UNIVERSITY of HAWAI'I HILO

Data Explorations in Ecology: Secondary Students' Knowledge, Skills and Attitudes Towards Data

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- Student participants
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Cary Institute of Ecosystem Studies

NSF

Next Generation Science Standards – Science Practices

BOX 3-1

PRACTICES FOR K-12 SCIENCE CLASSROOMS

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Data Literacy Skills

National Research Council. 2012. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.*


The data don't predict a tsunami with absolute certainty. I still say we wait.
NUEZ 10

I don't think we can ignore these data; after all, his book was on the best-seller list.

Data Exploration in Ecology Project (DEEP)

- PD focused on data literacy
- Teachers in SE and central NY
- Curricular materials on local problems (fracking, salt, etc.) blending work with first and second hand data
- Collected data on 14 MS and HS teachers and 356 students
- ½ students in 7th or 9th grade classes – basic environmental science, earth science, Living Environment
- ½ students in 10th-12th grade classes – advanced environmental science, marine science, research, electives

DEEP Research Questions

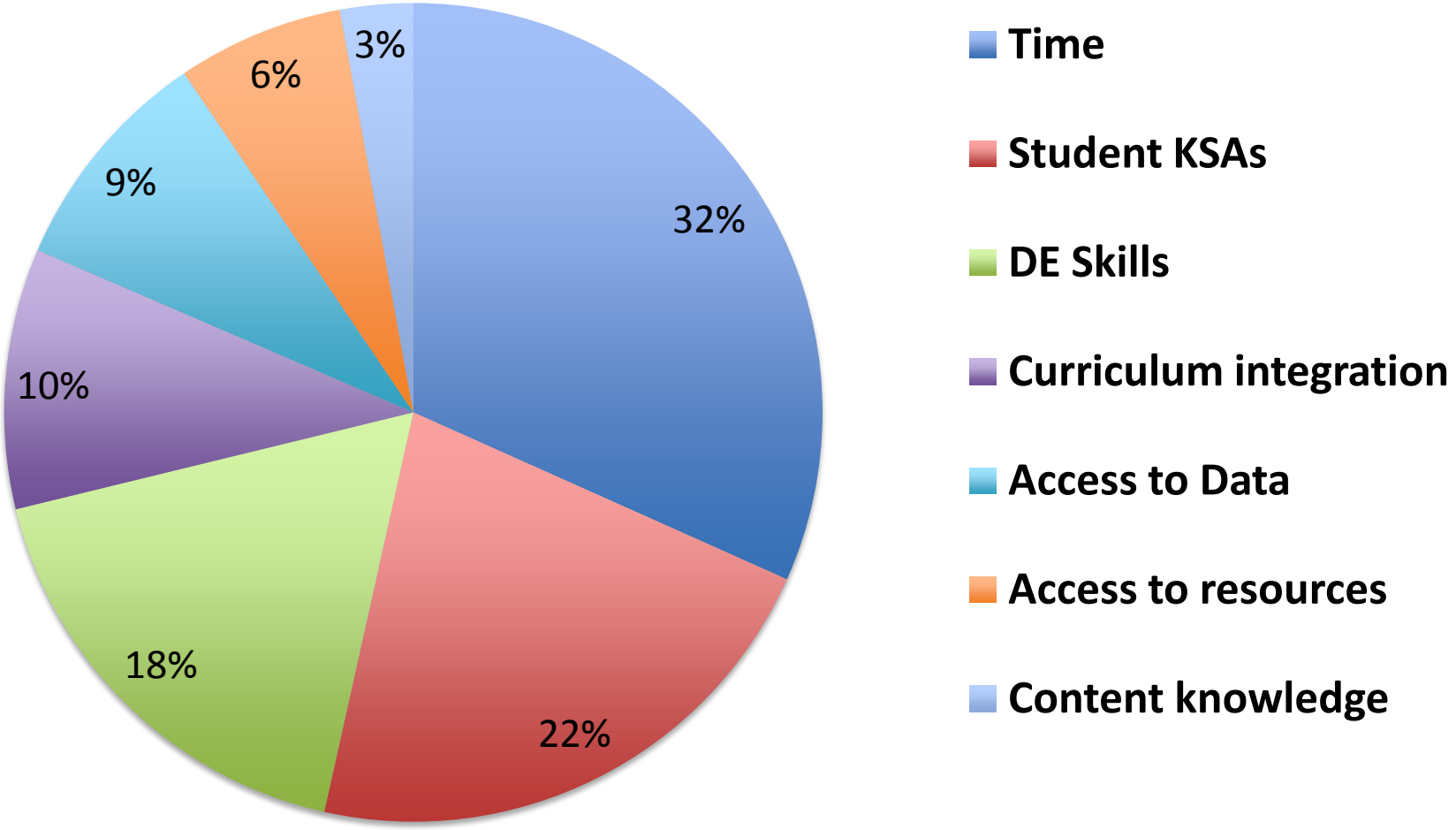
1) What data activities are common in secondary schools and what factors support and constrain teachers' implementation of instruction that targets data literacy skills?

