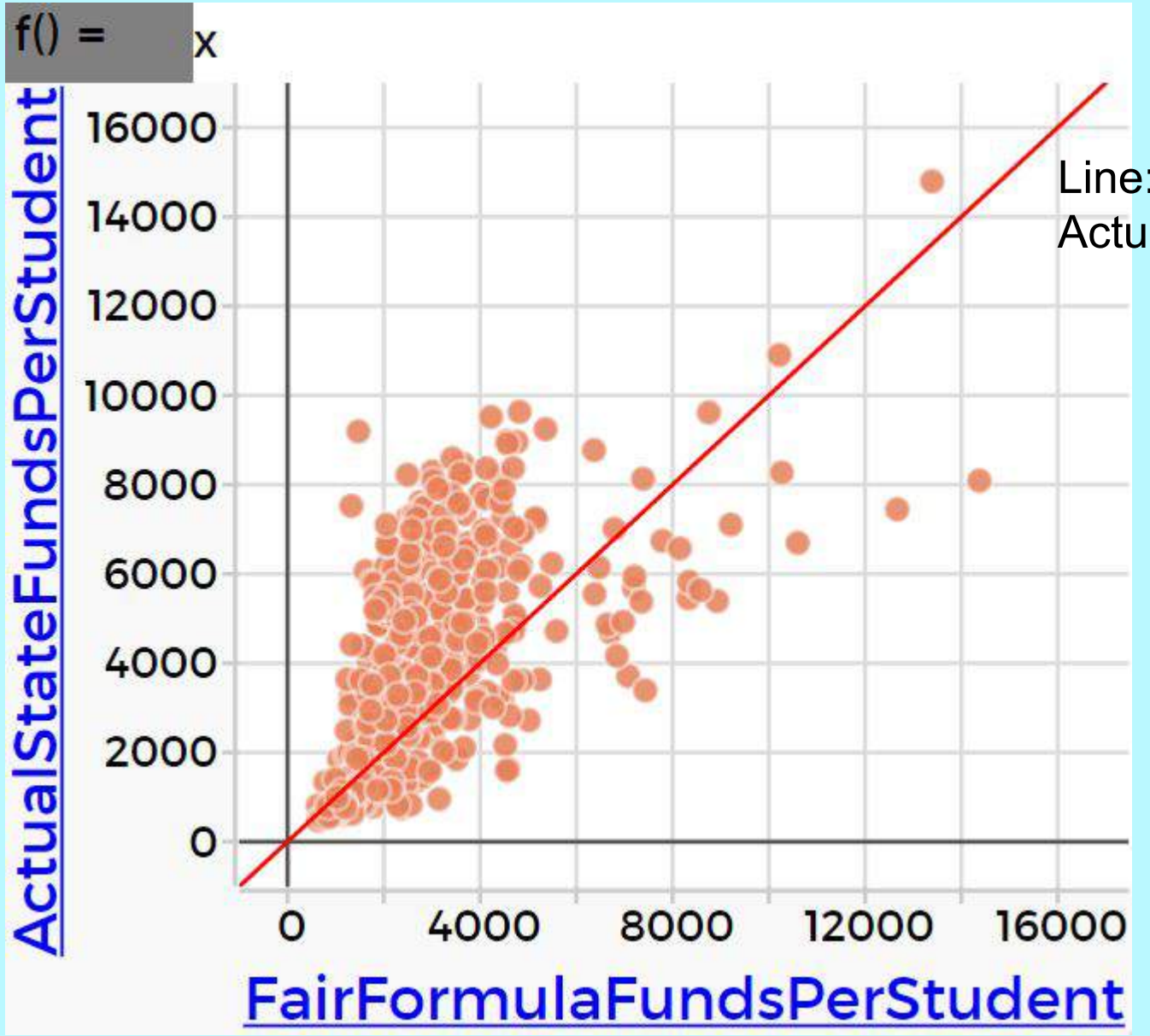
Mosenkis, David. (2016) Systemic Racial Bias in Latest Pennsylvania School Funding. https://powerinterfaith.org/wp-content/uploads/2016/08/PA-Racial-School-Funding-Bias-July-2016-1-1.pdf

Actual Funding Process:



