Exploring the Use of Statistics Curricula with Annotated Lesson Notes

Liz Arnold
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Jennifer Green
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CAUSE/JSDSE webinar series

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Host and Moderator:
Leigh Johnson
Capital University
Columbus, OH

What's new in the journal?

Article

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Hairui Yu PhD, Suzanne E. Perumean-Chaney PhD & Kathryn A. Kaiser PhD

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Article

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Ann M. Brearley, Kollin W. Rott & Laura J. Le

Accepted author version posted online: 10 Jan 2023

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Upcoming CAUSE/JSDSE Webinars

Next CAUSE/JSDSE Webinar
March 21, 2023
4 PM EST

Consortium for the Advancement of Undergraduate Statistics Education

USCOTS 2023

COMMUNICATING with DATA about

United States Conference on Teaching Statistics

https://www.causeweb.org/cause/uscots/uscots23

Final abstracts for the Posters and Beyond session should be submitted by **Sunday March 5, 2023**.

Abstracts submitted between **January 30th** and **March 5th** will be considered for selection, but will not receive feedback from the session organizers.

Save the date!

Workshops begin May 30th, Conference June 1st - 3rd, 2023

Liz Arnold

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Liz Arnold is an assistant professor of mathematics education in the Department of Mathematics at Colorado State University. Her research centers on the preparation and development of pre-service and in-service K-12 mathematics and statistics teachers, with a focus on the teaching and learning of statistics, mathematical modeling, and mathematical knowledge for teaching secondary mathematics. Her recent work on the NSF-funded Mathematical Education of Teachers as an Application of Undergraduate Mathematics (META Math) project led to the creation and use of curriculum materials for secondary teacher preparation in undergraduate mathematics and statistics courses; these materials highlight connections between undergraduate mathematics and school mathematics and include approximations of teaching practice for secondary school mathematics.

Jennifer Green

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Jennifer Green is an associate professor of statistics education in the Department of Statistics and Probability and the Program in Mathematics Education at Michigan State University. Her research focuses on the development of teachers in grades K-16, as well as the development of statistical methodology to characterize the impacts of educational programs for teachers. She investigates the teaching and learning of statistics through the development and refinement of programs for K-16 practitioners. Her current interests include K-12 teachers' uses of data and statistics in classroom inquiry, innovations to modernize and transform postsecondary statistics coursework, and graduate student development in teaching and scientific oral communication.

Welcome!

Type in the chat:

- Name
- Current role

Motivation

With new standards and recommendations (e.g., Bargagliotti et al., 2020; NGA, 2010), many high school teachers are being asked to teach statistics in ways that they **have not learned or taught** themselves (e.g., simulation) (Lazar & Franklin, 2015)

Lesson plans exist for teaching statistics topics, but…

- What types of info help support teachers in their teaching?
- How can we share that info in helpful ways?

Annotated Lesson Notes

Annotated lesson notes (ALNs) are one approach we have explored

What are ALNs?

Let’s Bake!

Source: https://sallysbakingaddiction.com/homemade-artisan-bread/

Let's Bake!

Ingredients

- 3 and 1/4 cups (about 430g) bread flour (spoon & leveled), plus more for hands and pan
- 2 teaspoons (about 6g) instant yeast
- 2 teaspoons coarse salt (see note)
- 1 and 1/2 cups (360ml) water, close to room temperature at about 70°F (21°C)
- optional: cornmeal for dusting pan

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Extra Notes, Tips, and Tweaks

Flour: For absolute best flavor and chewy texture, I strongly recommend using bread flour. You can use a 1:1 substitution of all-purpose flour in a pinch with no other changes to the recipe. I recommend avoiding whole wheat flour in this dough. If necessary, use half bread flour and half whole wheat flour. The bread will taste a bit dense.

Yeast: You can use instant or active dry yeast, but I highly recommend an instant (aka "rapid rise" or "quick rise" yeast). The bread will rise faster. I usually use Platinum yeast by Red Star, which is an instant yeast. 2 teaspoons is a little less than 1 standard packet. If using active dry yeast, there are no changes needed to the recipe. The rise time in step 2 may take longer.

