ENHANCING STATISTICS TEACHER EDUCATION WITH E-MODULES

Using Videos of Students' Statistical Reasoning to Support Preservice Teachers' Learning of Content and Pedagogy

Rick Hudson[1], Hollylynne Lee[2], & Gemma Mojica[2]

University of Southern Indiana[1], NC State University[2]

May 17, 2019

State College, PA

NC STATE UNIVERSITY | EASTERN MICHIGAN UNIVERSITY | UNIVERSITY OF SOUTHERN INDIANA | The Concord Consortium | NSF

Video in Mathematics Teacher Education

Seago & Mumme (2002) hypothesized four ways in which math teachers learn from videos

- Learn *useable* mathematics
- Generalize mathematical and pedagogical ideas by looking across cases
- Develop a more complex view of teaching
- Develop new norms of professional discourse and more precise language of practice through discussion

Examples of Projects Resulting in Videos of Students/Teachers

- Integrating Mathematics and Pedagogy (IMAP)
- Children's Mathematics / Cognitively Guided Instruction (CGI)
- Developing Mathematical Ideas (DMI)
- Learning & Teaching Geometry (LTG)
- Learning and Teaching Linear Functions

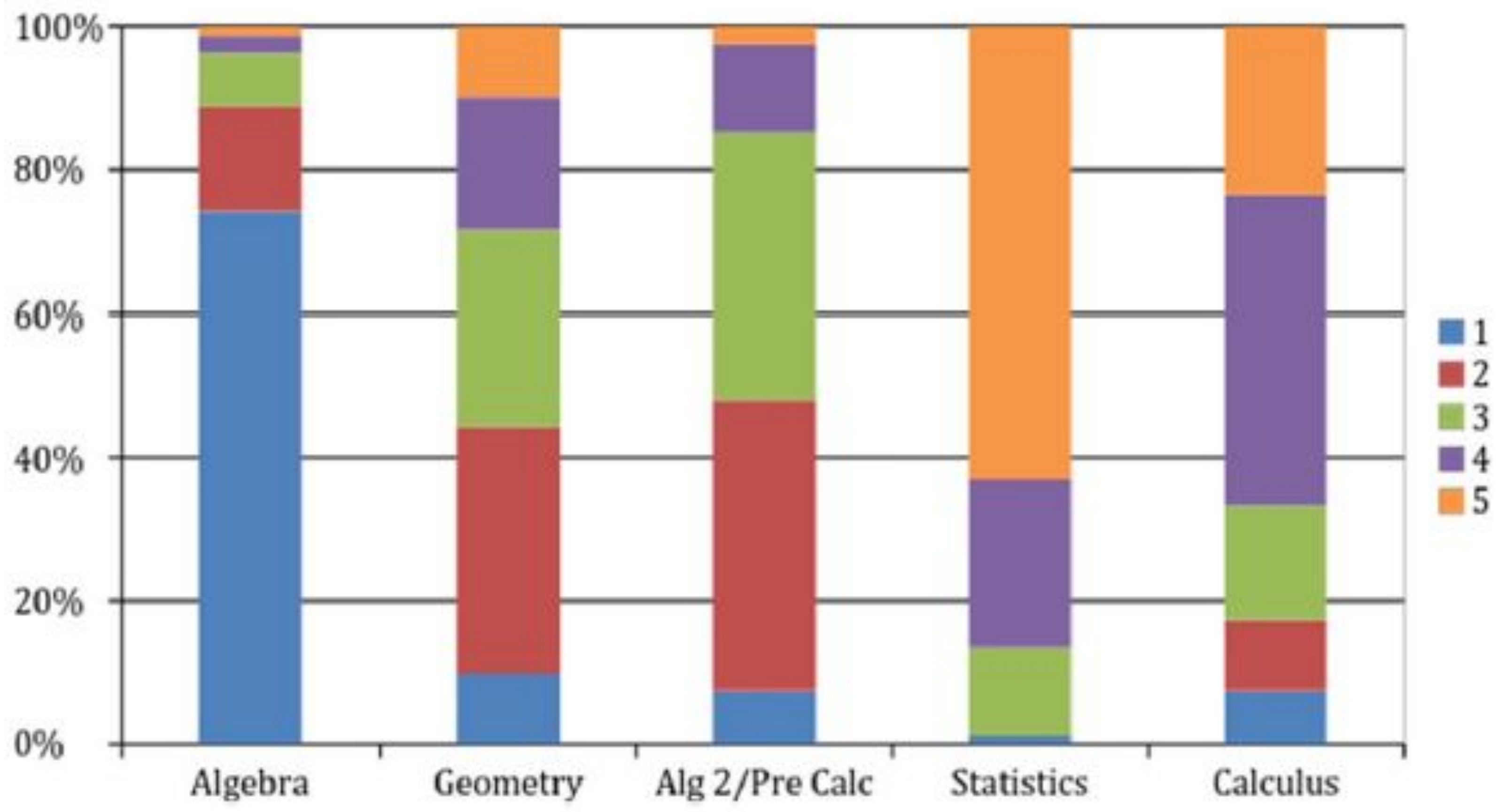
Presentation Outline

- Overview of the ESTEEM Materials
- Videos of Students' Thinking about Categorical Association
- Videos of Students' Investigations of Roller Coasters