2) What are secondary students' knowledge, skills, and attitudes toward data?

Classroom Data Practices

More Common	Less Common
First hand data collection	Processing, manipulating, analyzing data
Making representations	Discussing strengths and limits of different representations
Discussing sources of variability	Reasoning about variability
Constructing arguments based on evidence	Critiquing arguments based on evidence

Teacher Described **Constraints** to Implementation



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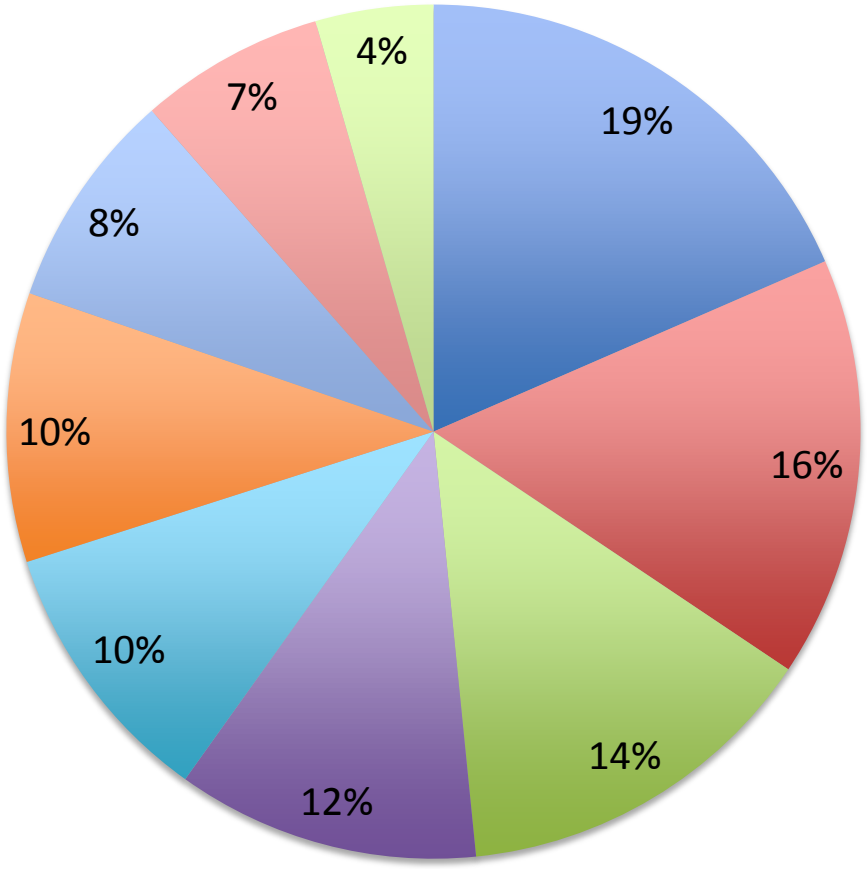
Teacher Described **Supports** to Implementation



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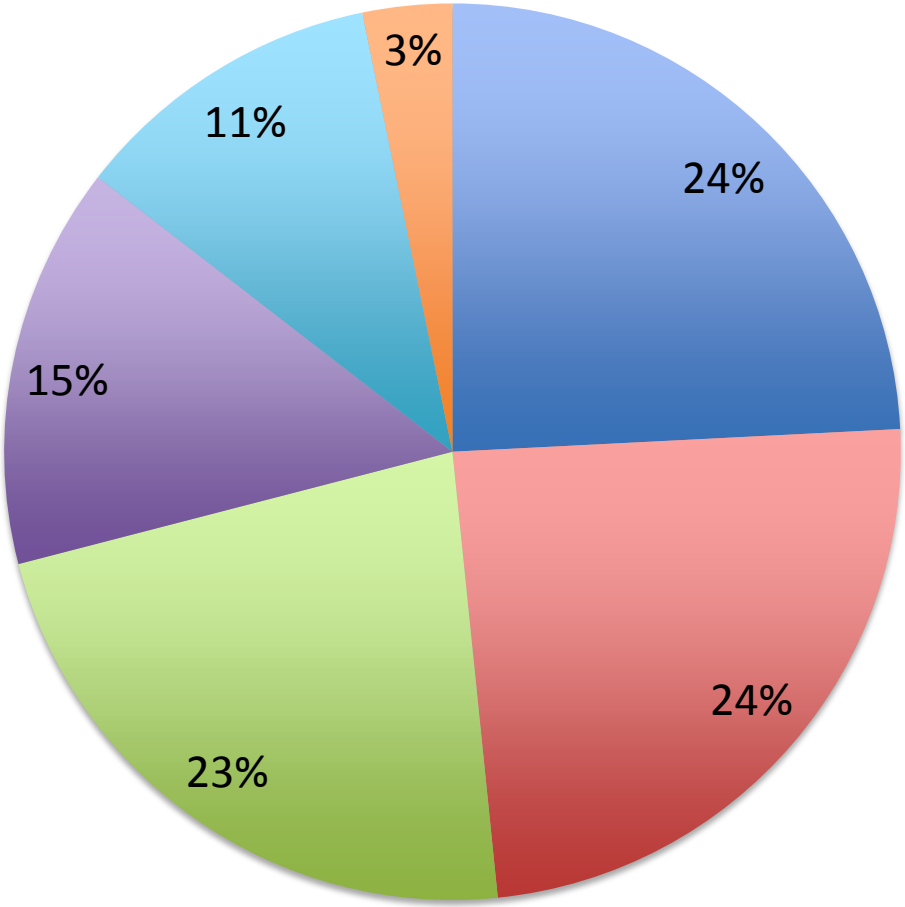
- **Student KSAs - data collection**
- **Participation in a PLC**
- **Working with Cary scientists**
- **Engagement in PD activities**
- **PD provider support**
- **Curriculum materials**
- **Teacher learning**
- **Involvement in module development**
- **Timing of the PD workshops**