Salt: Use a coarse salt, such as coarse sea salt, in this bread. I find the flavor slightly lacking when using regular table fine salt. If you only have fine salt, reduce to 1 and 1/2 teaspoons.

Source: https://sallysbakingaddiction.com/homemade-artisan-bread/

Annotated Lesson Notes

Hiebert and Morris (2012)

- Contain detailed information to help teachers implement a lesson as intended for their specific context
- Can be based on
  - Previous Teaching Experience and Reflections
  - Research on Statistical Knowledge for Teaching
- Updated continuously

ALNs Already Exist!

(e.g., STatistics Education Web (STEW) lesson plans)

Third Stage of the Lesson

Put details here. This should include a clear description of what the teacher is doing and what the students are doing at this stage.

For example, maybe you use a large group discussion to summarize what students learned during the activity. Specify the questions you use to prompt discussion. It may also be helpful to mention common responses.

- Discussion question 1
  - Example of a response that demonstrates incomplete understanding.
  - Example of a correct response
- Discussion question 2
- Discussion question 3

Attached Materials

List any additional materials that are attached. For example:

- Student handouts with sample solutions
- Slides that could be used to give instructions or guide class discussions
- Directions for using a particular technology tool

Reflections and Additional Recommendations (optional)

The contents of this optional section will vary from lesson to lesson. For example, it may include

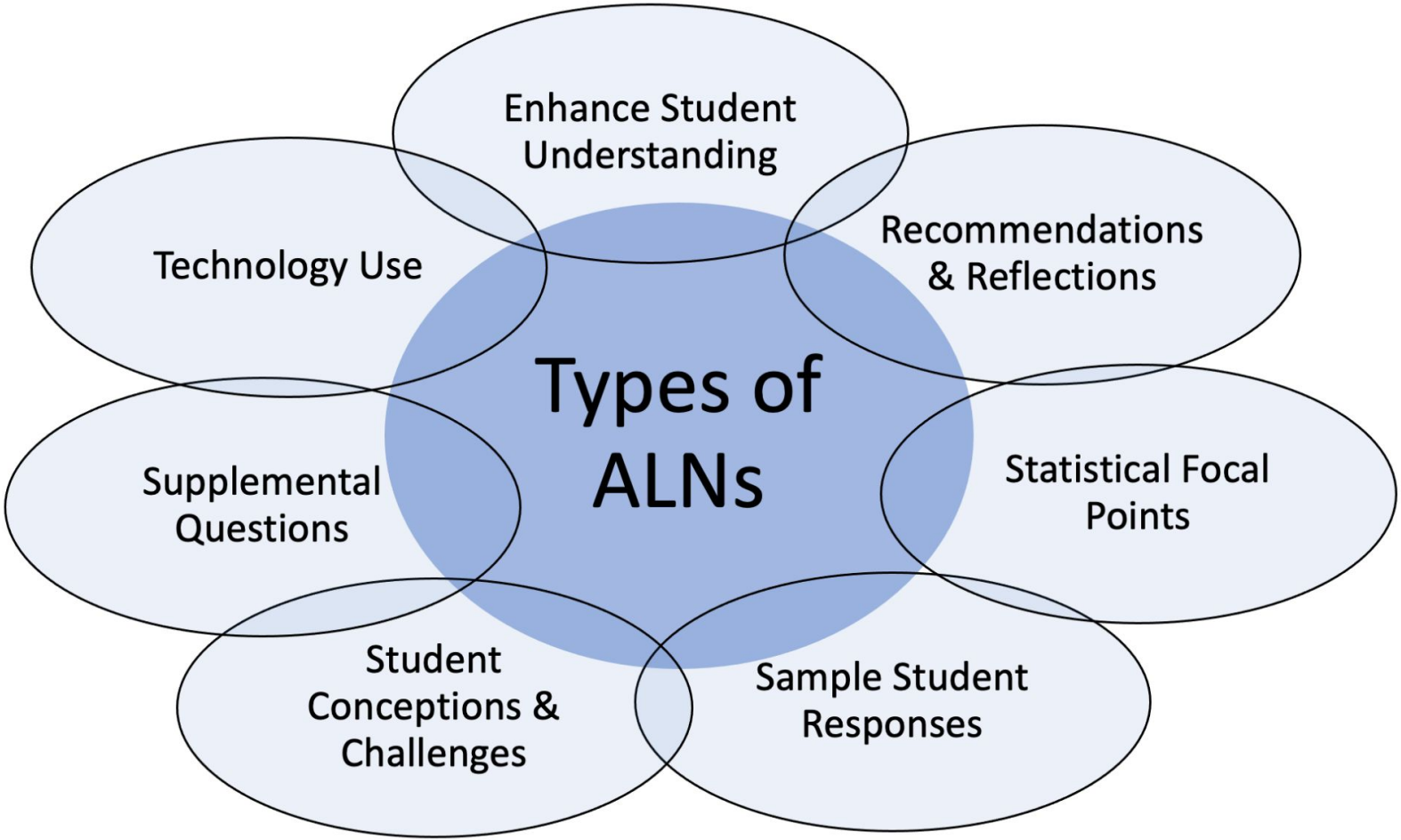
- Notes about possible extensions of the lesson
- Ideas for differentiation
- Teacher reflections on the lesson (student reactions, changes the teacher is considering)
- Recommendations for where to learn more about relevant teaching approaches or statistical content.

