ESTEEM ENHANCING STATISTICS TEACHER EDUCATION WITH E-MODULES

ESTEEM Webinar for Mathematics Teacher Educators

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The Concord Consortium
NSF

Webinar Goals

- Experience key aspects of the Foundation Module, the Association Module and the Inferential Reasoning Module.
- Understand how CODAP can be used to guide statistical investigations.
- Discuss pedagogy for preparing teachers to teach statistics.
- Understand how to access materials for use in your LMS.
- Get to know one another!

INTRODUCTIONS

To access the ESTEEM modules ...

Open the following link:

https://place.fi.ncsu.edu/course/view.php?id=80

- In the ESTEEM Place, we *show you* what modules look like.
- To *use* modules in your courses, you have to download the appropriate file for your LMS and import into your course.
- Then you control the materials!

Goals of ESTEEM

1. Create **online** resources for statistics preservice teacher education
    - Develop CODAP as an online tool to support high school statistics
    - Classroom videos of statistics teaching and learning
    - Rich multivariate data tasks
    - Video interviews with experts in statistics education

2. Design modules and approaches for using these online resources

3. Implement resources and modules in undergraduate mathematics teacher education programs.

Four Year Project

Year 1: Design resources, expand CODAP, capture video, publish materials in PTMT portal (http://go.ncsu.edu/ptmt)

Year 2**:** Develop and test Foundational module, Faculty workshops

Year 3: Finalize and disseminate Association and Inference modules. Field testing and faculty workshops continue.

Year 4: Revisions, faculty webinars, and research

Year 5: NCE--Research and expand our reach!

