Hold My Calls:
Introducing the Statistical Process with Activity

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“Every high school graduate should be able to use sound statistical reasoning to intelligently cope with the requirements of citizenship, employment, and family and to be prepared for a healthy, happy, and productive life.”

Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report: A Pre-K-12 Curriculum Framework. Franklin, et.al (2007)

Statistical Reasoning

Gal (2000, 2002)

The ability to problem solve and reason with data in a way that makes data succinct and understandable.

Four standard phases of statistical work:

1. Specify the problem and outline a plan
2. Collect the required data
3. Analyze and represent the findings
4. Interpret and discuss the findings

Statistical reasoning in the classroom

Garfield & Ben-Zvi (2007), p. 374

"Inappropriate reasoning about statistical ideas is widespread and persistent, similar at all age levels, and quite difficult to change"

Garfield & Ben-Zvi (2009)

To create environments that scaffold learning and engage students, instructional strategies must provide support so that students can experience the full range of the statistical process

Things that we don't let students experience

(often enough, at least)

1. Enter the problem
2. Allow for dissonance
3. Make connections to existing topics

A Model of the Statistics Process

Franklin, et. al (2005). *Guidelines for Assessment and Instruction in Statistics Edcuation (GAISE): A Pre-K-12 Curriculum Framework.* Alexandria, VA: American Statistical Association

1. Formulate Questions - *Anticipating Variability*
2. Collect Data - *Acknowledging Variability*
3. Analyze Data - *Accounting for Variability*
4. Interpret Results - *Allowing for Variability*

Organized into three sequential developmental levels. As students progress across levels, learning is increasingly student-directed and engagement is more nuanced and sophisticated.

How do we help students (and teachers) understand and experience the statistics process?

According to the National Safety Council, cell phones are a factor in 1.3 million traffic accidents, resulting in thousands of deaths, each year. Many people have conjectured that this is due to decreased reaction time and attentiveness

Adapted from the STatistics Education Web (STEW) of the American Statistics Association

Formulate Questions

GAISE Report
p. 11, 16

A statistics question does not “anticipate a deterministic answer”, but instead “anticipate an answer based on data that vary”.

Question should be specific enough to define and clarify the problem, and should be addressable with data, but not directed at an issue that can be resolved with a single data point.

Does cell phone use impact reaction time?

Collect Data

GAISE Report
p. 11-12

Data collection acknowledges variability, by reducing potential alternative sources of variability. We want to emphasize that reaction times will vary by individual and investigate the impact that cell phone use has on the variability, minimizing other potential sources of variability.

What are some other potential sources of variability?

Data Collection Procedures

Option 1 (technology required):

Work in pairs

Measure reaction time using humanbenchmark.com (take mean of 5 trials)

Each group do one trial without cell phone and one trial while talking to each other on cell phones.

Option 2: (no technology required):

Work in groups of 4 (two pairs)

Measure reaction time by catching a ruler dropped by a partner. The point where it is caught measures reaction time.

Each group does a trial without cell phones and one trial where two “catchers” talk on cell phones

Simulating a Conversation

Each person will come up with a list of 10 words.

During cell phone conversation, Person A will list their 10 words. Person B will repeat back as many as he or she can while Person A keeps track of how many B gets correct.

The roles then reverse.

Data Collection Procedures

Both of these procedures leave open other possible sources of variability. What norms and procedures do we need to establish?

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Reaction time w/o cell phone (ms)	Reaction time w/ cell phone (ms)	Reaction time w/o cell phone (ms)	Reaction time w/ cell phone (ms)
583	677	684	749
593	741	451	652
691	1162	410	528
495	527	572	711
574	920	637	1248
523	683	609	745
457	512	561	645
487	506	455	575
588	761	573	711

Reaction 'time' w/o cell phone (in.)	Reaction 'time' w/ cell phone (in.)	Reaction 'time' w/o cell phone (in.)	Reaction 'time' w/ cell phone (in.)
12	34	6	20
9	19	7	11
5	14	8	36
11	22	11	33
5	6	14	20
15	18	9	16
6	10	13	19
9	13	9	14
12	22	7	16

Analyze Data

GAISE Report
p. 12

"Accounting for variability with the use of distributions is the key idea in the analysis of data."