http://bit.ly/codappadistricts00

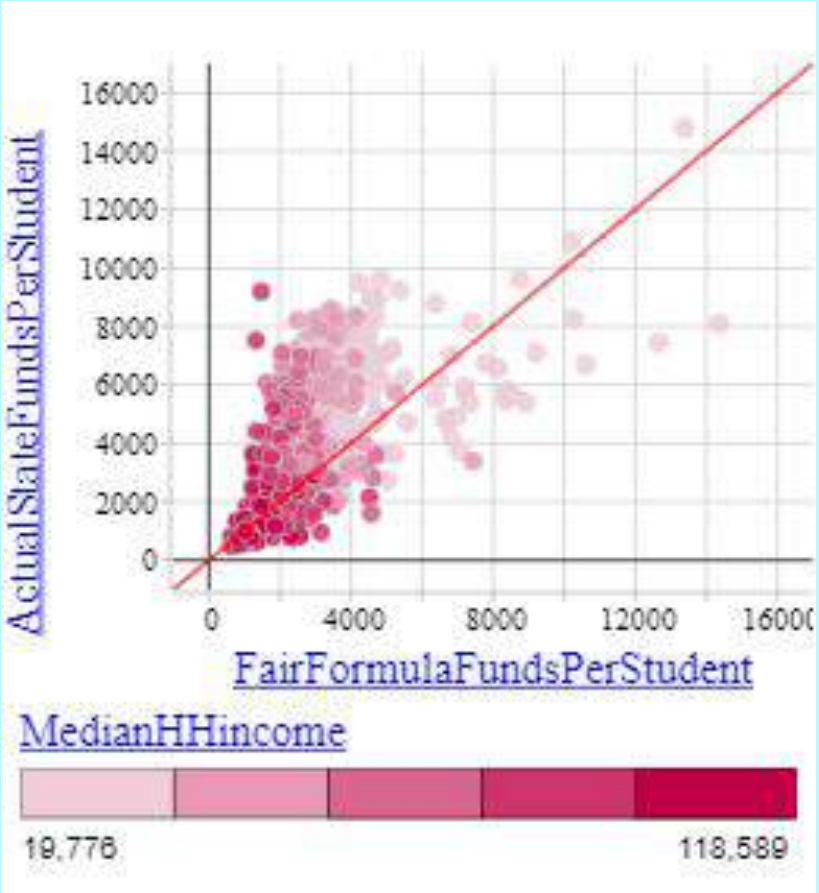
Exploratory Data Analysis

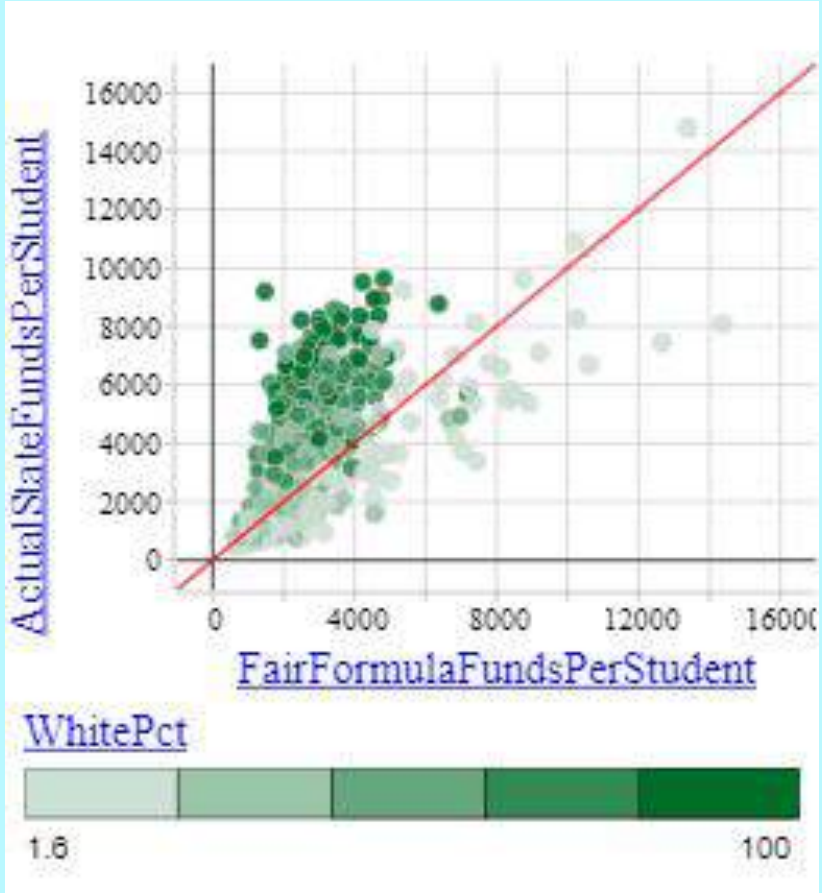


Line: f(x) = x, or
Actual Funding = Fair Formula Funding

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

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





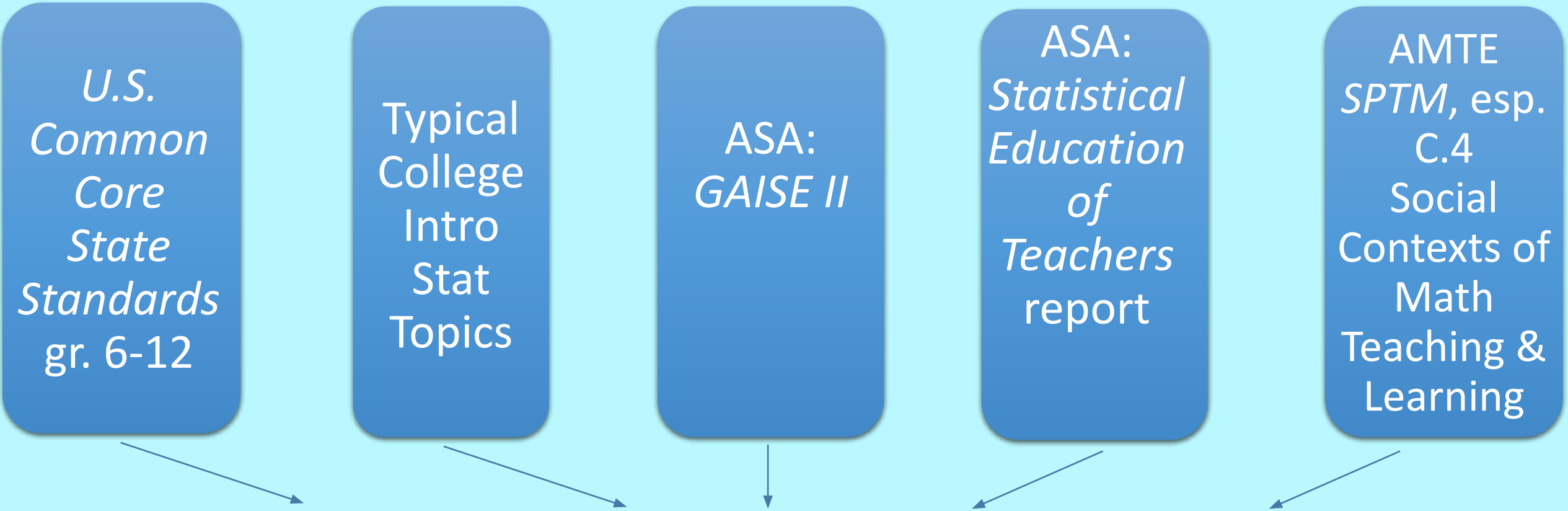
MedianHHincome: Median Household Income

WhitePct: Percentage of White students in the district

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

What other topics can you think of that students might be interested in where statistics might reveal a large-scale systemic inequity with a reasonably clear way to address the problem?