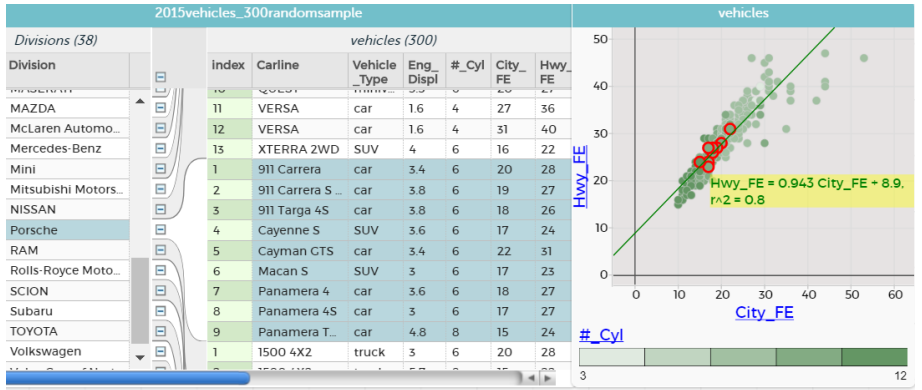
Yr 1: Update PTMT Materials

Data Analysis and Probability

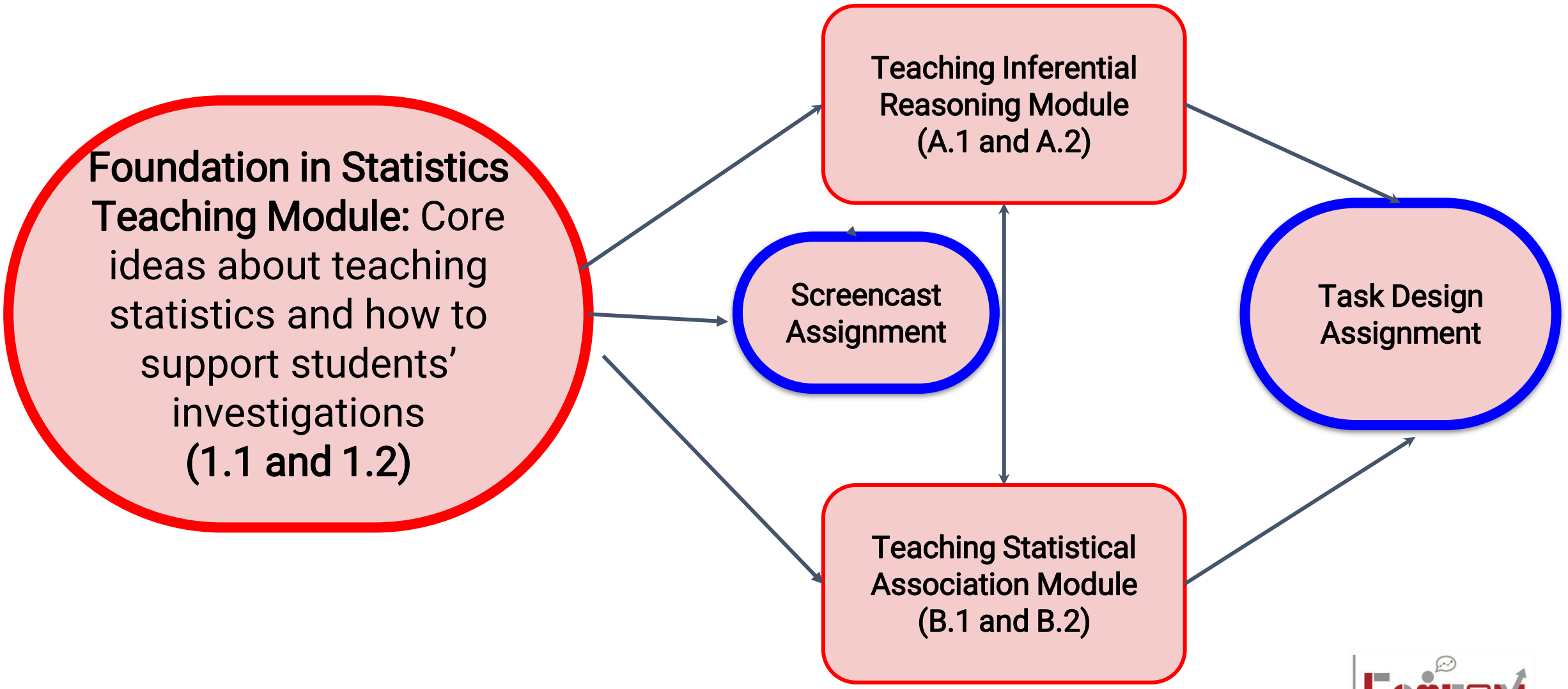
There are 6 chapters in this set of materials that utilize tools such as TinkerPlots, Fathom, Excel, and graphing calculators to engage in statistics investigations using multivariate data. Topics addressed include distributions, variability, bivariate relationships, probability, and simulations.

Statistics Investigations

There are 4 chapters in this set of materials that use large multivariate data and a new free online tool, CODAP, to engage in similar investigations that are in Chapters 1-4 in the Data Analysis and Probability materials. These new materials are developed as part of the ESTEEM project, aiming to enhance statistics teacher education through developing e-materials.



ESTEEM Modular Approach



Structure of an E-Module

Each Module has 2 Parts. Each part about 5-8 hours of materials

Each Part has 3 Sections:

Read & Watch

- Essential Materials: Readings, videos and quizzes or interactives
- Learn from Practice: videos with teachers and students!

Engage with Data

- Active statistics investigation using CODAP or other tools
- Focus on pedagogical aspects of investigations

Synthesize & Apply

- Activities, reflections, discussions that help teachers connect ideas and apply to practice of teaching

Annotated Table of Contents

- Planning and Overview Document
- Brief Goals for each module and Part of a module
- For each Module
  - Lists Type of Activity and brief descriptions
  - Estimates of time

https://fi-esteem.s3.amazonaws.com/lmsbackups/annotated_table_of_contents.pdf

Roller Coaster Investigations using CODAP

1.1.g: Investigating Older Roller Coasters in the US

1.2.g: Investigating More Roller Coasters

Launching a Statistical Investigation

1.1.g: Investigating Older Roller Coasters in the US

Watch a video of how a teacher launches this investigation with students using a video of the Jack Rabbit roller coaster in Kennywood Park (Pittsburgh, PA), one of the coasters in the sample of data. Listen carefully to how the teacher makes purposeful attempts to ensure students have a strong foundation about the context of roller coasters that can help spark curiosity about variability among coasters.