Teacher Described **Motivations** to Teach Data Exploration



- DE makes science lessons more authentic
- DE is interesting or enjoyable for students
- DE skills are important
- Teacher learning
- Teaching about DE is interesting or enjoyable
- Being treated like a professional

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DEEP Research Questions

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2) What are secondary students' knowledge, skills, and attitudes toward data?

Identifying and Interpreting Data Representations

	7th and 9th (n=194)	10th – 12th (n=162)
Identify bar graphs	99%	99%
Identify line graphs	91%	93%
Identify scatter plot graphs	80%	84%
Identify basic trends when shown basic line graphs or scatter plots	91%	97%
Identify data tables and bar graphs with error bars	**24%**	**67%**

*Students across grades are familiar with, and able to identify basic trends in certain kinds of data representations but they have a limited range of representations they are comfortable with

Understanding Variability

	7th and 9th (n=302)	10th – 12th (n=318)
Identify variability in data	72%	95%
Provide a correct description or definition of variability	54%	82%
List two possible causes or sources of variability	64%	82%

*Across grade levels the most common descriptions of variability included variability as changes or fluctuations in data (32%), differences in data (23%) and a measure of deviation from the average (8%).

Implications of Variability in Data

	7th and 9th (n=302)	10th – 12th (n=318)
No idea of why it is important to think about variability in a set of data	**41%**	**31%**
Variability influences confidence in a claim	4%	14%
Variability is an indication of potential measurement error	4%	18%
Variability shows a change in general	12%	4%
Variability provides more information in general	10%	8%
Variability in data provides evidence of natural variations in a system.	18%	20%