Research Question

When secondary mathematics teachers implement a statistics lesson plan that contains different types of annotated lesson notes, how do the teachers' instructional actions compare to what was prescribed in those lesson notes?

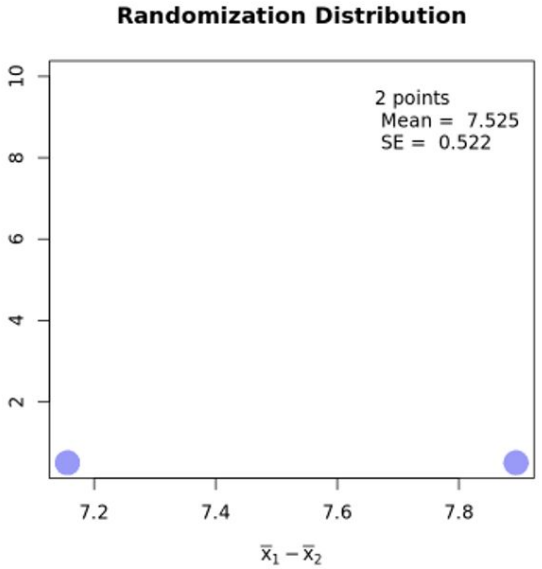
Setting

Context of High School Intermediate Algebra Course	
Daily Schedule: 50-minute class periods each day	Block Schedule: Alternating days with 75-minute class periods
Statistics content standards added near the end of the year	Statistics content standards integrated throughout the year
Two Simulation-Based Lessons with ALNs	
Observational Studies vs Experiments	Interval Estimation and Margin of Error


Types of ALNs
Enhance Student Understanding
Technology Use
Recommendations & Reflections
Supplemental Questions
Statistical Focal Points
Student Conceptions & Challenges
Sample Student Responses

Enhance Student Understanding

Ways a teacher may enhance their students' statistical and conceptual understanding during instruction.



Ask students, "How is one dot created?

How is this web applet mimicking what you did by hand with the cards?

Recommendations & Reflections

Strategies, recommendations, and reflections provided by other teachers who have implemented a similar or previous version of the lesson.

For this class activity, we have found that groups of 2 with 1 computer work well.

The activity works best when students first have time to discuss and think about their answers together in their small groups before any large group discussion.

Sample Student Responses

Sample student responses to teacher-led prompts and activity questions to help an instructor anticipate how students may respond to questions during instruction.

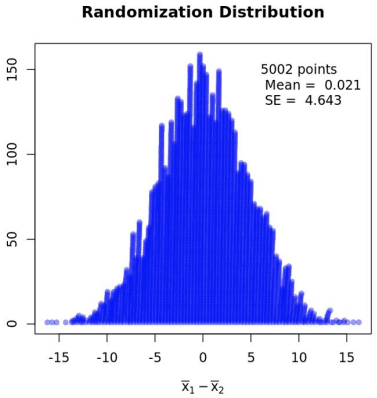
How is one dot created?