Influences for Statistics MODULE(S^2)



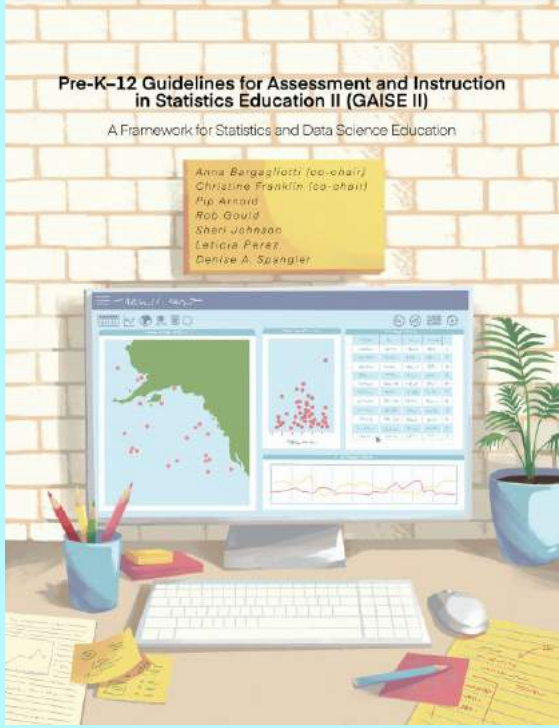
MODULE(S^2): Statistical Knowledge for Teaching (gr. 6-12)

Module 1: Study Design and Exploratory Data Analysis

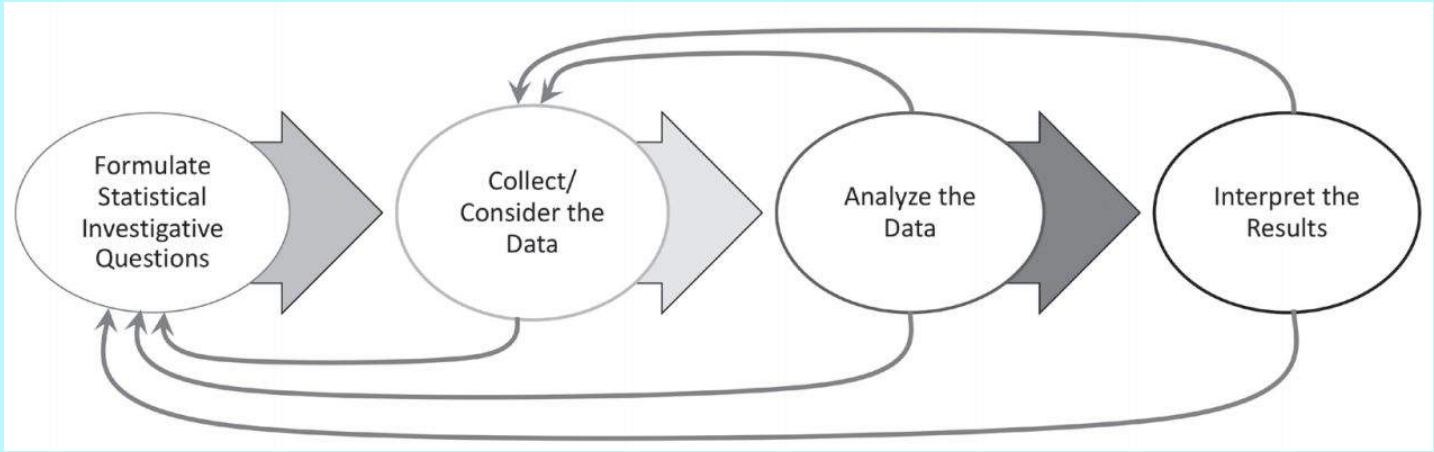
Module 2: Statistical Inference (Confidence Intervals, Hypothesis Tests)

Module 3: Statistical Association (incl. Regression, 2-Way Tables)

Alignment with *GAISE II (2020)*



- Large, Multivariate, Real data sets
- Develop the necessary statistical reasoning skills along with the content knowledge... Statistical topics should be developed through meaningful experiences with the **statistical problem-solving process**.