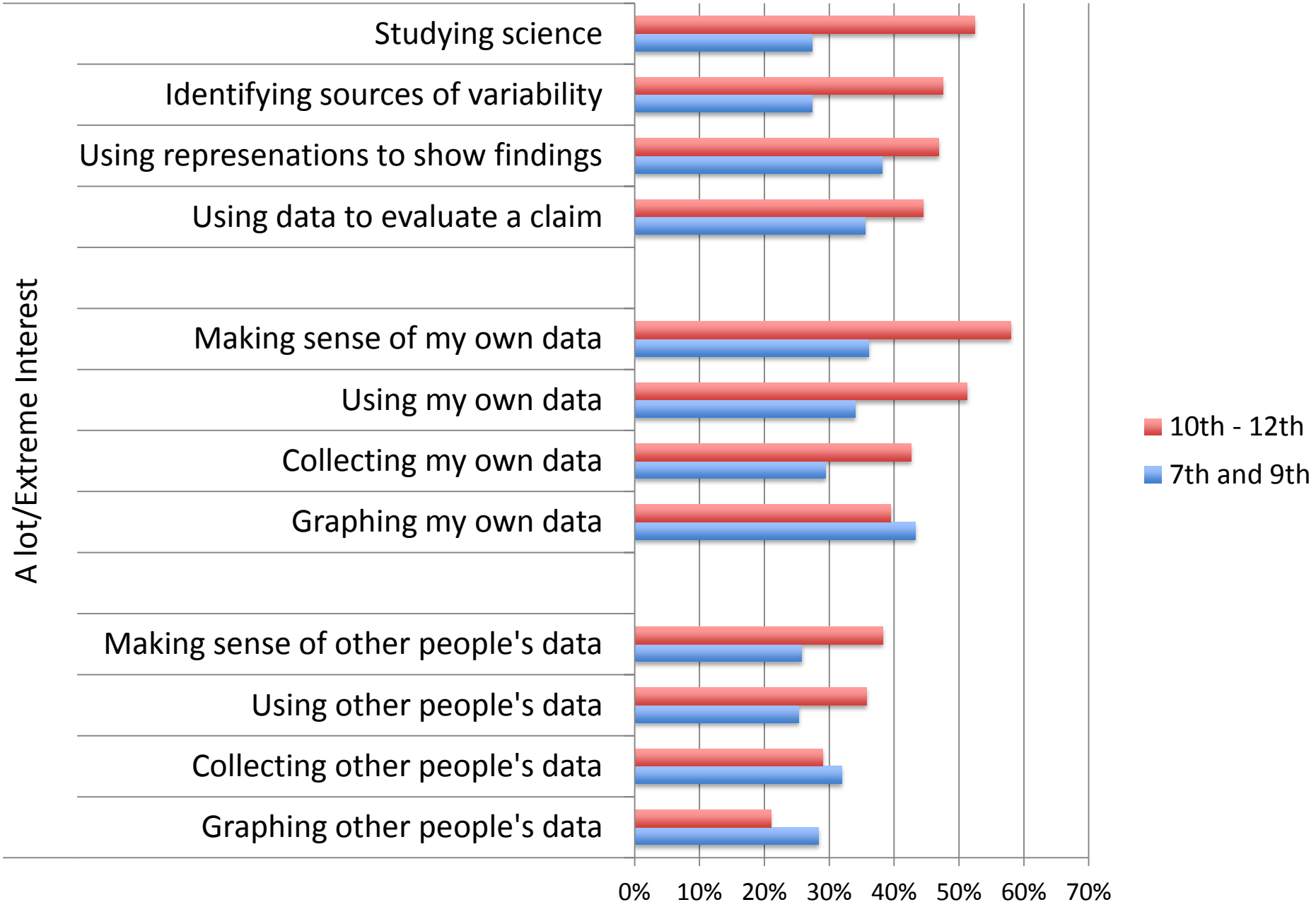
Evaluating Claims Based on Evidence

	7th and 9th (n=302)	10th – 12th (n=318)
Cite data when evaluating a claim supported by a chart or graph	14%	42%
Cite data when evaluating claims made in an article that references data	9%	32%
• Insufficient amount of data to support the claims made	7%	20%
• Data were not relevant to the claim	1%	4%
• Insufficient amount of information about the data	1%	3%
• Insufficient data to show causation		10%
• Cite source bias		4%

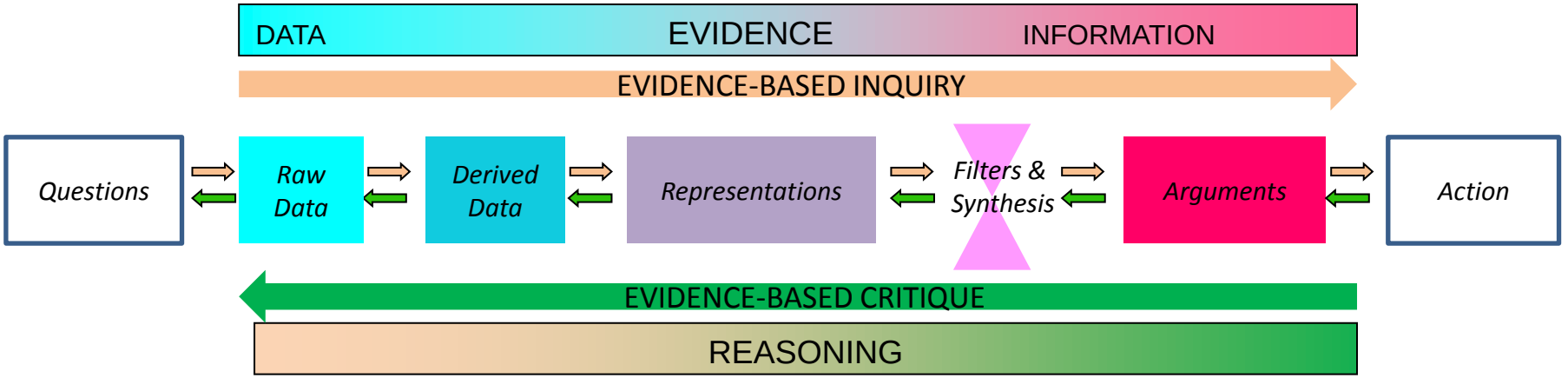
In General ...

- Most students can define and identify variability, and list potential sources, with HS > MS
- Few students can explain why variability is important for answering a scientific question, or making a claim or a prediction.
- Students in both the lower and upper grades have data exploration knowledge and skills that are useful in helping them evaluate claims based on the data provided, but they seldom use these skills in the (citizenship based) contexts where they are most pertinent.