Investigating Older Roller Coasters

- What aspects of roller coasters might make them thrilling?
- What aspects of roller coasters might make them scary?

CODAP

https://codap.concord.org

Common

Online

Data

Analysis

Platform

CODAP works best in Google Chrome

Your turn to try CODAP!

Work in breakout rooms, with a mix of beginner and advanced CODAP users

1.1.g: Investigating Older Roller Coasters in the US

1.2.g: Investigating More Roller Coasters

Start where it says ***Your Assignment***

- Open CODAP
- Open Word or PDF with assignment directions

Design of these investigations

- 1.1.g: Case card view → `extreme attributes → modalclump`
- Univariate → `bivariate`-->multivariate
- Continual connection to context (e.g., map, questions stated in context)

Debrief

- Things to consider when using CODAP for the first time with PSTs

  *drag and drop

  *hover

  *types of variables and graphs impacts menus

- It's okay to learn CODAP alongside them!
- Use of 'large', multivariate data sets
- Anticipated difficulties PSTs will have and suggestions for addressing

  *open-ended investigation may be uncomfortable; need experience posing a question

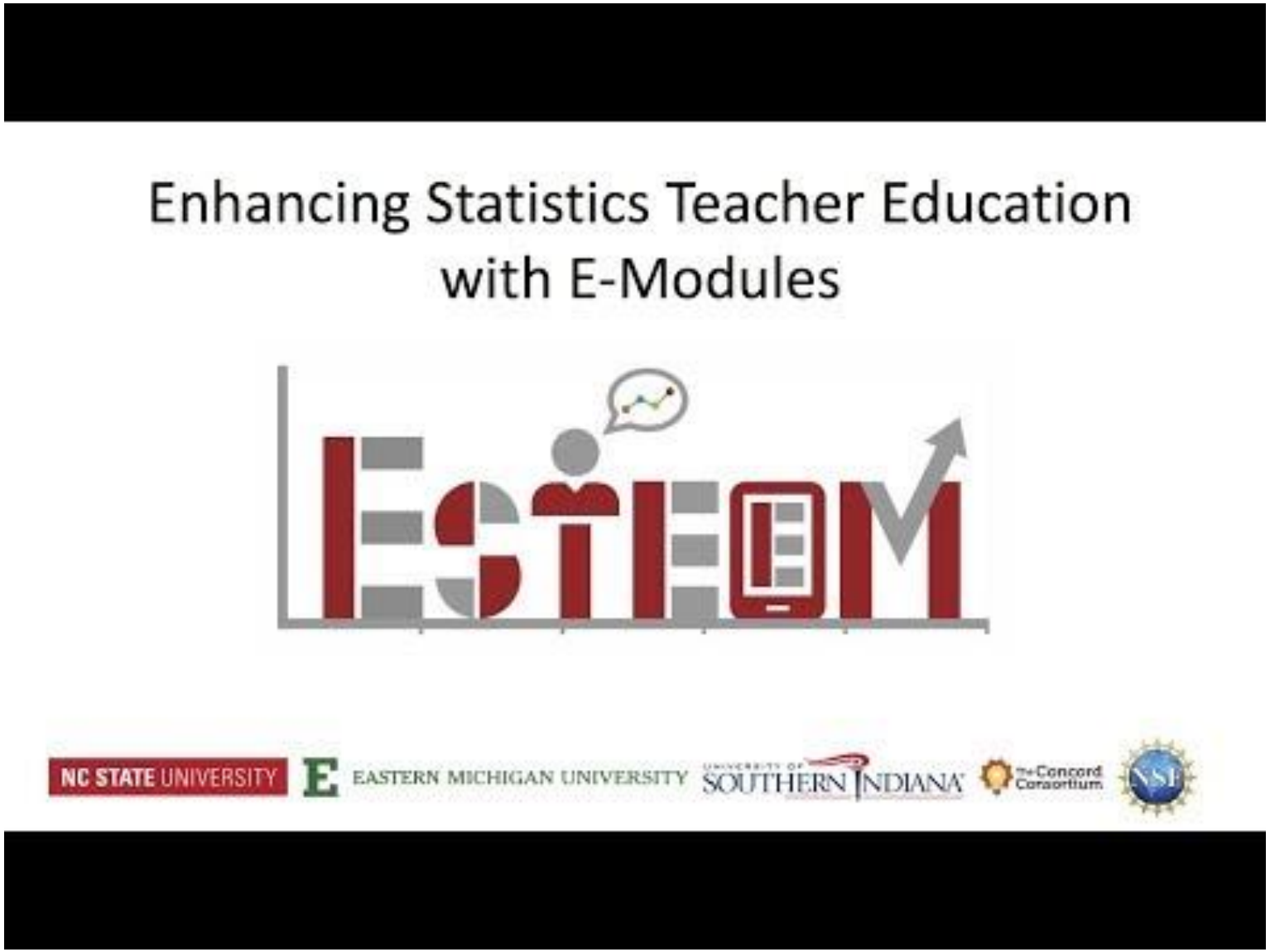
  *large data set may be overwhelming

1.2.i Supporting Statistical Discourse with the Roller Coaster Task

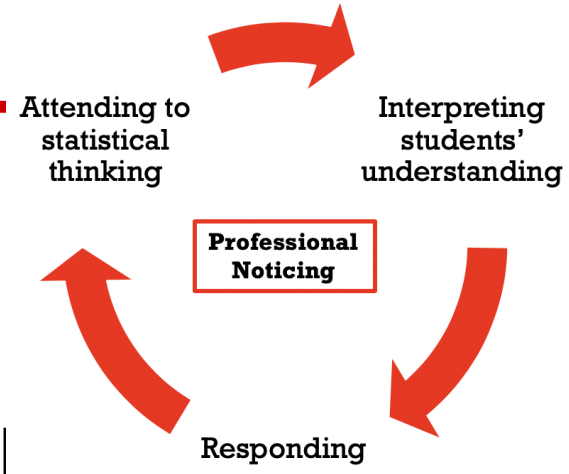
As you watch the following video, consider these questions….

- What do you notice about students' statistical thinking?
- How does the teacher sequence students' work to account for different student approaches to analysis and interpretations?
- How does the teacher use student ideas to make connections between statistical ideas?

1.2.i. Supporting Statistical Discourse with the Roller Coaster Task



Five Practices Model for Facilitating Mathematical (Statistical) Discussions



Select mathematical goals and tasks.

- ***Anticipating*** likely student responses
- ***Monitoring*** students' responses during the ex
- ***Selecting*** specific students to present mathematical ideas during the discuss and summarize phase
- ***Sequencing*** student responses that will be publicly displayed