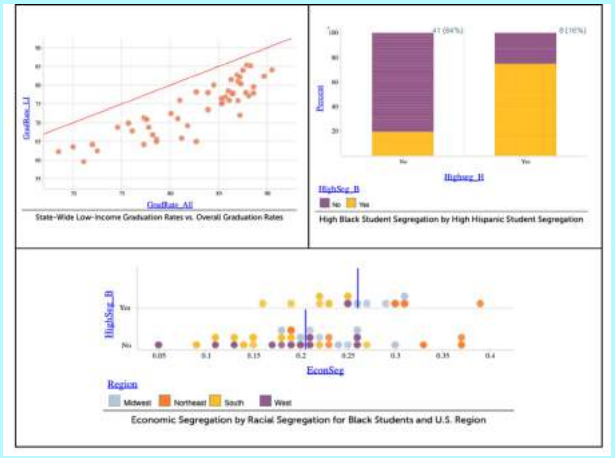
Emphasizing the Statistical Problem-Solving Process

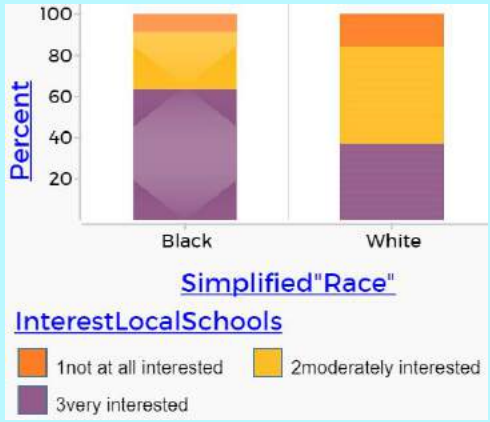
Question 8) What other questions do you have about low-income graduation rates compared to overall graduation rates that cannot be answered using these 1-variable graphs?

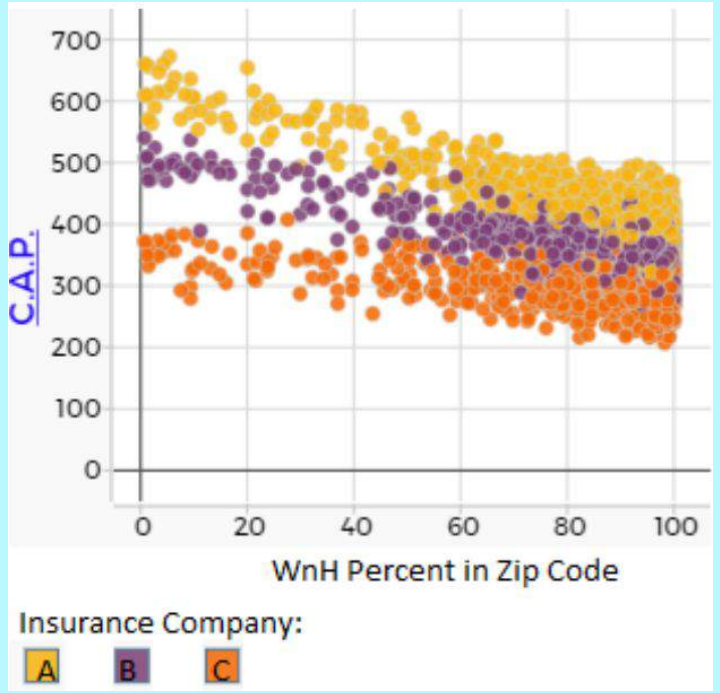
Question 9) Create a 2-variable graph to further investigate the relationship between low-income and overall graduation rates.

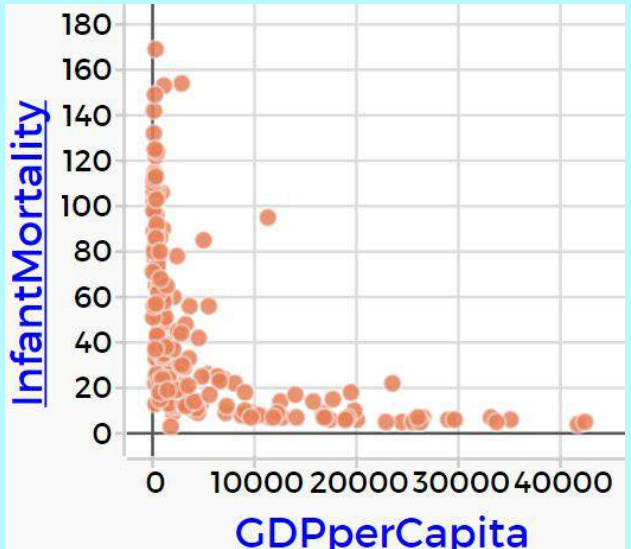
a. Interpret this graph in context.