Student Interest in Data Exploration Practices



An Evidence- and Reasoning-Based Critique and Inquiry Framework



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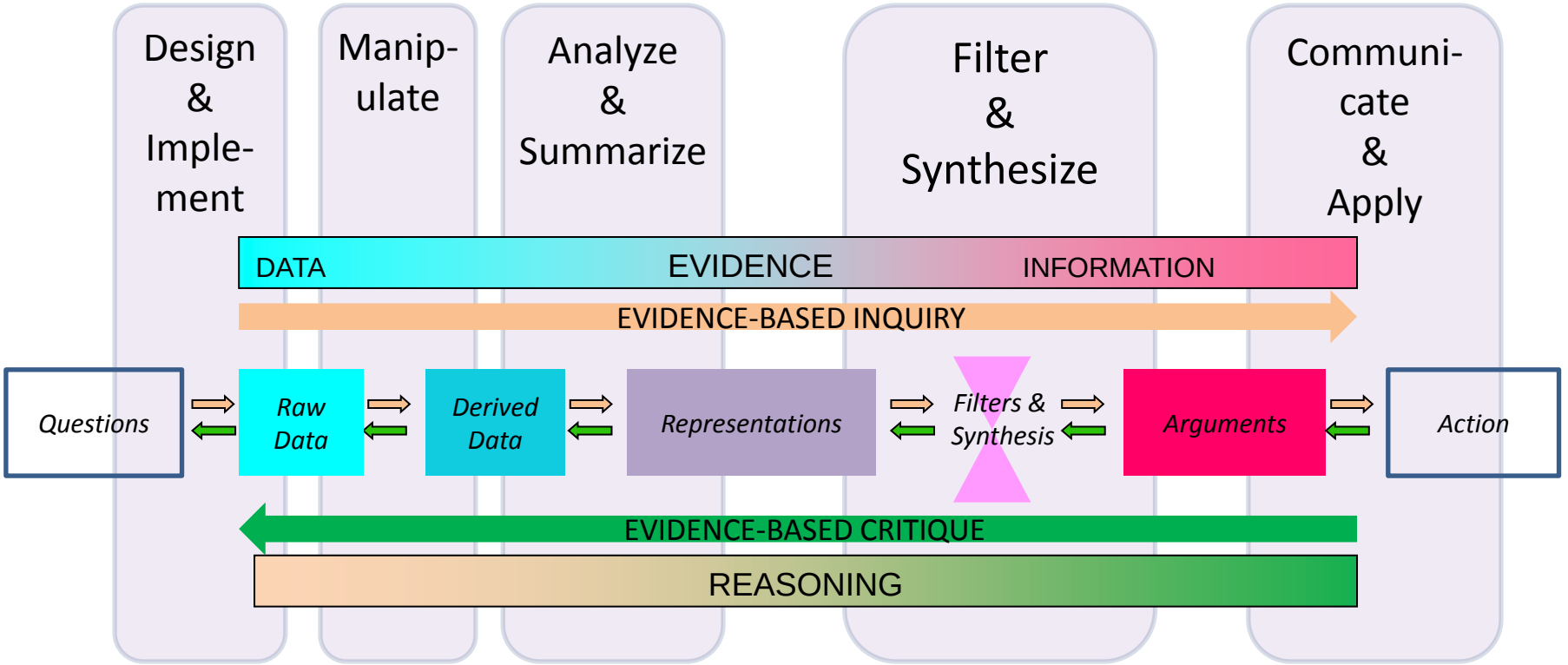