- ***Making connections between student responses*** and key ideas

Smith & Stein (2011); Stein, Engle, Smith, & Hughes (2008)

How would you respond?

- What did you notice about students' statistical thinking?
- How did the teacher sequence students' work to account for different student approaches to analysis and interpretations?
- How did the teacher use student ideas to make connections between statistical ideas?

Example: PST's Reflection (Disc. Board)

The sequence she chose allowed the students to **see a progression of graphs that compared the same attributes, top speed and drop height**. The first group created two dot plots and generally focused on a specific case of the maximum in both categories. In the 4-expert video we watched, Dr. Lee discussed trying to get **students to move from special cases to more generalization about the group as a whole. She did this by asking the students to extend their thought process and see if the minimum in both categories was also similar.** The second group she had present also had a graph showing top speed and drop height but theirs was all on one graph which made it a bit easier to make some generalizations. The final group also created a graph with top speed and drop height but they made a scatterplot and color coded it with the types of coasters. This **allowed the students to go further in their analysis by comparing two groups** but also opened the door for higher level interpretation. The students **made claims and began to think** in the context of the problem discussing the possible danger of wooden coasters at high speeds. They **looked at the cluster of wooden roller coasters and discussed the lack of variability**. They were also truly able to **see a clear relationship** between drop and speed which the teacher help to summarize.

Connecting to Big Ideas from the Foundational Module Materials

Important Considerations for PSTs

In preparation for today's webinar, we asked you to read a short excerpt from the first part of the ESTEEM Foundation Module. Based on this reading, how would you answer the following question?