Overview of the ESTEEM Materials

Hollylynne Lee

Preservice teachers feel least prepared to teach statistics



Lovett & Lee, 2017

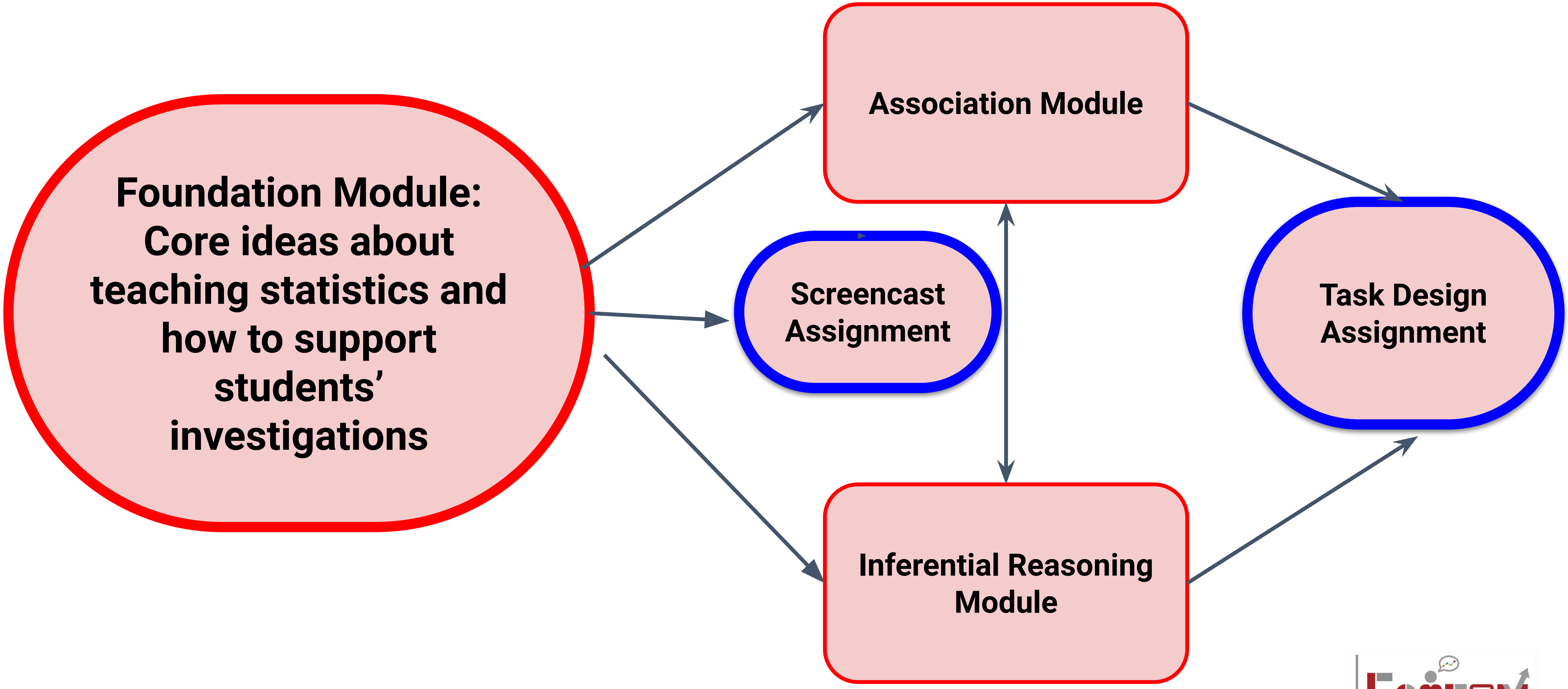
Goals of ESTEEM

1. Create **online** resources for statistics preservice teacher education
    - Develop CODAP as an easy to use tool to support high school statistics
    - Create classroom videos of statistics teaching and learning
    - Develop rich multivariate data tasks
    - Orchestrate 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.

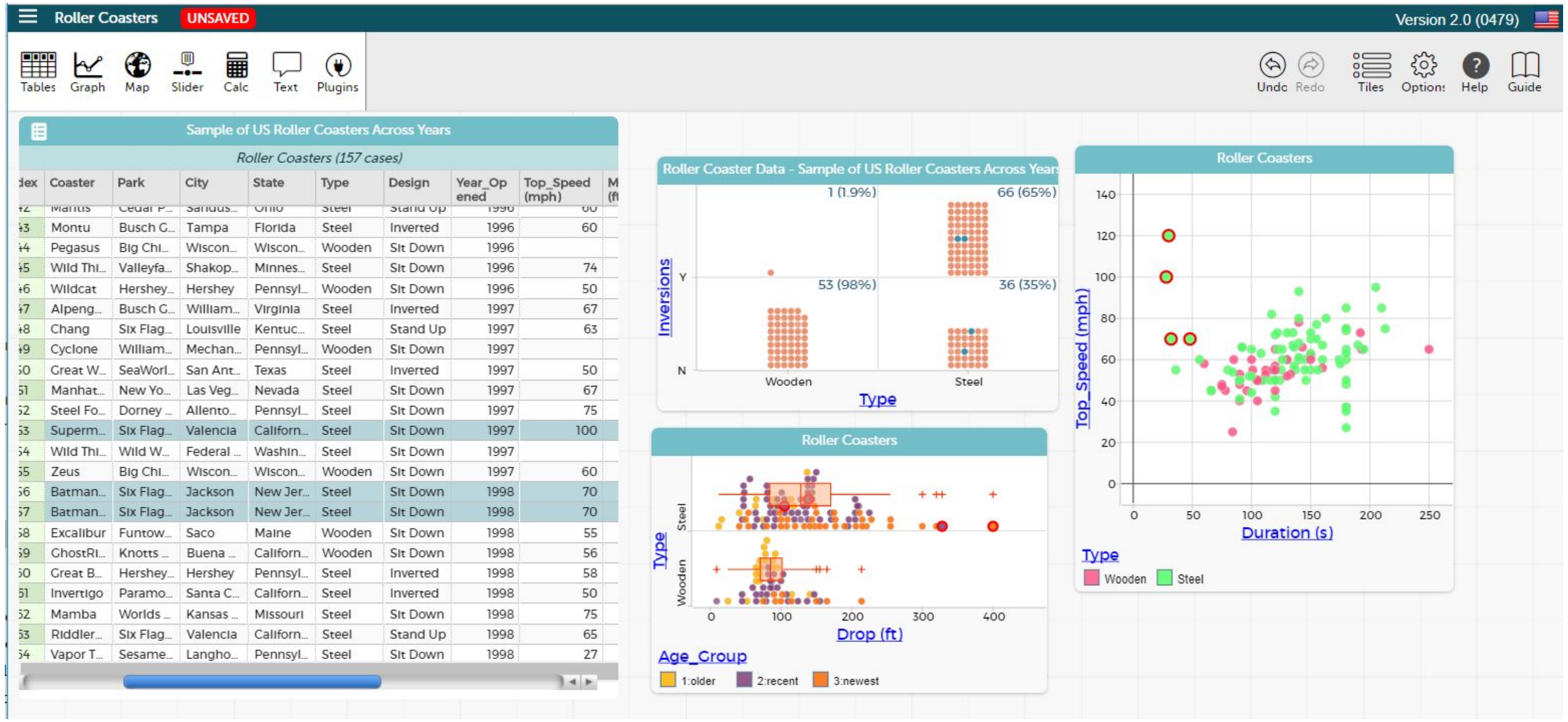
ESTEEM Modular Approach



CODAP

https://codap.concord.org

Common
Online
Data
Analysis
Platform



CODAP is supported on Firefox 46+, Chrome 50+, Windows Edge 14+, and Safari 10+. CODAP is not actively supported on other browsers at this time.

ENHANCING STATISTICS TEACHER EDUCATION WITH E-MODULES

hirise.fi.ncsu.edu/projects/esteem

The development of some materials used in this presentation is supported by funding from the NSF (DUE # 1625713).