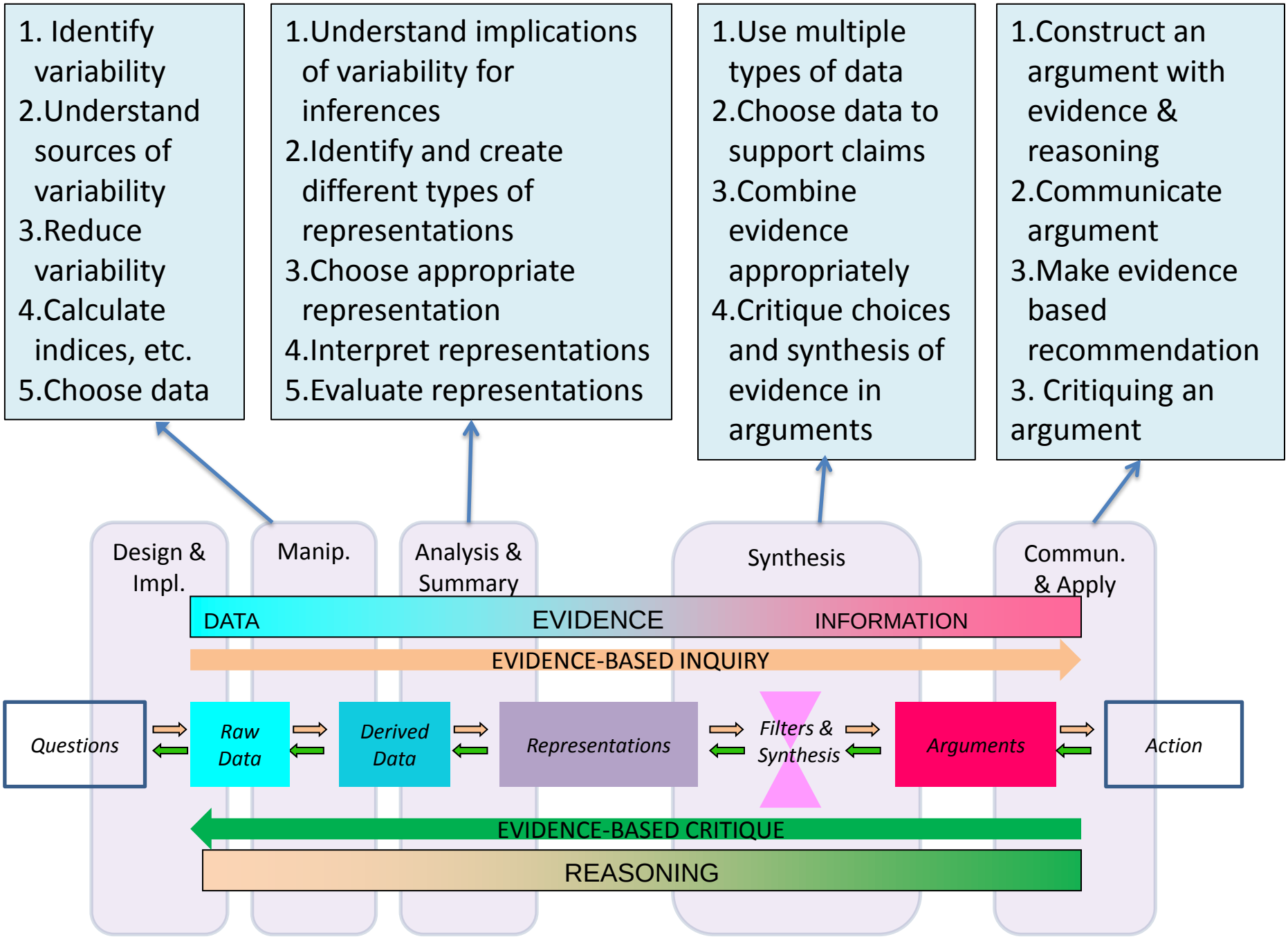
1. Identify variability
2.Understand sources of variability
3.Reduce variability
4.Calculate indices, etc.
5.Choose data
1.Understand implications of variability for inferences
2.Identify and create different types of representations
3.Choose appropriate representation
4.Interpret representations
5.Evaluate representations
1.Use multiple types of data
2.Choose data to support claims
3.Combine evidence appropriately
4.Critique choices and synthesis of evidence in arguments
1.Construct an argument with evidence & reasoning
2.Communicate argument
3.Make evidence based recommendation
3. Critiquing an argument
Design & Impl.
Manip.
Analysis & Summary
Synthesis
Commun. & Apply
DATA
EVIDENCE
INFORMATION
EVIDENCE-BASED INQUIRY
Questions
Raw Data
Derived Data
Representations
Filters & Synthesis
Arguments
Action
EVIDENCE-BASED CRITIQUE
REASONING