Data analysis uses statistical tools to make sense of the variability in the data.

Reaction time w/o cell phone (ms)	Reaction time w/ cell phone (ms)	Reaction time w/o cell phone (ms)	Reaction time w/ cell phone (ms)
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Types of Analysis

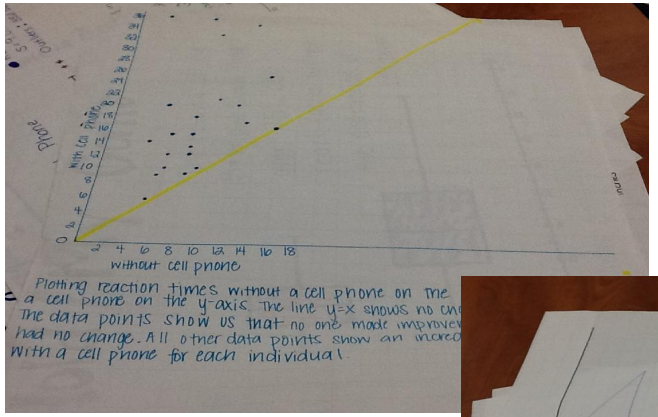
Participants in this example were asked to analyze the data by creating a graph.

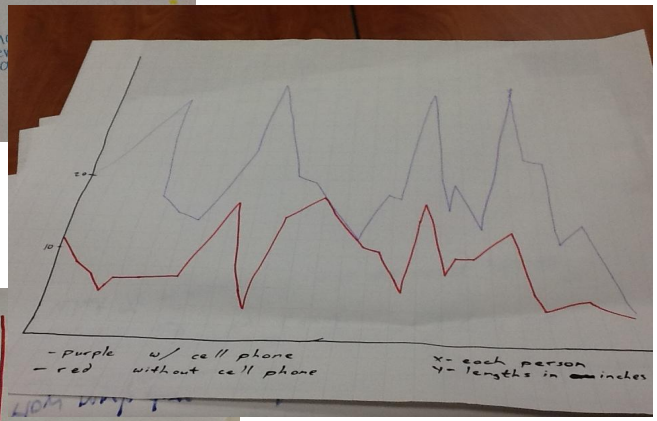
Groups took several different different approaches to their analysis

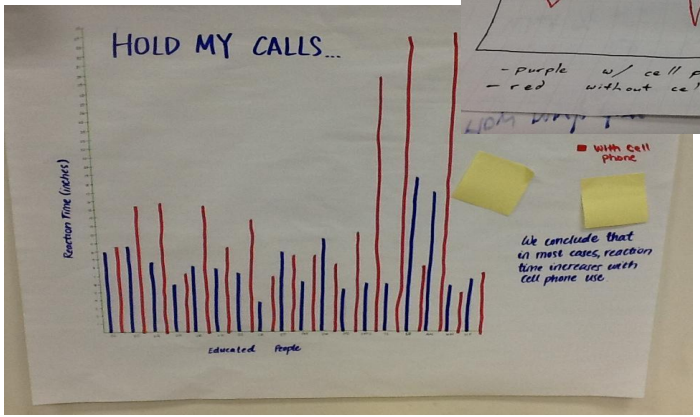
	Conditional	Difference
Individualized	Graph compares each individual's reaction time for each condition: with and without cell phone	Graph illustrates the difference in two reaction times for each individual
Aggregate	Graph compares the aggregate data for each condition: with and without cell phone	Graph illustrates the difference in reaction time for the overall data set, instead of by individual

Individualized - Conditional Graphs

Graph compares each individual's reaction time for each condition: with and without cell phone.