Videos of Students’ Thinking about Categorical Association

Rick Hudson

Professional Noticing Framework

- “Expertise in attending to children’s strategies is foundational to deciding how to respond on the basis of children’s understanding” (Jacobs, Lamb, Philipp, & Schapelle, 2011, p. 111).
- Three Components (Jacobs et al., 2010)
  - Attending to students’ thinking
  - Interpreting mathematical understandings
  - Deciding how to respond

Categorical Data in CCSS-M

CCSS.Math.Content.8.SP.A.4

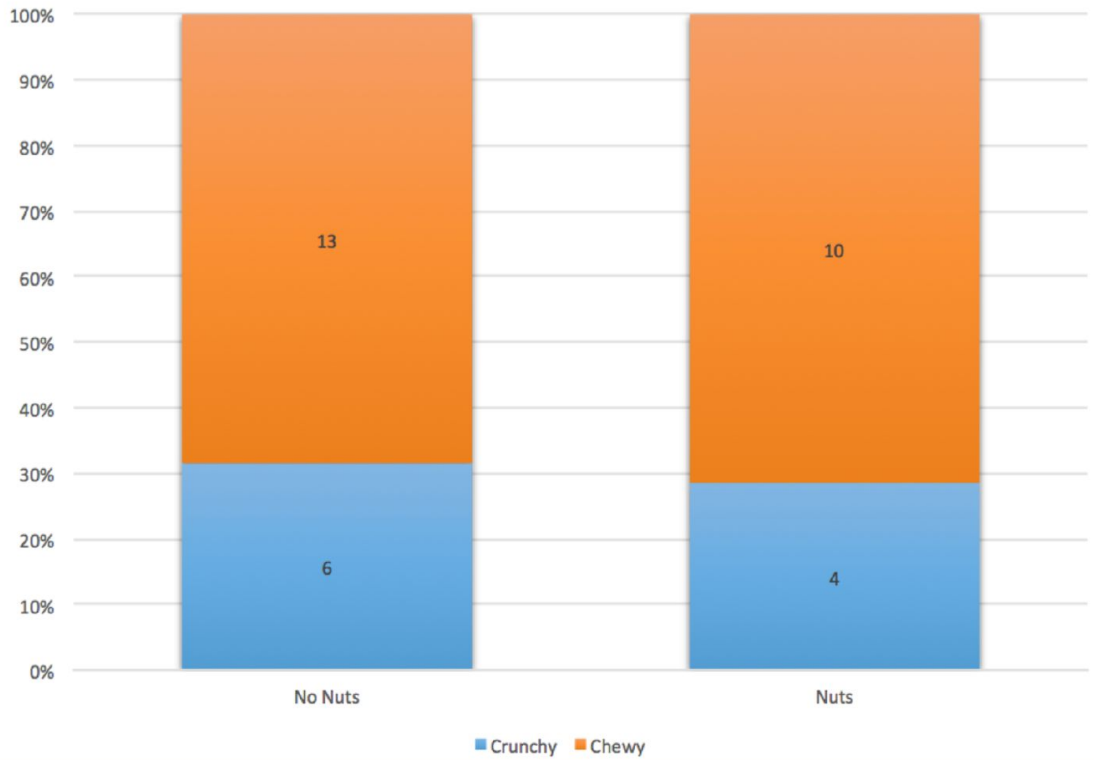
Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables.

CCSS.Math.Content.HSS.ID.B.5

Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.

Is there a relationship between whether a granola bar has nuts and its texture (chewy/crunchy)?

	NO NUTS	NUTS
CHEWY	13	10
CRUNCHY	6	4

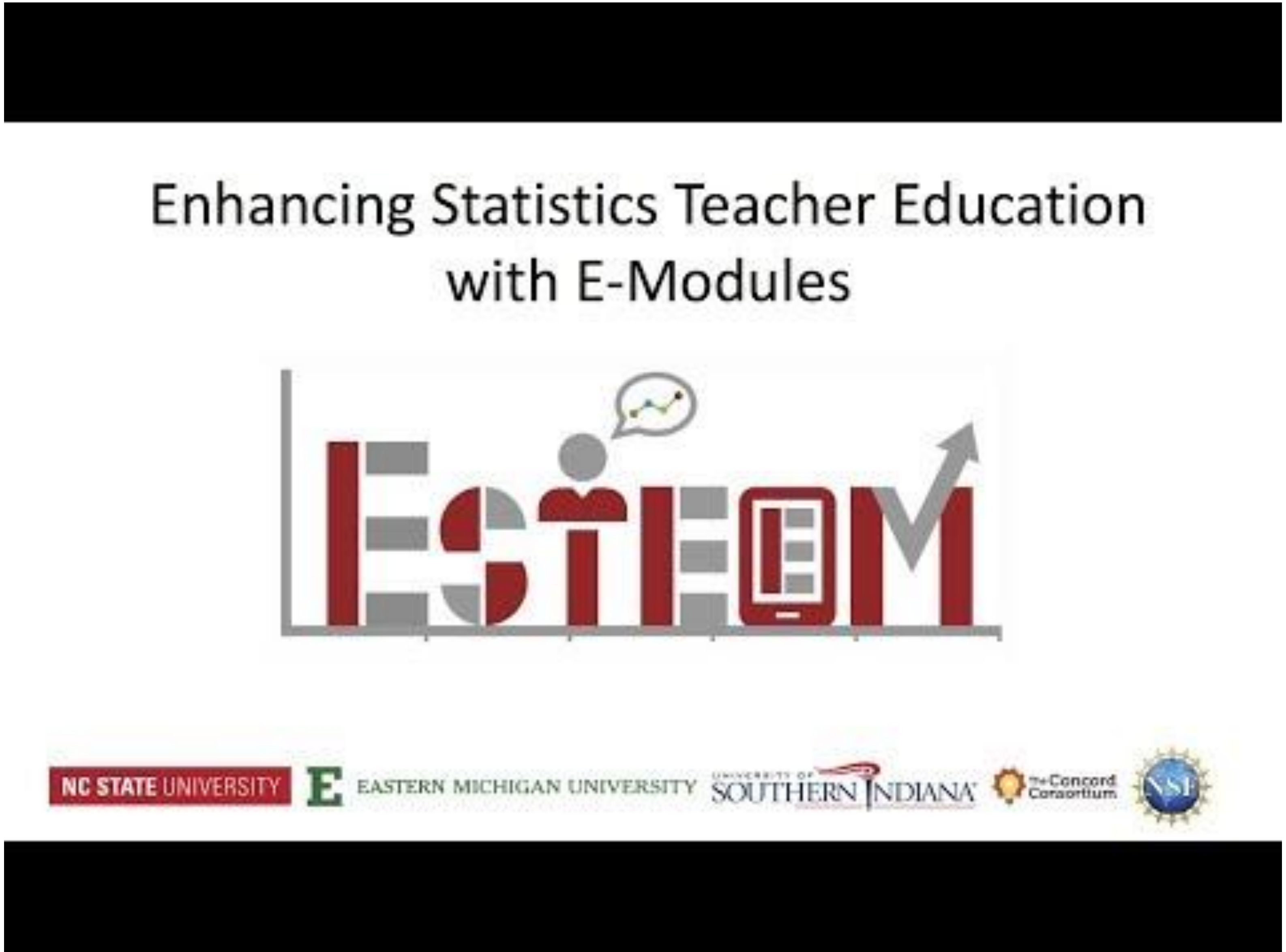


Transcripts

Go to
https://tinyurl.com/AssocTranscript

Or view the QR code at the right.