- **How is mathematics different from statistics?**
  - Important Role of Context
  - Issues of Measurement
  - Variability & Uncertainty

Big Ideas Embedded in ESTEEM Materials

- Doing statistics involves a cycle of investigation

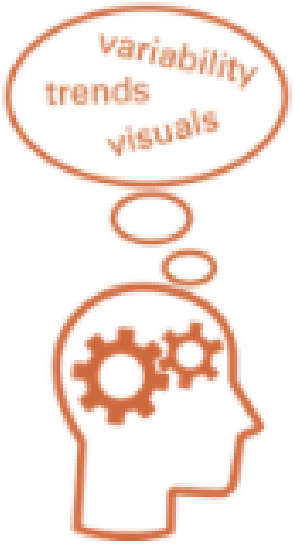
- Secondary students should develop statistical habits of mind
  - Always consider the context of data
  - Ensure the best measure of an attribute of interest
  - Anticipate, look for, and describe variation
  - Embrace uncertainty, but build confidence in interpretations
  - Attend to sampling issues
  - Use several visual and numerical representations to make sense of data
  - Be a skeptic throughout an investigation

- Students should use real, “large,” and multivariate data sets

Reflecting on the Rollercoaster Investigation

- Consider the rollercoaster investigation we completed earlier.

DISCUSS: How did you have opportunities to engage in these habits of mind? How could you build opportunities for PSTs to engage in them with this data set?



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- Use several visual and numerical representations to make sense of data
- Be a skeptic throughout an investigation

Considerations for Design and Implementation of Statistics Tasks (C-DIST)

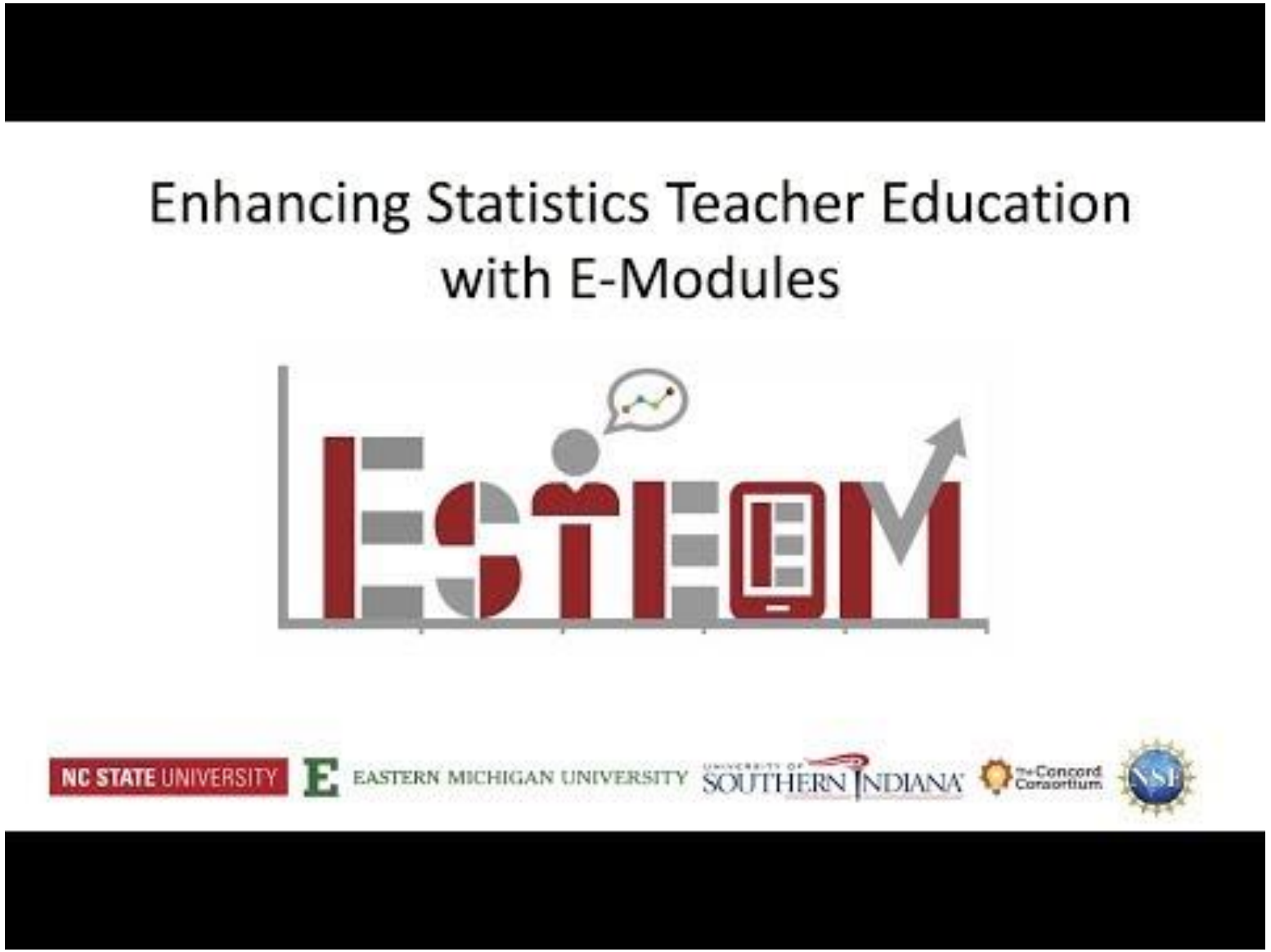
We expect future teachers to learn how to design and implement statistical tasks well.