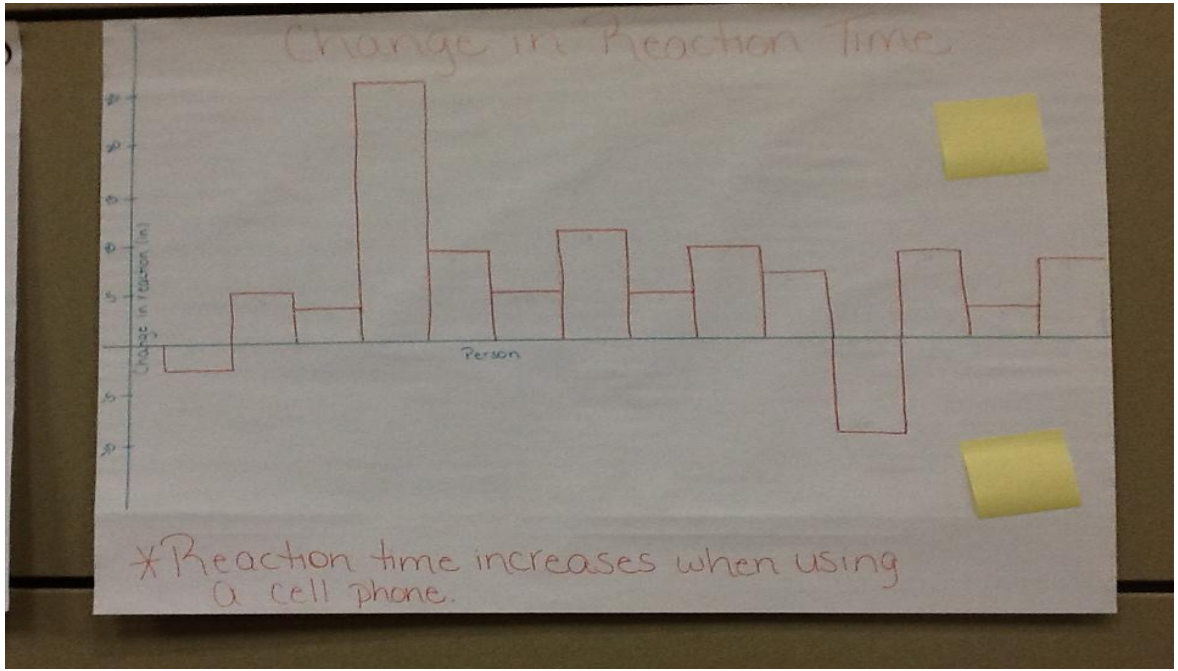






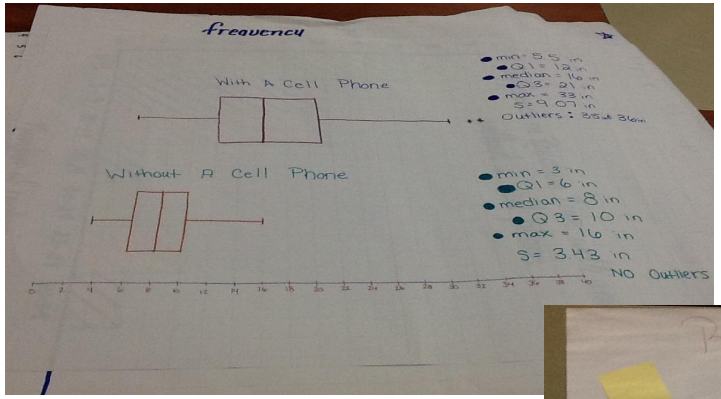
Individualized - Difference Graphs

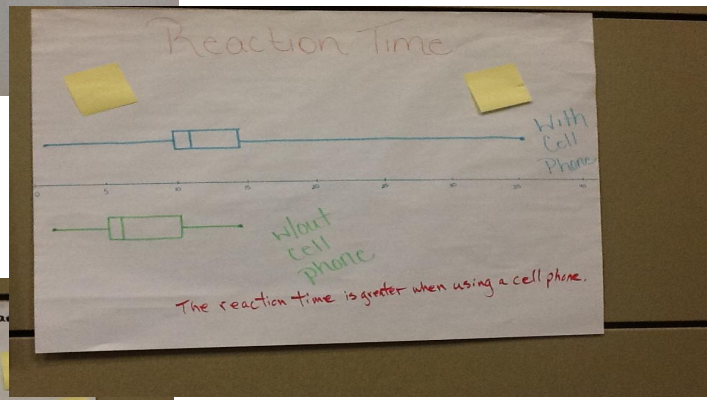
Graph illustrates the difference in two reaction times for each individual