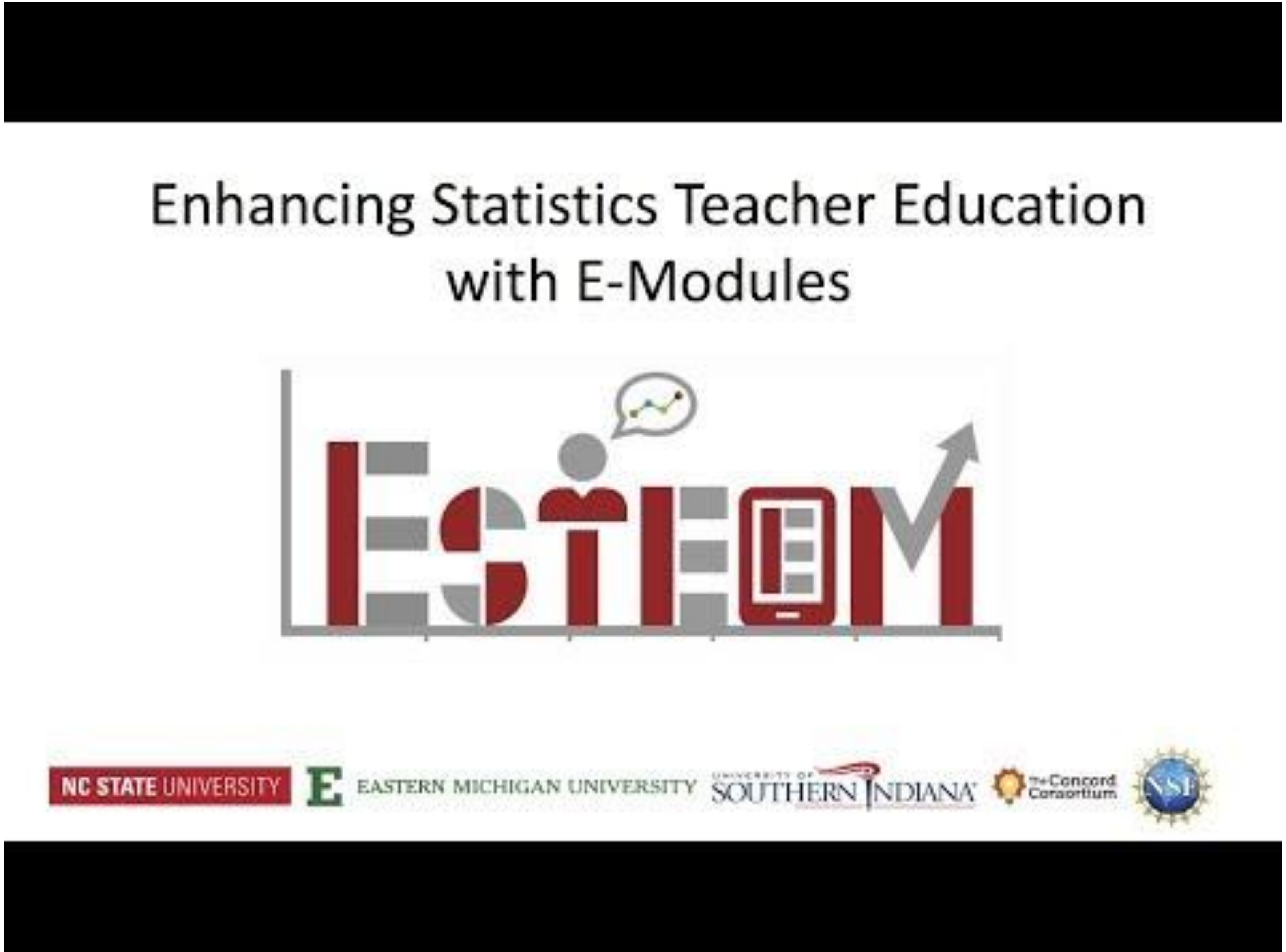
Hector


Enhancing Statistics Teacher Education
with E-Modules
NC STATE UNIVERSITY
EASTERN MICHIGAN UNIVERSITY
SOUTHERN INDIANA
Concord Consortium
NSF

Interpreting Hector

- **Attend:** Identify a statement/action Hector made that you found significant.
- **Interpret:** What does Hector's statement tell you about his thinking?
- **Decide:** If you were Hector's teacher, how would you respond to his statement?