The ESTEEM modules introduce the C-DIST framework to help teachers consider the important characteristics of a statistical task and how to implement it well.

Students' Statistical Reasoning about Roller Coasters

1.2.h. Examining Students' Work on the Roller Coaster Task

Examining Students' Statistical Reasoning



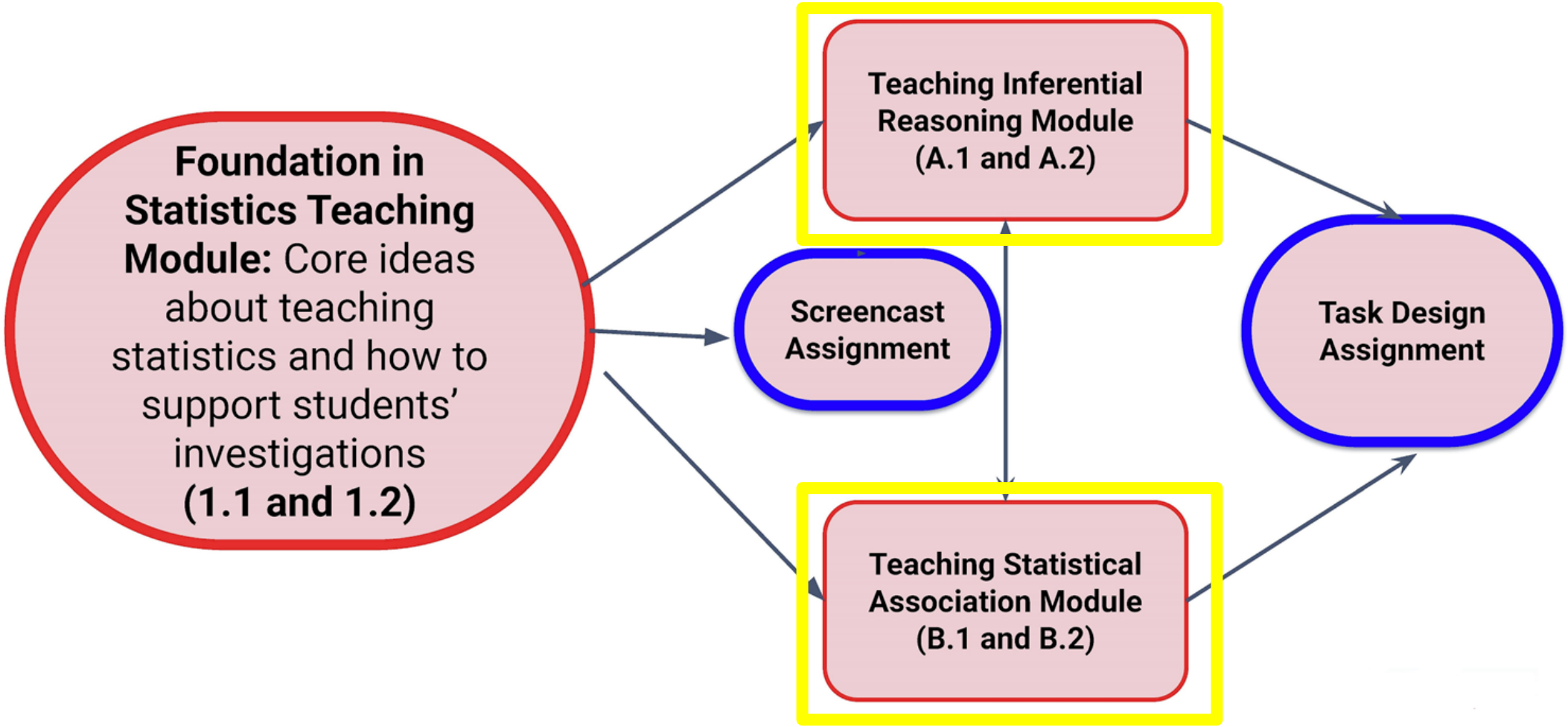
Watch as students in 6th grade, 7th grade and high school AP Statistics explore this data set. This is the first time that students used CODAP to conduct a statistical investigation.