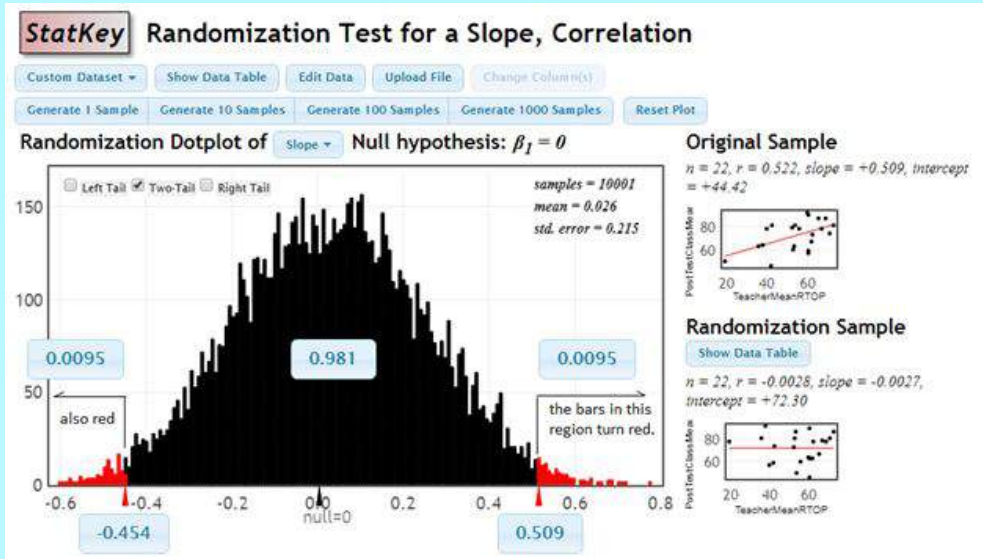
GAISE II: “Technology should be embraced to the greatest extent possible”











codap.concord.org

lock5stat.com/StatKey

Alignment with ASA's "*The Statistical Education of Teachers*" (*SET*) Report

SET Report calls for HS teachers to take 3 stats courses:

- An introductory course that emphasizes a modern data-analytic approach to statistical thinking, a simulation-based introduction to inference using appropriate technologies, and an introduction to formal inference (confidence intervals and tests of significance)
- A second course in statistical methods that builds on the first course and includes both randomization and classical procedures for comparing two parameters based on both independent and dependent samples (small and large), the basic principles of the design and analysis of sample surveys and experiments, inference in the simple linear regression model, and tests of independence/homogeneity for categorical data
- A statistical modeling course based on multiple regression techniques, including both categorical and numerical explanatory variables, exponential and power models (through data transformations), models for analyzing designed experiments [ANOVA], and logistic regression models

Alignment with ASA's "*The Statistical Education of Teachers*" (*SET*) Report

SET calls for HS teachers to take 3 stats courses; Our materials include the underlined topics:

- An introductory course that emphasizes a modern data-analytic approach to statistical thinking, a simulation-based introduction to inference using appropriate technologies, and an introduction to formal inference (confidence intervals and tests of significance)
- A second course in statistical methods that builds on the first course and includes both randomization and classical procedures for comparing two parameters based on both independent and dependent samples (small and large), the basic principles of the design and analysis of sample surveys and experiments, inference in the simple linear regression model, and tests of independence/homogeneity for categorical data
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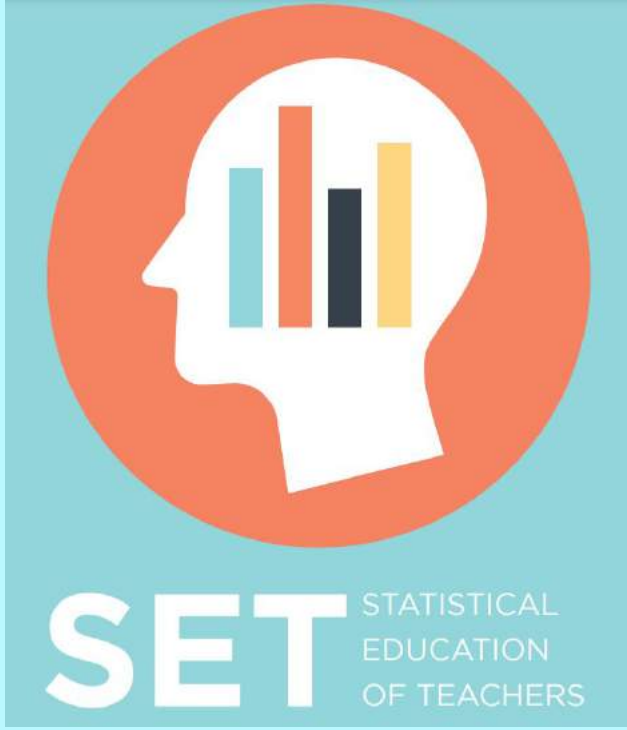
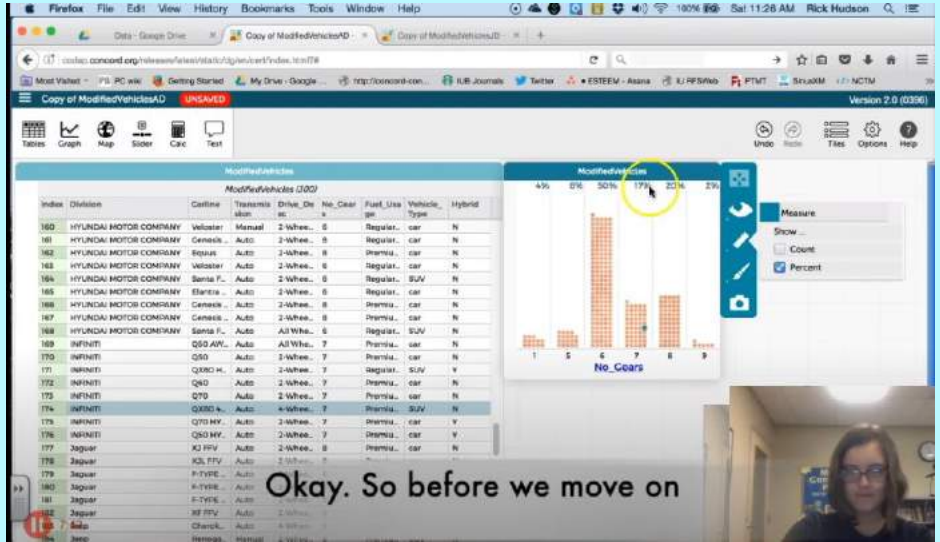
SET Report: Attention to Development of Pedagogical Content Knowledge