DEEP Research Instruments and Curricular Materials

https://sites.google.com/site/teachingecosystemliteracy/Home/deep

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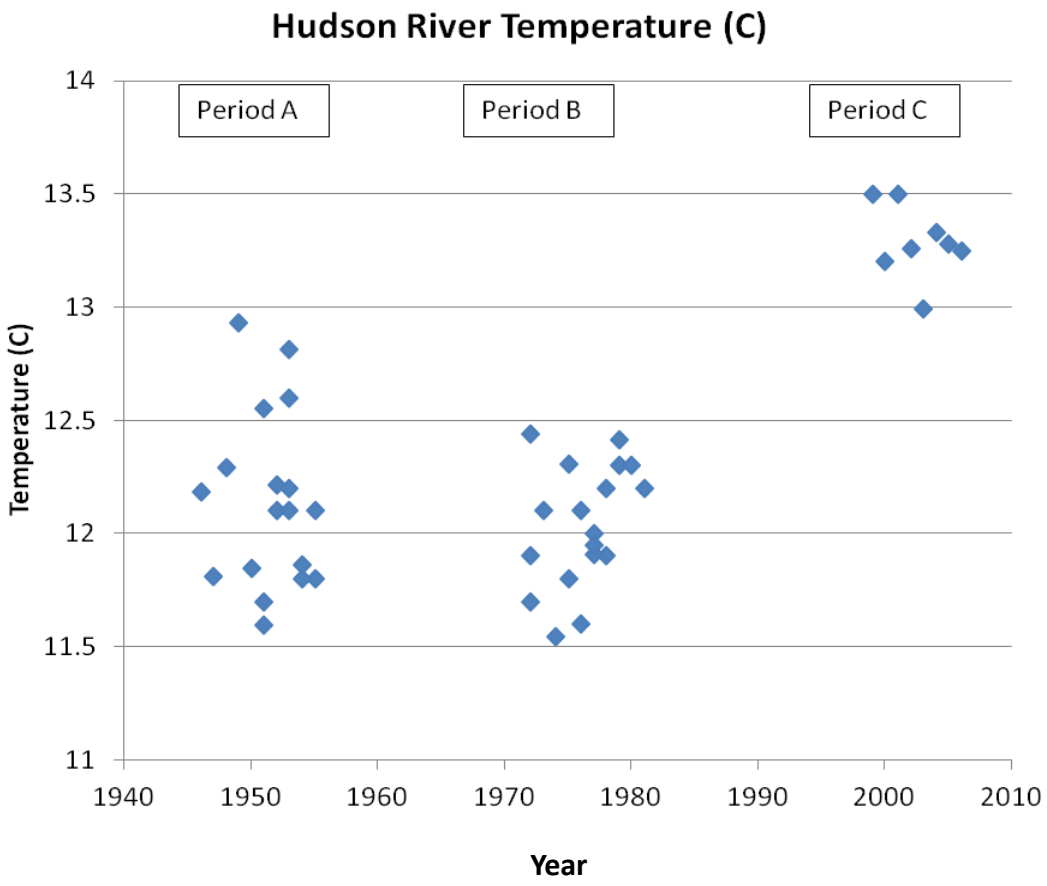
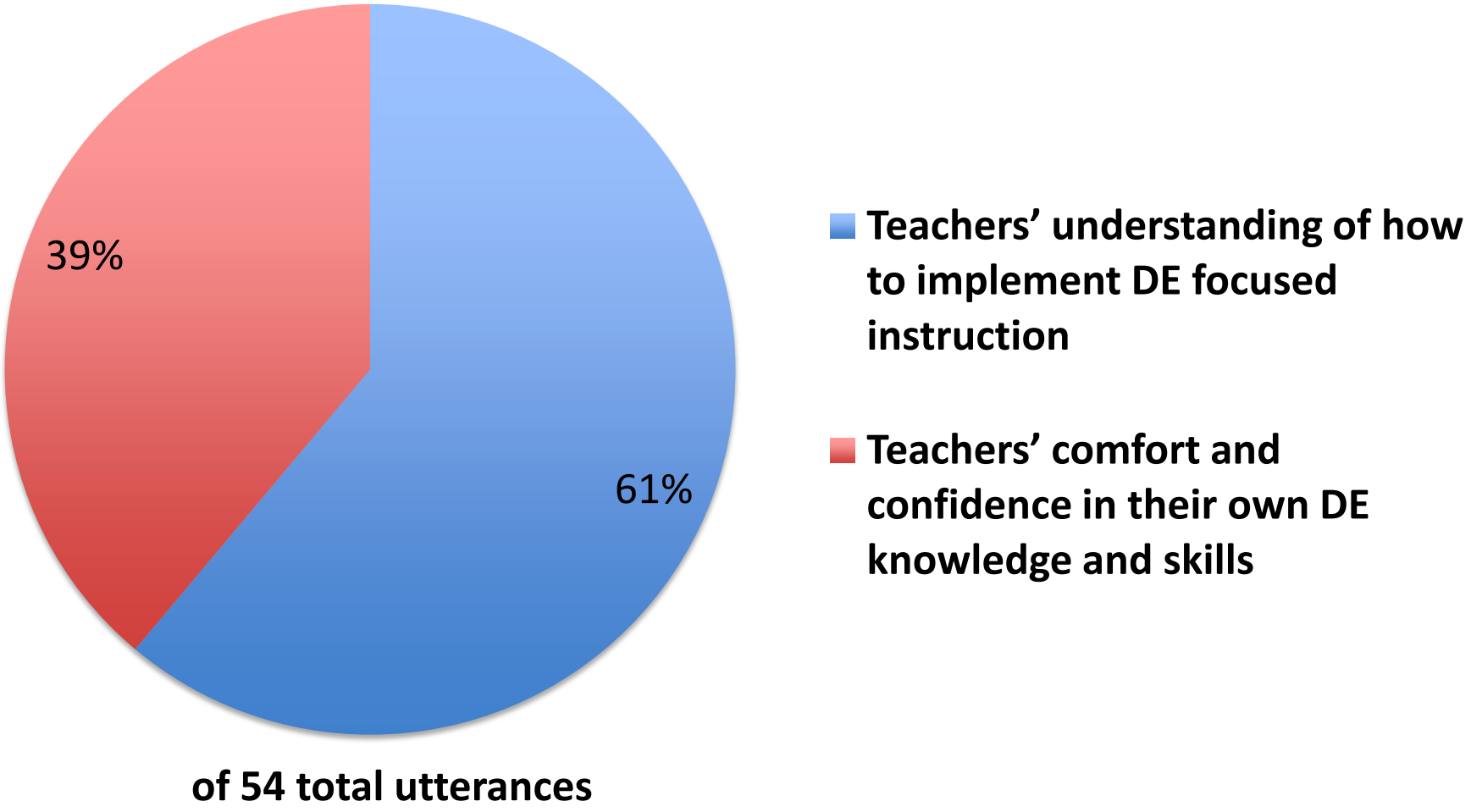
Example Item