In small groups, discuss the following:

Compare and contrast how the four pairs of students reasoned statistically in relationship to the following ideas. Be sure to support your claims with evidence that includes what students did and said.

a. The ways the context supports or hinders students' statistical thinking as they engage in the investigation.
b. The ways they engaged in posing a question of interest to them.
c. The ways the students were analyzing and interpreting the data at different levels of sophistication.

Modular Approach



A “sample” of the Teaching Inferential Reasoning Module

Focus of Inferential Reasoning Module

Role of questions and tasks for promoting IR

How models, modeling and simulations support IR

Role of samples, sampling, and sampling distributions in IR

Using CODAP's Sampler plug-in to build and test models, and explore relationships between population (or models) and empirical distributions,

Engaging with A.1c

A.1.c Using Models to Build Inferential Reasoning

A modeling process includes translating observations and assumptions of a contextual situation into a pseudo-concrete working model, mathematizing the model into a hypothesis-driven model that can be enacted (often through simulation), validating a model through examining how a model fits with empirical data, and interpreting the model within the context of the problem (Chaput, Girard, Henry, 2011; Lee, 2018).

Modeling a Duck Pond Game

A carnival Duck Pond game has a collection of rubber ducks in a pond where **20% of ducks are marked on their belly for a prize.**
If a player picks a marked duck, they win a prize!

- **Once a duck is picked it is returned to the pond and the booth operator swirls them around to mix them up**.
- **Each player pays $1.00 to pick 3 ducks**
- The booth owners expect about **50 students** to play the game at the carnival.

Possible Questions to Pursue

1. How many prizes should they be prepared to give away after 50 students play the game? What variation might we expect in the total number of prizes that would be won after 50 students play?
2. After choosing 3 ducks, how many prizes will most students win? 0, 1, 2, or 3?
3. If at the end of the day only 10 prizes were won, would you think the owners were telling the truth about 20% of ducks being marked?

Inferential Reasoning in Standards

Opportunities for Inferential Reasoning in Common Core Standards

(which are likely similar to statements found in State-level standards)

Middle School

- Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. (CCSS.MATH.CONTENT.7.SP.A.2)
- Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. (CCSS.MATH.CONTENT.7.SP.C.7)

High School

- Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (CCSS.MATH.CONTENT.HSS.IC.A.1)
- Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. (CCSS.MATH.CONTENT.HSS.IC.A.2)
- Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. (CCSS.MATH.CONTENT.HSS.IC.B.5)

Statistical Association Module

- Often our most important and interesting questions about data are about associations: what are *relationships between different attributes?*
- Fundamental statistical concept (Burrill & Biehler, 2011)
- Many relevant content standards at both the middle and high school levels

- Two parts:

  B.1: Statistical Association of **Categorical** Variables

  B.2: Statistical Association of **Quantitative** Variables

Key characteristics of Association Module

Annotated Table of Contents

- **More attention to developing content knowledge with categorical variables**

B.1.a Investigating Categorical Variables in CODAP

●Reading(~2 paragraphs) - Defining categorical variables and their use.