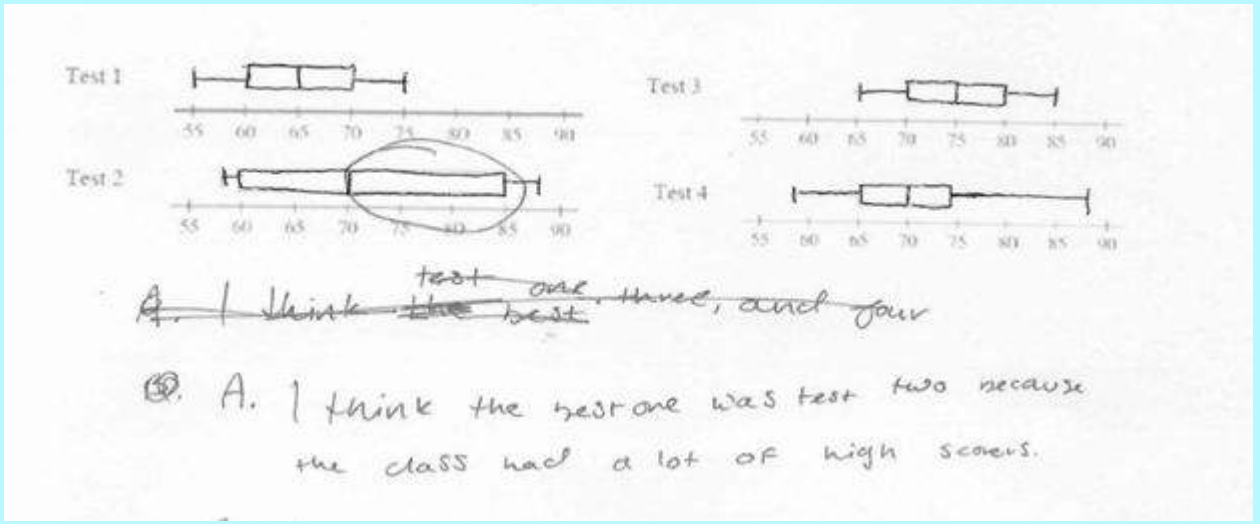
- MS: Develop an understanding of how statistical concepts in middle grades build on the content developed in elementary grades, provide a foundation for the content in high school ...
- HS: Develop an understanding of how statistical concepts develop throughout PreK–8 and how they connect to high-school statistics content...
- All: Develop pedagogical content knowledge necessary for effective teaching of statistics. Pre-service and practicing teachers should be familiar with common student conceptions, content-specific teaching strategies...



Developing Pedagogical Content Knowledge for Teaching Statistics

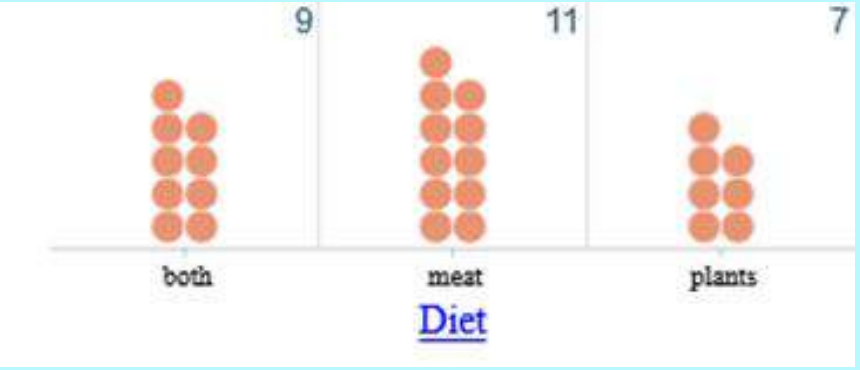
Analyzing artifacts or approximations of the practice of teaching secondary statistics





Developing Pedagogical Content Knowledge for Teaching Statistics

Knowledge of Content and Students



Case Value	Attend to one particular case, often the student's own, the largest, or the smallest	My favorite mammal is the lion. [Student clicks on lion in data table and point is highlighted in CODAP graph]. Lions eat only meat.
Classifier	Attend to the frequency of cases with a chosen attribute value	Seven of the mammals eat just plants.
Aggregate	View the data as an entity with properties that individual cases can't have, such as center, shape, or linear model	Less than half of the mammals eat both meat and plants.