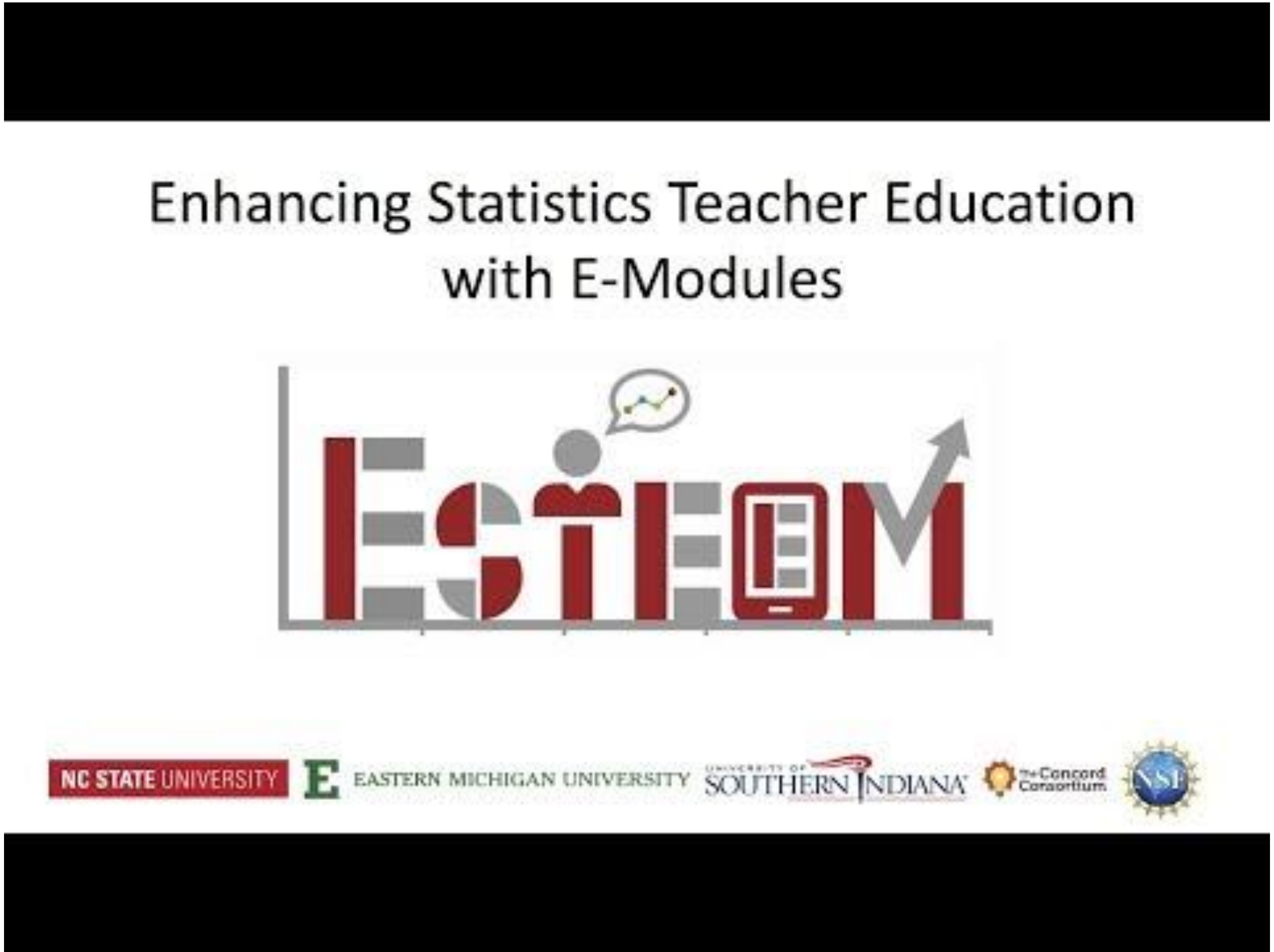
Trina


Enhancing Statistics Teacher Education
with E-Modules
NC STATE UNIVERSITY
EASTERN MICHIGAN UNIVERSITY
SOUTHERN INDIANA
The Concord Consortium
NSF

Interpreting Trina

- **Attend:** Identify a statement/action Trina made that you found significant.
- **Interpret:** What does Trina's statement tell you about her thinking?
- **Decide:** If you were Trina's teacher, how would you respond to her statement?

Andrea

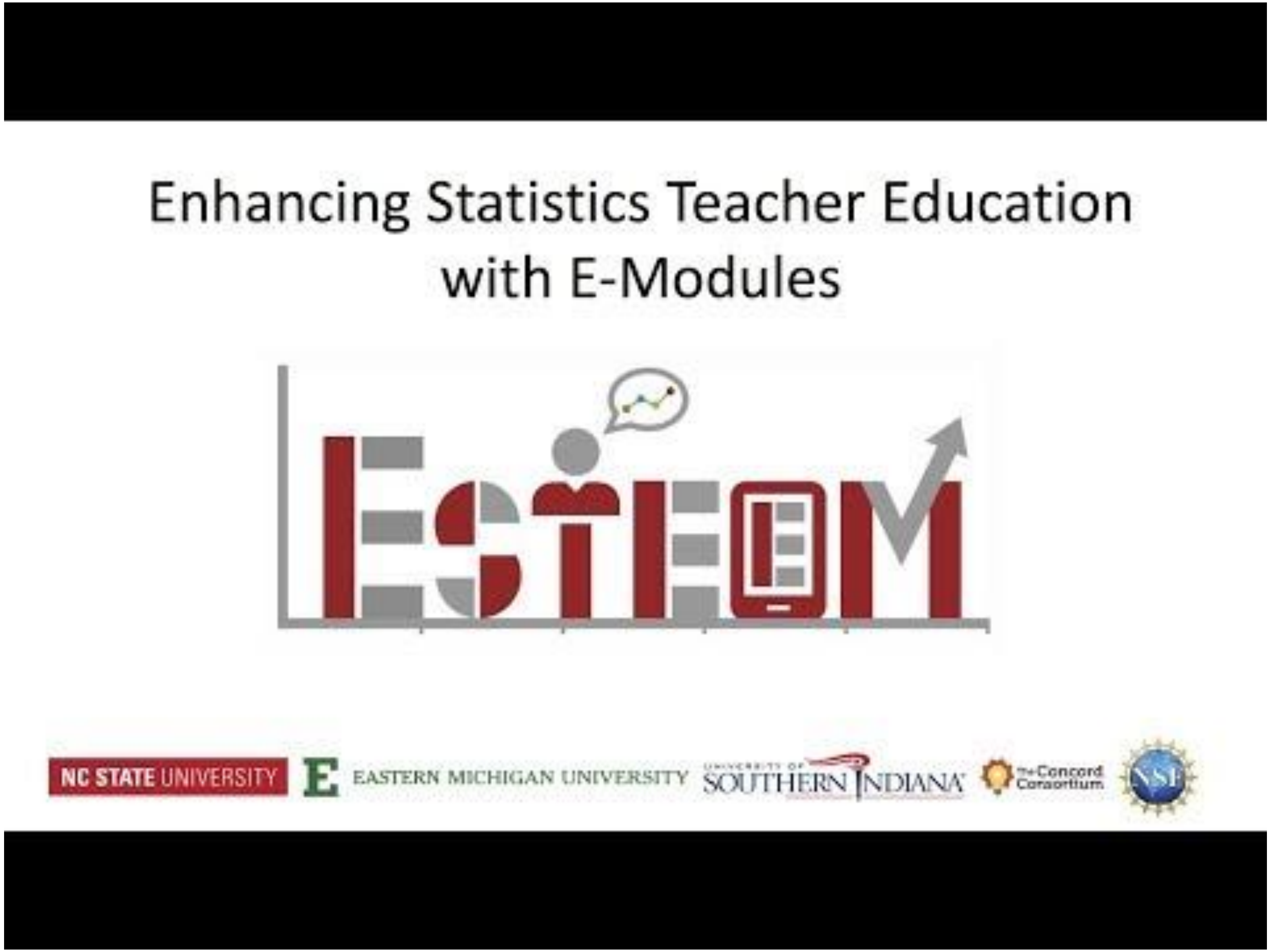

Enhancing Statistics Teacher Education
with E-Modules
ESTEEM
NC STATE UNIVERSITY
EASTERN MICHIGAN UNIVERSITY
UNIVERSITY OF SOUTHERN INDIANA
The Concord Consortium
NSF

Interpreting Andrea

- **Attend:** Identify a statement/action Andrea made that you found significant.
- **Interpret:** What does Andrea's statement tell you about her thinking?
- **Decide:** If you were Andrea's teacher, how would you respond to her statement?