●2 videos (total ~16 minutes) - How to examine bivariate categorical data in CODAP and how to investigate whether there is an association between the two variables.

- Models a way to engage students: guess the historical event the data are from

Key characteristics of Association Module

Annotated Table of Contents

- More attention to developing content knowledge with categorical variables
- **Improve knowledge of content and students (KCS) for teaching statistical association**

Documentation types:

***Written student work**

***Videos of individual student interviews**

***Videos of classrooms**

***Animations of classrooms**

B.1.d Student-created Graphs of Bivariate Categorical Data

- Videos of individual student interviews
- Transcript provides written student work (graphs students created)

B.2.a Introducing Students to the Topic of Statistical Association

- Animations of class session, based on documentation of actual class sessions

B.2.g Teaching Statistics with CODAP

Video of high school class session where they used CODAP to investigate attributes of vehicles

Key characteristics of Association Module

Annotated Table of Contents

- More attention to developing content knowledge with categorical variables
- Improve knowledge of content and students (KCS) for teaching statistical association
- **Develop professional noticing skills of attending, interpreting, and responding to student thinking**

Common Student Approaches

- B.1.b Common Student Approaches when Analyzing Bivariate Categorical Data

  From research studies in statistics education, we have identified and named common student approaches. For this activity we created animations to depict students taking these approaches using quotations of students from the studies.

- B.1.d Student-created Graphs of Bivariate Categorical Data

  We conducted a research study Summer 2017 which generated these videos. Graded discussion activity where PSTs analyze video of 3 students and think about how to sequence and connect their work in a class discussion.

- B.1.g Students' reasoning about a Segmented Bar Graph

  Assignment develops PSTs' professional noticing skills; they are asked to attend to, interpret, and respond to students' reasoning concerning a segmented bar graph. 5 students' interpretations of a graph are presented in video clips. Videos come from our summer 2017 study with middle school students.

Key characteristics of Association Module

Annotated Table of Contents

- More attention to developing content knowledge with categorical variables
- Improve knowledge of content and students (KCS) for teaching statistical association
- Develop professional noticing skills of attending, interpreting, and responding to student thinking
- **Build on work from other Modules**

B.2.h Discuss Differences between Math & Stats in the Study of Association

Recall from Essential Material 1.1.a that mathematics is different from statistics. Key differences between mathematics and statistics are prominent in the study of statistical association of quantitative variables.

View B.2.h assignment

CODAP-based data investigations

B.1.e Investigating Data about Granola Bars

Investigative task using CODAP (12 questions) - Examining a dataset concerning the nutritional value of granola bars. Teachers examine associations between categorical variables and make conclusions about whether granola bars are healthy.

B.2.f Investigating Data about Vehicles

Investigative task (~9 questions) - Involves a data set containing information about 300 vehicles. Teachers investigate scatter plots, lines of best fit, residuals, sums of squared residuals, and correlation coefficients.

B.2.i Investigating Data from the Census at School Random Sampler

Teachers pose and investigate three questions with different types of association.

Key characteristics of Association Module

Annotated Table of Contents

- More attention to developing content knowledge with categorical variables
- Improve knowledge of content and students (KCS) for teaching statistical association
- Develop professional noticing skills of attending, interpreting, and responding to student thinking
- Build on work from other Modules
- Learn about resources for teaching statistics (ASA/NY Times ‘What’s going on in this graph?, Census at School)

Logistics of Working with ESTEEM Modules

Learning Management Systems

Moodle

Blackboard

Canvas

Common Course Cartridge

How to get materials into your course

https://place.fi.ncsu.edu/

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Face-to-Face or Hybrid Implementation

- Read and Watch Materials can be used as homework items with brief class discussions during the next class period.
- Watch and discuss shorter videos together.
- Introduce and engage with tech tools in pairs during class.
- Transform discussion boards into classroom discussions.

ESTEEM ENHANCING STATISTICS TEACHER EDUCATION WITH E-MODULES

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hirise.fi.ncsu.edu/projects/esteem/