- "It's the difference in sample sizes"
- "It's a data point"

Statistical Focal Points

Descriptions of the main statistical ideas present in the lesson and the corresponding activity problems that address them (if any).

Problem #12 is a very important question and addresses the main advantage of a randomized experiment.



In the randomization plot, we can see that there are values far from 0 (such as -7.5, -4.5) which indicate that the mean IQ scores are not always the same between the two treatment groups, but **on average** (indicated by the mean of the randomization plot after thousands of simulations), they are.

Student Conceptions & Challenges

Descriptions of different ways students may conceive statistical ideas and identification of common challenges students may encounter.

14. When we randomly assign people to two groups:

   a. Is it possible for a categorical lurking variable like SAT prep to be imbalanced across the two groups? Explain.

   b. Will the lurking SAT prep variable "usually" be poorly balanced across the two groups? Explain?

Students may struggle with these questions and have trouble understanding the wording, especially "usually." Oftentimes, students think that it isn't possible for a lurking variable to be imbalanced across the two groups because they focus on the center of the randomization plot. Remind students what the endpoints of that plot represent. It <u>is</u> possible that the lurking variable is imbalanced across the two groups, but <u>on average</u>, this is not the case.

Supplemental Questions

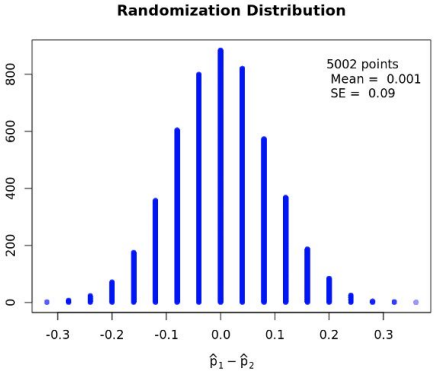
Supplemental questions to help motivate content or extend the lesson plan.

Another lurking variable would be the fact that some students have taken a short course as an ACT prep course and others haven't. This would be a categorical lurking variable. The following set of questions provide students additional practice using the web applet to investigate a categorical lurking variable in the context of randomized experiments.

Technology Use

Descriptions of when using technology may enhance instruction, along with instructions for using technology.