ESTEEM

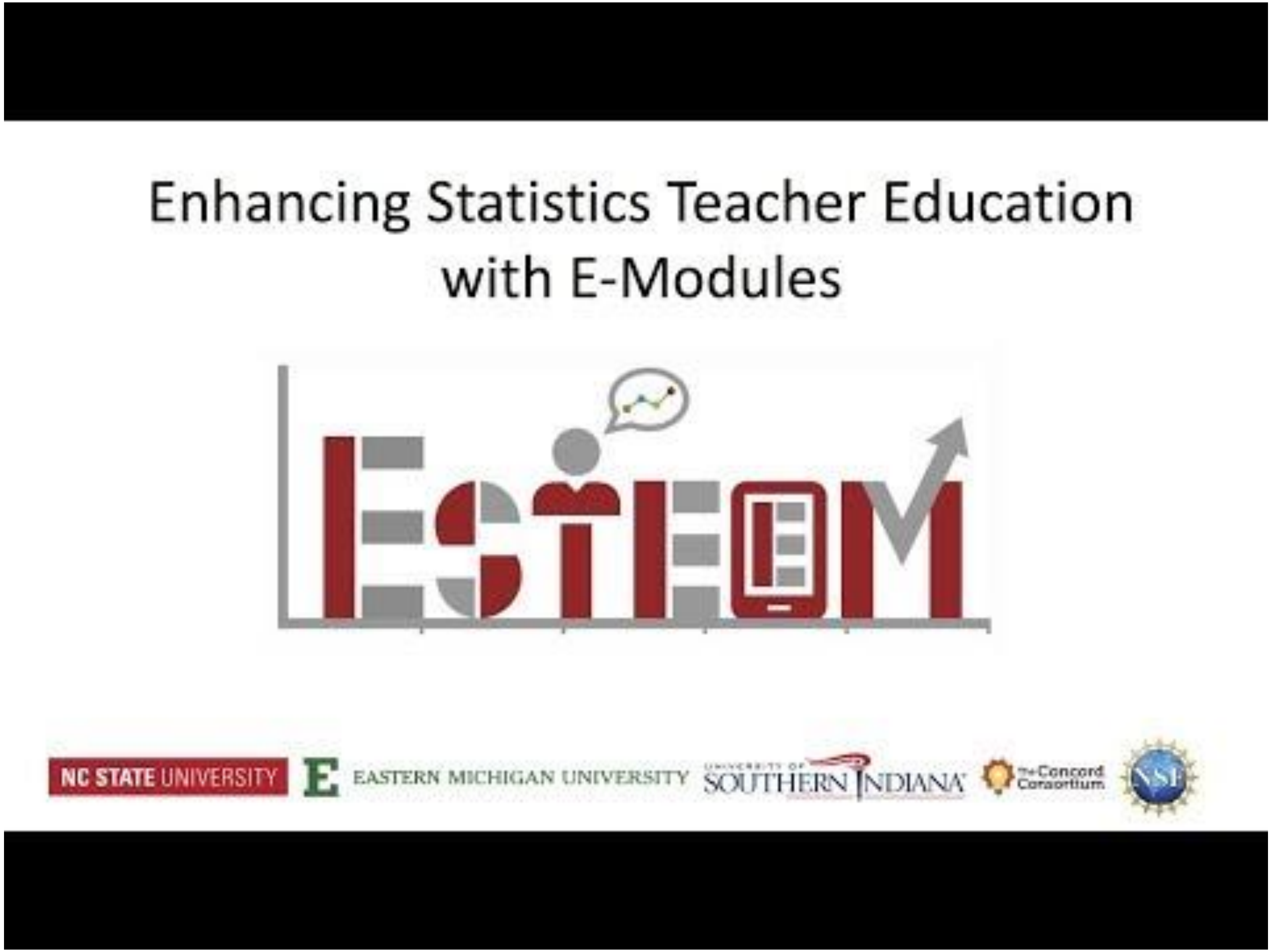
Xavier


Enhancing Statistics Teacher Education
with E-Modules
NC STATE UNIVERSITY
EASTERN MICHIGAN UNIVERSITY
UNIVERSITY OF SOUTHERN INDIANA
The Concord Consortium

Interpreting Xavier

- **Attend:** Identify a statement/action Xavier made that you found significant.
- **Interpret:** What does Xavier’s statement tell you about his thinking?
- **Decide:** If you were Xavier’s teacher, how would you respond to his statement?

Lana


Enhancing Statistics Teacher Education
with E-Modules
ESTEEM
NC STATE UNIVERSITY
EASTERN MICHIGAN UNIVERSITY
SOUTHERN INDIANA
Concord Consortium
NSF

Interpreting Lana

- **Attend:** Identify a statement/action Lana made that you found significant.
- **Interpret:** What does Lana's statement tell you about her thinking?
- **Decide:** If you were Lana's teacher, how would you respond to her statement?

Reflecting on one PSTs' Thinking

This student was not correctly reading the graph. If she would have switched the variables in her sentence to say that 30% of bars with no nuts are chewy, she would have correctly stated the conditional relative frequency. As her teacher I would want to clear up this misconception **by having her understand that the column is what describes the 100% of no nut bars and the colors break up the bar into the type. I would ask her to flip the variables in her sentence and ask her what the different between that statement and the original statement is.** Hopefully she would understand that the first variable in the conditional relative frequency is the variable that is 100% and the second variable is the one that breaks up the 100% into two parts.

Reflecting on another PSTs' Thinking

She said 70 percent are chewy and have nuts but then corrected it to 70 percent are chewy and have no nuts. She has a wrong referent conception. She should have said 70 percent of the granola bars without/with nuts are chewy. 10/33 (about 30 percent) granola bars are chewy and have no nuts, but 13/19 (about 68 percent) granola bars without nuts are chewy. **I would ask her what she thinks the numbers on the bar graph represent. I would ask how many total granola bars have no nuts. Then I would ask what percent of granola bars without nuts are chewy.** Then how many granola bars are there total and then what percent of ALL of the granola bars are chewy AND have nuts.

Discussion

What are the ways you might use videos of students thinking in your course setting?

What are the benefits or drawbacks of using the Professional Noticing framework with preservice teachers?

Videos of Students' Investigations of Roller Coasters

Gemma Mojica

Investigating US Roller Coasters

[1.2.g. Investigating More Roller Coasters]

https://go.ncsu.edu/rollercoasters

Mod 1: Part 2

Investigating MORE Roller Coasters Developed Over the Past 100 Years!

CONTEXT: Amusement Parks are located in various locations across the United States, and many Americans include a trip to an amusement park as a favorite vacation option. These parks often have one or more roller coasters. While not all students have ridden roller coasters before, they have seen them in the media, and the internet is full of videos made by roller coaster enthusiasts. Some parks have older coasters that they have continually maintained over the years, like the Jack Rabbit at Kennywood park, built in 1921 and still in operation today. Many parks, like Cedar Point in Ohio, also continually try to build new coasters to attract new visitors and keep their existing visitors coming back, like the Millenium Force which opened in 2000, shown in picture. Advances in engineering over the years have certainly expanded how coasters are built.