Analyzing Real Students' Thinking

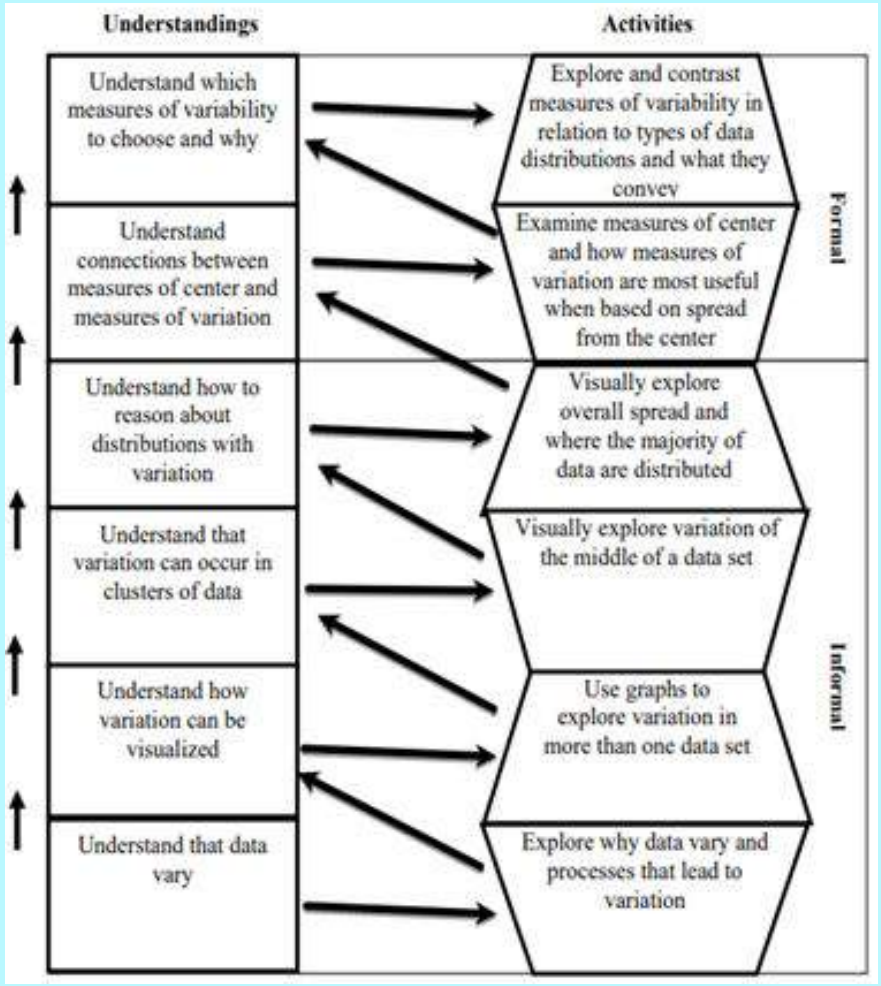
- Association Lesson 1 Video 8: Ball Bounce Heights and spaghetti lines
- Summarize and analyze students' approaches to placing the line:

Student name	Maggie	Ashara	Dee
Approach for placing the line			
Potential reasons/sources for approach			
Is the approach generalizable? If not, draw at least one counter example.			

- "Pick one of the students and describe in detail your response to the student as his/her teacher. Be specific when describing this and future responses to students, writing exactly what you would say and/or draw in your response."

Developing Pedagogical Content Knowledge for Teaching Statistics

Knowledge of Content and Teaching



Developing Pedagogical Content Knowledge for Teaching Statistics

Knowledge of Content and Curriculum

"What pre-requisite knowledge is needed for students to be able to engage this topic [Curriculum standard shown]? In what ways does this topic require integrating different ideas?"

Developing Pedagogical Content Knowledge for Teaching Statistics

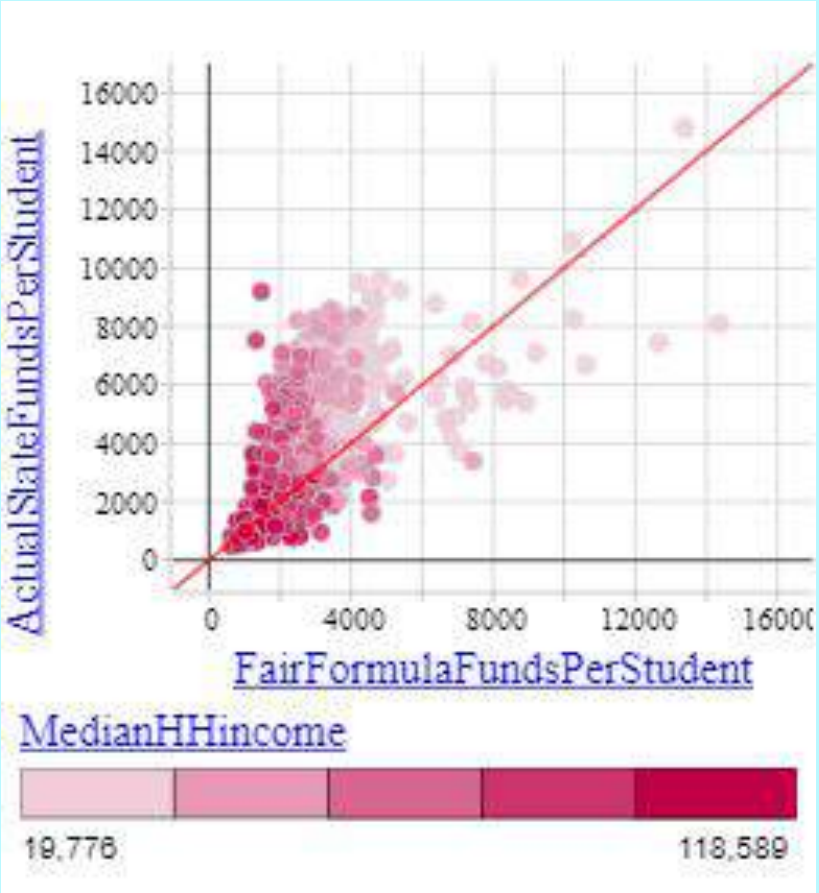
- Simulating the work of teaching
  - Professional noticing of students' thinking (interpreting and responding to student thinking)
  - Designing tasks
  - Orchestrating productive discussions
- Video Simulation of Practice example:
  - … simple random sample of 50 students from the school collected data on how much sleep they got last night… 95% confidence interval for the mean is (6.39, 6.91)
  - Julio says, "It means, like, 95% of the kids at our school get between 6.39 and 6.91 hours of sleep a night."
  - Record a video of yourself where you include:
    1) Your interpretation of Julio's response, incl. what is worthwhile/reasonable in his thinking.
    2) Your response to Julio (exactly what you would say/write) as part of this class discussion….
  - Luciana says ""But we only asked like 50 kids and we have a really big school. So I think we need to ask more kids because that will get us a bigger confidence interval."
  - Record a video of yourself … (same prompts as above)