1. Look at the temperature data at different times within EACH of the three periods. Compare them and then decide which period shows the most variability. *Explain why you picked that period.*

2. *Please list at least two possible causes or sources of this variability*



Factors Influencing Teachers' **Self-Efficacy** Regarding Teaching About Data



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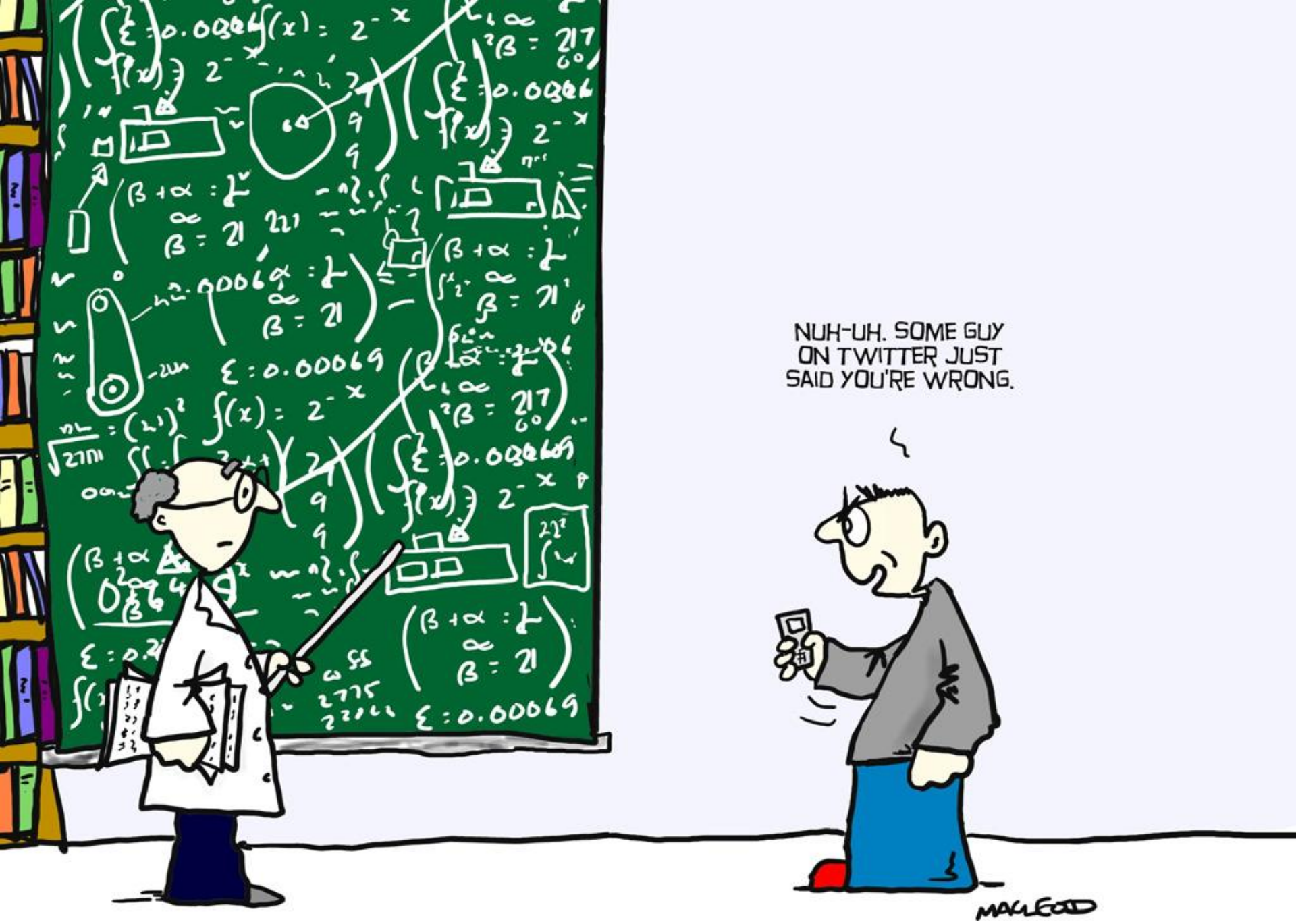

Student Attitudes Toward Data Exploration Practices