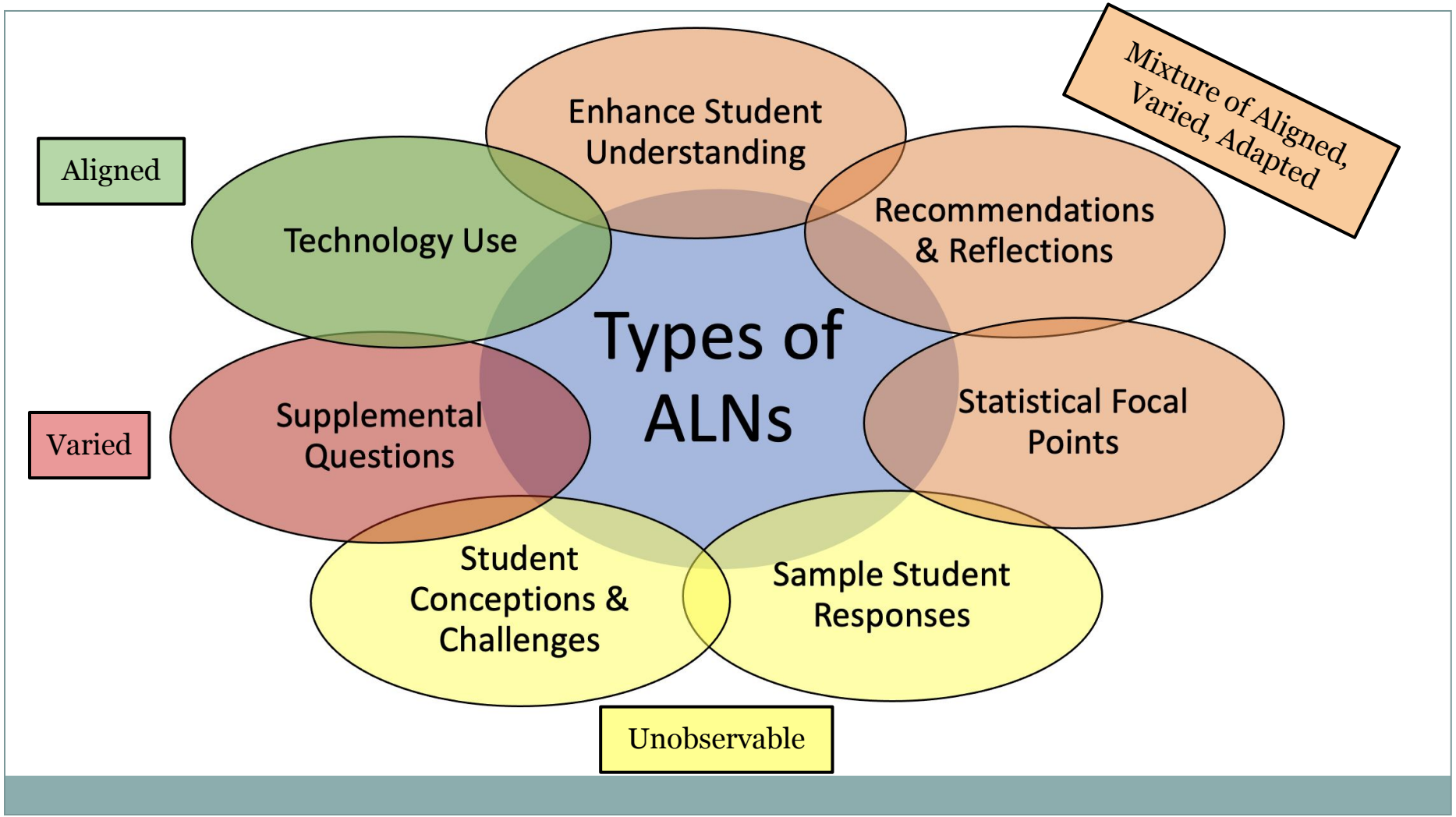
A hidden feature of this web applet is the ability to click on a single dot in the plot. When you click on a dot, a table with appear, displaying the proportions for the treatment and control groups.



Another Randomization

	Prep	n	Prop
Control	14	50	0.280
Treatment	14	50	0.280

Difference in proportions: 0


Types of ALNs
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Sample Student Responses
Aligned
Varied
Unobservable
Mixture of Aligned, Varied, Adapted

Affordances and Limitations

1. Knowledge can be stored in annotated lesson notes!

- Knowledge about teaching statistics was transferred to instruction
  - "Very helpful" (e.g., "one dot" annotation)

- Also include knowledge about what *not* to do during instruction
  - "Avoid using a static diagram of a pre-made sampling distribution because it limits students' opportunities to develop a conceptual understanding of how sampling distributions arise and what they represent."

Affordances and Limitations

2. Include annotated lesson notes directly in activity handouts

- "Essential" annotated lesson notes have a place in both the lesson plan and classroom materials (e.g., "click on one dot")
  - Add questions in the activity such as, "How does this computer simulation relate to the simulation you did by hand at the beginning of the activity?"

Affordances and Limitations

3. Find a balance between details and prep time when writing annotated lesson notes

- It can be time-consuming to read through an annotated lesson plan, understand the annotations, and prepare for instruction.
  - "[They] were not something that I felt like I could pick up, read through it, and say, 'okay, I am ready to go.'"
- Make annotated lesson notes more manageable. Limit the number and types of annotated lesson notes to focus on a few key concepts

The Evolution of Annotated Lesson Notes

Groth (2015, p. 14) - *"[it's] imperative that curriculum development not end with the production of written curriculum."*

- How can we capture and monitor improvements to continue building and storing a knowledge base for teaching statistics?
  - Developing a dynamic system (with hyperlinks) that enables teachers to update and revise annotated lesson notes

- Our categorization of different types of annotated lesson notes can be useful for organizing and communicating different ideas about teaching statistics.

Thank You!

Questions?

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