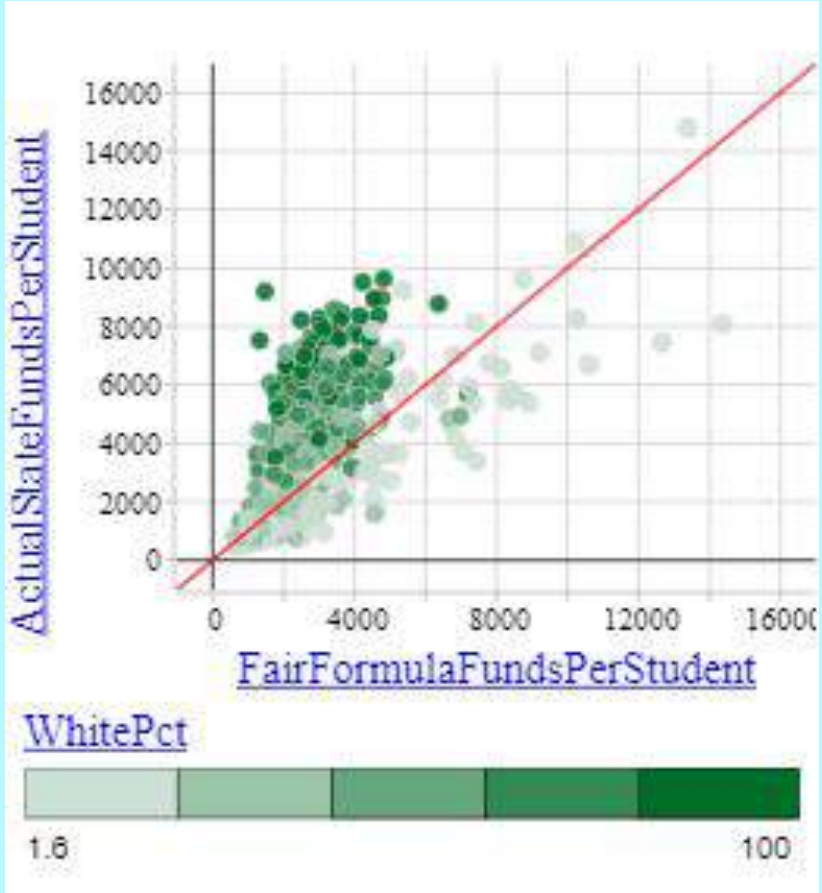
AMTE *SPTM* C.4 Standard:
Social Contexts of Mathematics Teaching & Learning

Well-prepared beginning teachers of mathematics realize that the social, historical, and institutional contexts of mathematics affect teaching and learning and know about and are committed to their critical roles as advocates for each and every student.

- C.4.1. Provide Access and Advancement
- C.4.2. Cultivate Positive Mathematical Identities
- C.4.3. Draw on Students' Mathematical Strengths
- C.4.4. Understand Power and Privilege in the History of Mathematics Education
- C.4.5. Enact Ethical Practice for Advocacy

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





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Qualitative Analysis of End-Of-Course Survey

What was most helpful about this course for learning ways to include equity and social justice topics in teaching?

We looked at race and poverty and how those play into our school system and 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 and how we can address these things as teachers so all of our students are getting a fair and equal education.

Including topics about equity and social justice can engage and encourage students to look into the topics that interest them and that they do have something to contribute to these ideas.

Interested in more information?

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- Project website: www.Modules2.com

  Materials broadly available Spring/Summer 2022

- Interested in piloting the materials: 'Use Our Materials' section of website (www.Modules2.com)

  $4000 stipend +Professional Development

  Summer 2021 professional development+teach with materials during 2021-22 academic year

  Tell friends in your department and others!

- Contact us: scasey1@emich.edu andrew.ross@emich.edu