(image from: https://en.wikipedia.org/wiki/Millennium_Force)

In this investigation, you have an opportunity to use CODAP online to explore a sample of 157 roller coasters at parks across the United States.

Getting Familiar with the data set.

Open the data in CODAP. There are 157 cases, organized hierarchically based on when they were built (the attribute Age Group to the left of the table). Click on the different age groups and explore the table. You can make the Table window larger and also scroll to the right and down to see all 10 attributes and all 157 cases.

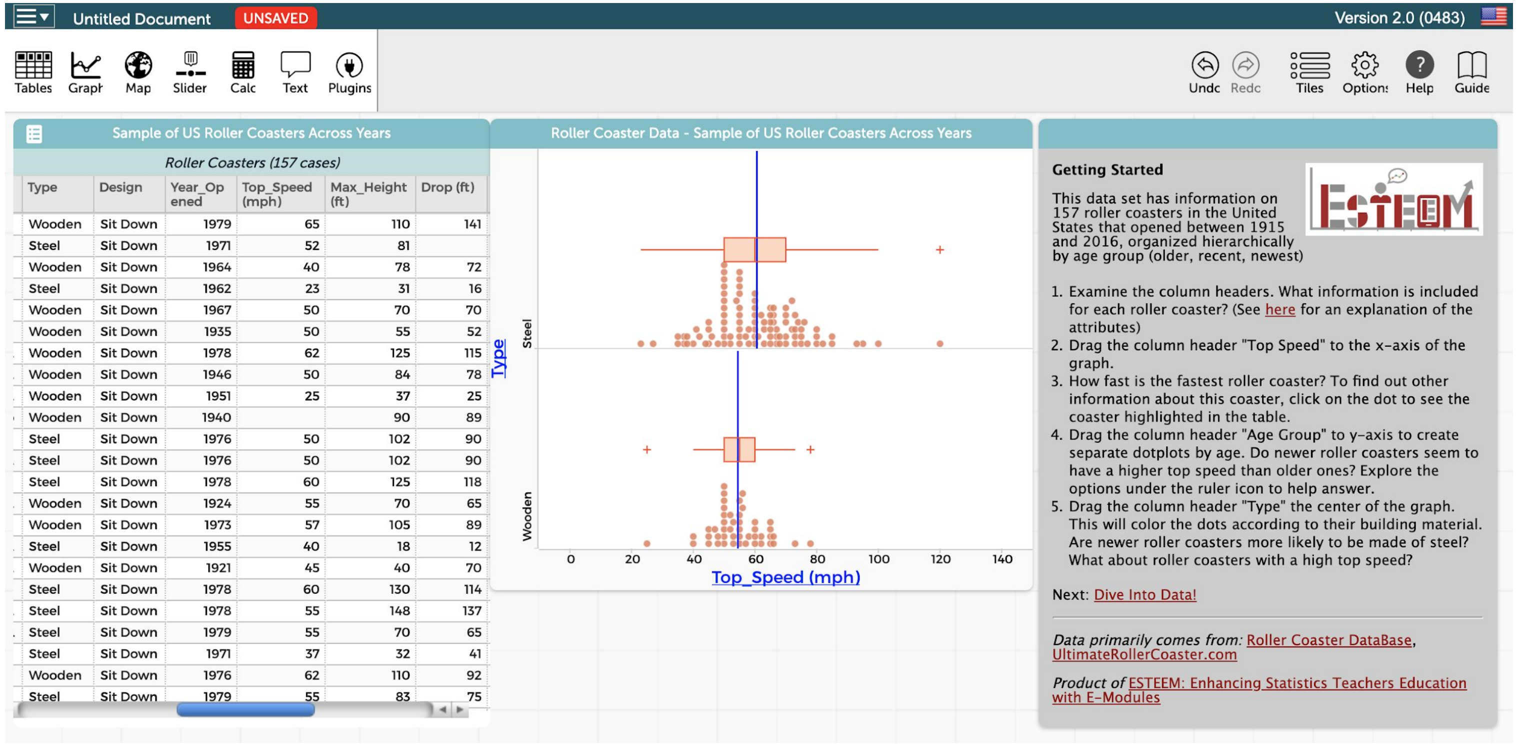
Review the attribute definitions by hovering over the name of an attribute in the column header. The definitions of all attributes are also explained more in the Appendix to this document.

Open the Map (click on Map on the top shelf). Each location of the amusement parks is indicated by a point. Click on the Map. In the Map menu (right-hand side), click on the ruler and change Point to Grid. The rectangular grids shown on the map are different shades of red, depending on how many coasters from that park are in the sample of data.

Click on various grids on the map for a location of an amusement park and then scroll through the table to see which roller coasters correspond.

Page 1 of 4

Lee, H. S., & Mojica, G. F. (2017). Enhancing Statistics Teacher Education with E-Modules. Retrieved from: https://s3.amazonaws.com/module1/part2/esteem_mod1_part2_roller_coaster_investigation.pdf