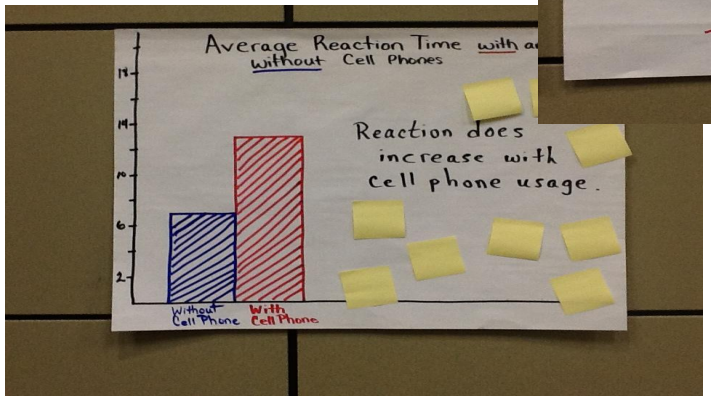


Aggregate - Conditional Graphs

Graph compares the aggregate data for each condition: with and without cell phone

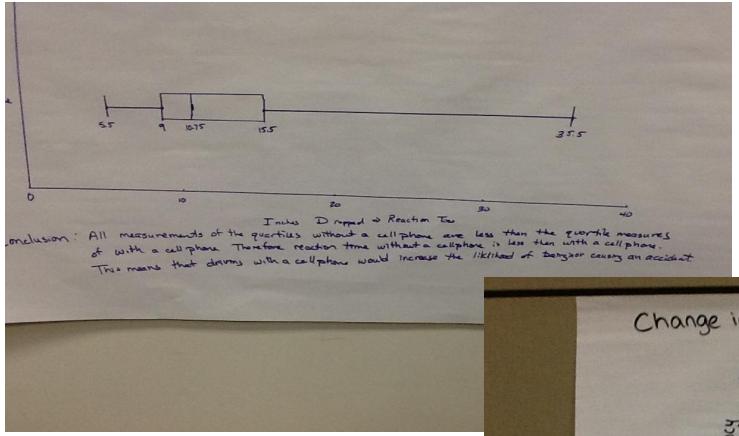


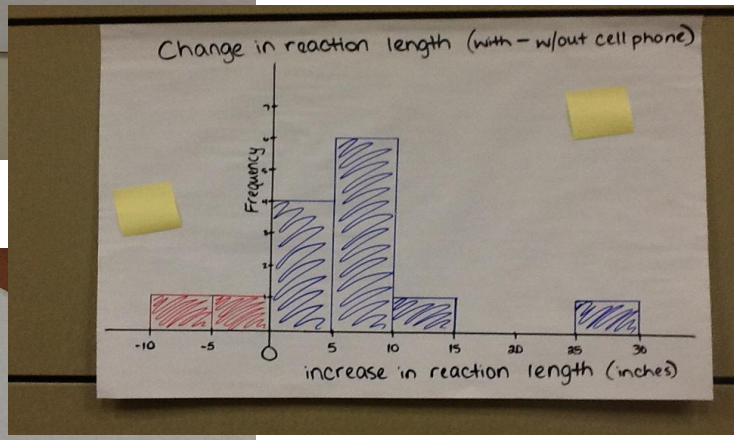


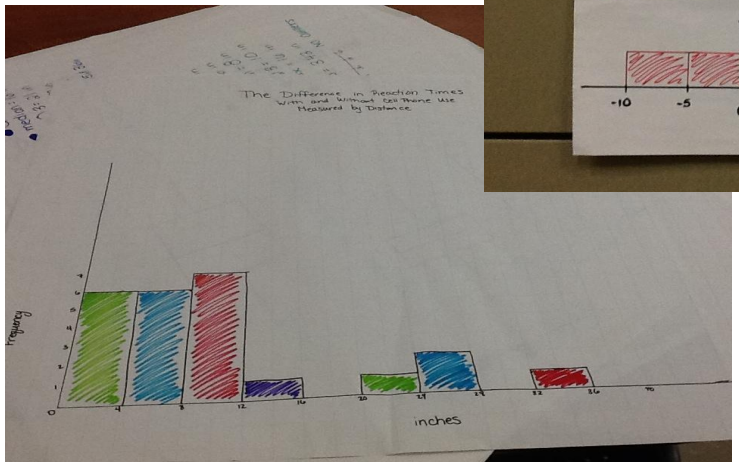


Aggregate - Difference Graphs

Graph illustrates the difference in reaction time for the overall data set, instead of by individual







Interpret Data

GAISE Report
p. 12

"Looking beyond the data to make generalizations must allow for variability in the data."

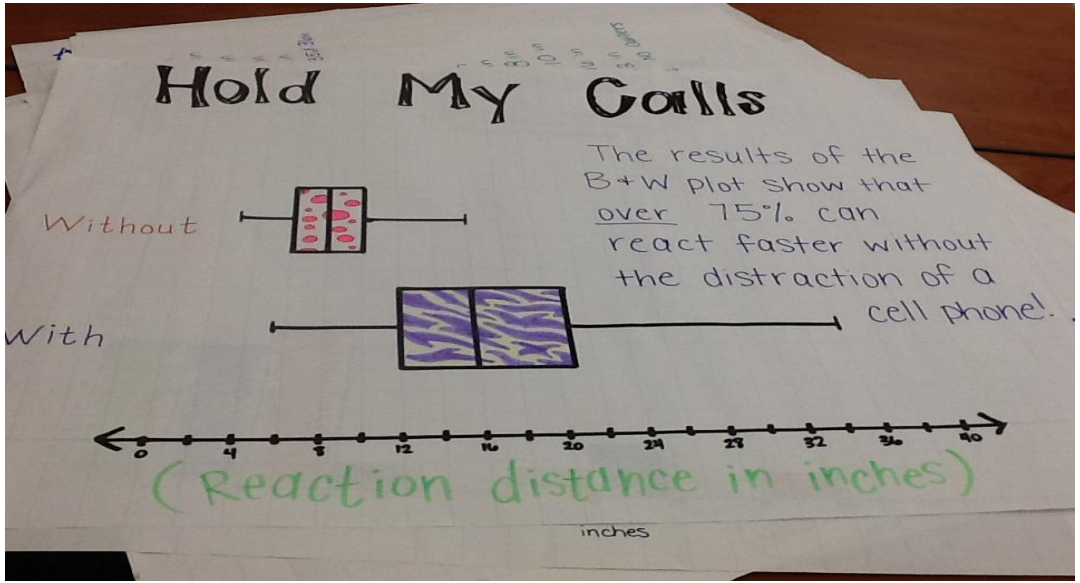
In interpretation, we try to generalize results, allowing for variability and its impact on generalizability, not making any unwarranted claims

Interpretation of Data

Each table group was asked to write the conclusions they could draw from their graphs.

To emphasize the importance of interpreting results in a meaningful and well-supported way, participants were asked if they were confident enough in their conclusions to:

1) change their own behavior.
2) use it as evidence to influence the behavior of others.
3) present it to others



Adapting the lesson

The goal is to engage with the statistical process - that guides the structure of this particular lesson. How might it be adapted?

See your handout with the GAISE framework adjusted by level

- To adjust the GAISE level?

- To emphasize different content or ideas?

Final Thoughts ...

1. Students need a chance to engage in **all** phases of the statistical process
2. Levels of engagement and understanding are progressive
3. Different phases can be emphasized depending on instructional goals, and different phases can be at different levels

Thank you!

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