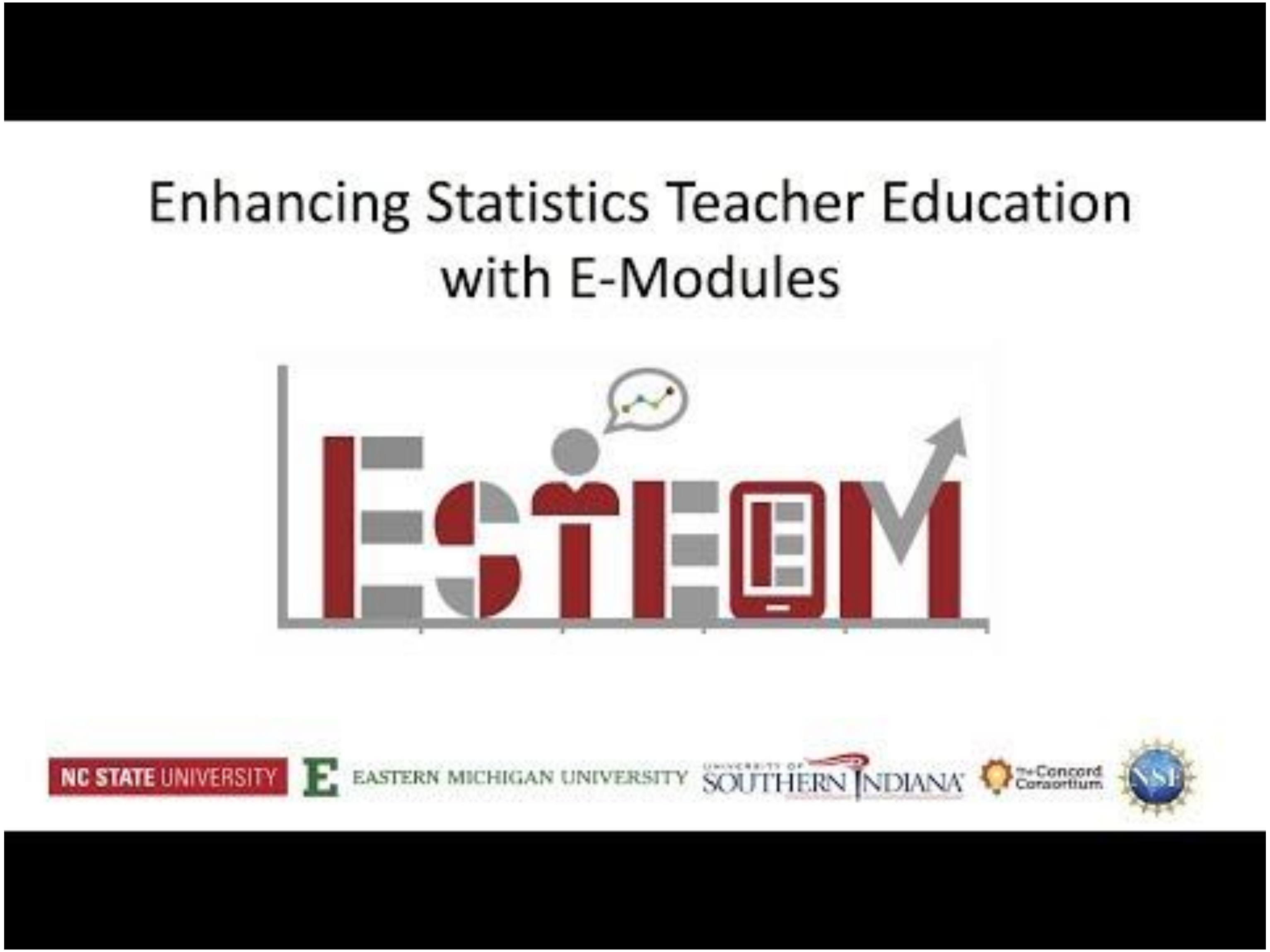


Type	Design	Year_Opened	Top_Speed (mph)	Max_Height (ft)	Drop (ft)
Wooden	Sit Down	1979	65	110	141
Steel	Sit Down	1971	52	81	
Wooden	Sit Down	1964	40	78	72
Steel	Sit Down	1962	23	31	16
Wooden	Sit Down	1967	50	70	70
Wooden	Sit Down	1935	50	55	52
Wooden	Sit Down	1978	62	125	115
Wooden	Sit Down	1946	50	84	78
Wooden	Sit Down	1951	25	37	25
Wooden	Sit Down	1940		90	89
Steel	Sit Down	1976	50	102	90
Steel	Sit Down	1976	50	102	90
Steel	Sit Down	1978	60	125	118
Wooden	Sit Down	1924	55	70	65
Wooden	Sit Down	1973	57	105	89
Steel	Sit Down	1955	40	18	12
Wooden	Sit Down	1921	45	40	70
Steel	Sit Down	1978	60	130	114
Steel	Sit Down	1978	55	148	137
Steel	Sit Down	1979	55	70	65
Steel	Sit Down	1971	37	32	41
Wooden	Sit Down	1976	62	110	92
Steel	Sit Down	1979	55	83	75

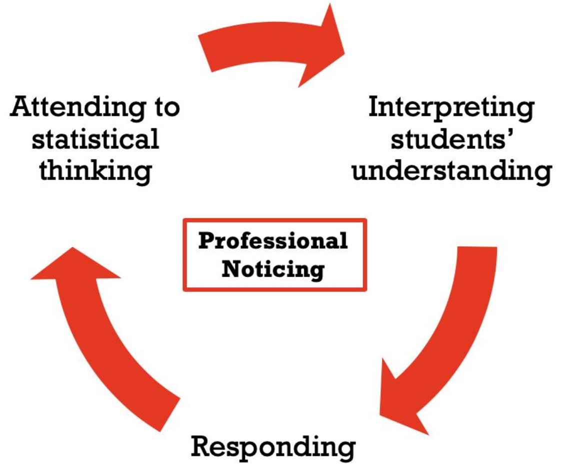
As you watch the video, consider the following ...

- What do you notice about students' statistical thinking? In particular, what do you notice about students' use of statistical habits of mind (e.g., role of context, sampling, attending to variability, measurement, being skeptical, accounting for uncertainty)?
- What does this tell you about students' understanding?
- How does the teacher sequence students' work to account for different student approaches to analysis and interpretations?
- 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)

Example: PST's Reflection

The teacher facilitated the investigation by prompting a higher level of statistical thinking. When s**tudents were making Level A interpretations of the graphs created with one variable (i.e., this is a rollercoaster with a highest top speed), the teacher prompted them to compare one attribute with relation to another (for example top speed and the height of the drop)**. She then **introduced the idea of bivariate associations**. The instructor was encouraging students' statistical thinking by **focusing on modeling the relationships in various ways (with the aid of CODAC tool)**. Instead of, for example, stressing the proper name of the type of graph created. She mentions that the graph they created is called a scattered plot, but since it's not imperative to the analysis that the students are conducting, she moves on and tells them that they will learn more about scattered plots later on.

Example: PST's Reflection

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.

Discussion

- Is there evidence that the teacher supported students' use of statistical habits of mind (e.g., role of context, sampling, attending to variability, measurement, being skeptical, accounting for uncertainty)? Provide specific examples.
- In what ways did the teacher's interactions with pairs or the whole class build on students' thinking and move that reasoning forward? Explain.
- **How did the teacher sequence the order of students' sharing of their work to account for different student approaches to analysis and interpretations? Explain your thinking.**
- Did the teacher use student ideas to assist the class in making connections between the statistical ideas that were reflected in the shared strategies and representations? If so, how?

Questions?

Acknowledgements

Stephanie Casey, Co-PI
Eastern Michigan University

Bill Finzer, Co-PI
The Concord Consortium

Christina Azmy, RA
NC State University

Heather Barker, RA
NC State University

Taylor Harrison, RA
NC State University

Jonathan Sandoe, Senior Software Engineer
The Concord Consortium

ENHANCING STATISTICS TEACHER EDUCATION WITH E-MODULES

Principal Investigators:

Hollylynne Lee, North Carolina State University
William Finzer, The Concord Consortium
Stephanie Casey, Eastern Michigan University
Rick Hudson, University of Southern Indiana

Research Associate:

Gemma Mojica, North Carolina State University

This project is supported by the National Science Foundation under Grant No. DUE 1625713 awarded to North Carolina State University. Any opinions, findings, and conclusions or recommendations expressed herein are those of the principal investigators and do not necessarily reflect the views of the National Science Foundation.

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