Informal Comparative Inference: What is it?
Hand Dominance and Throwing Accuracy

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Logistics: This activity addresses mathematics content standards for seventh-grade, but can be adapted for use in sixth-grade and eighth-grade. Additionally, this material can be extended for use in high-school by incorporating experimental design and sampling simulation.

Students will be throwing foam balls at a target placed a distance of 2 meters from a wall. It is recommended that the data collection portion of the activity be completed in a large, open space or a hallway. This activity can also be done in a larger classroom.

Hand Dominance Materials:

for each team of four students:

- *Target template*
- *Foam Ball (3 ½" to 4" preferred)*
- *Painter's Tape*
- *Meter stick*
- *Post-it note sheets (3" x 3")*
- *Markers*
- *Sentence Strips*
- *Computer with Internet Access (optional)*
- *Graphing Calculator (optional)*
- *Student pages (for each student)*

Estimated Time:
Introductory Discussion: 15 minutes
Data Collection: 30 minutes
Data Analysis: 45 minutes
Interpret and Present Results: 30 minutes
Difference Data Analysis and Interpretation: 30 – 45 minutes

Objectives/Standards:
The objectives of this activity are to:

- Discuss the criteria for statistical questions and generate potential statistical questions related to the topic of handedness. **CCSS.Math.Content.6.SP.A.1**
- Develop a strategy for randomizing experimental treatments and discuss the rationale for randomization. **CCSS.Math.Content.7.SP.A.1**

NOTES

- Create appropriate graphical representations of data, such as dot plots and box plots.
  CCSS.Math.Content.6.SP.B.4
- Find, use and interpret measures of center and spread.
  CCSS.Math.Content.6.SP.B.5
- Use informal comparative inference to make claims about the underlying populations.
  CCSS.Math.Content.7.SP.B.3; CCSS.Math.Content.7.SP.B.4
- Justify claims using a claim-evidence-reasoning strategy.
- Extend discussion to using differences in measured treatment values by subject to support inferences about the populations.

References to Next Generation Science Standards adapted from NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press

NGSS Science and Engineering Practices: SEP1, SEP3, SEP4, SEP7
Common Core Standards for Mathematical Practice:
CCSS.Math.Practice.MP1, CCSS.Math.Practice.MP2, CCSS.Math.Practice.MP3, CCSS.Math.Practice.MP4, CCSS.Math.Practice.MP5
Common Core State Standards ELA/Literacy: CCSS.ELA-Literacy.RI.5.4, CCSS.ELA-Literacy.SL.5.1, ELA-Literacy.W.5.1.C

Introduction:

According to the Guidelines for Assessment and Instruction in Statistics Education (GAISE) PreK-12 Report, students should have the opportunity to engage in statistical inquiry. This inquiry is seen as an investigative process that incorporates the following components: formulating and/or refining a question that can be answered with data, designing an appropriate data collection plan, using graphical and numeric methods to analyze the collected data, and interpret the results to address the original question under investigation. Thus, the purpose of performing comparative reasoning is established through the investigative question and inferences to the population from which the sample is drawn can be made in context.

At the middle-school level, students are not expected to perform inferential reasoning through formalized confidence intervals and hypothesis tests. Rather, students should begin reasoning about populations through a construct known as **informal inferential reasoning**. Zieffler, Garfield, Delmas, and Reading (2008) have defined informal inferential reasoning as "the way in which students use their informal statistical knowledge to make arguments to support inferences about unknown populations based on observed samples." Thus, students are expected to make

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generalizations that extend beyond the data that is in front of them. To make these generalizations, students will use features of the data in hand as evidence for their claims. Probabilistic language is employed to illustrate the uncertainty in making these generalizations. It is important to define the population of interest and also to define the sample. Randomizing sample selection (representation) and increasing sample size can informally be discussed relative to confidence in making a generalization to a population.

For activities designed to engage students in making informal inference, it is essential to activate the reasoning process without relying on probability distributions and formulas. Students should reason about the possible characteristics of a population based on a sample of data, reason about possible differences between two populations based on observed differences in sample data, and reason about whether or not a particular sample of data is surprising based on a claim (Zieffler, 2008).

Informal comparative inference, in conjunction with informal inferential reasoning, asks students to reason about the possible differences between two populations based on the observed differences in the sample data that is available. Thus, students must be aware that differences in the sample data can potentially be used to make claims about differences in the underlying population. Students need to make a judgment on whether or not they believe the differences are due to chance alone or due to some other effect. To accomplish this, students need to have some understanding of the idea that "their" sample data is but one possible sample that could be obtained. "What if…?" questions can be posed relating to samples obtained by students in other classrooms, or in other schools, to allow students to reason about potential variability from sample to sample.

For middle school students, box plots provide a mechanism for looking at differences in the sample data. Pfannkuch (2006) identifies eight elements of reasoning that can be drawn from the comparison of box plots:

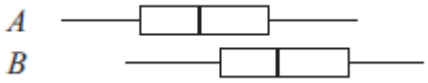
1. Hypothesis generation (to reason about the overall trend)
2. Summary (students compare equivalent and non-equivalent five-number summary values)
3. Shift (in comparing boxplots, this refers to the relative "shift" in location between box plots)
4. Signal (comparing overlap of middle 50% (box) of data)
5. Spread (looks at spread within and between box plots)

NOTES

6. Sampling (comparing sample size, what might happen if another sample was drawn, and the population on which to make an inference)
7. Explanatory (views the data in light of the context in order to figure out if the findings make sense, considers alternative explanations)
8. Individual case (addressing outliers and comparing individual cases)

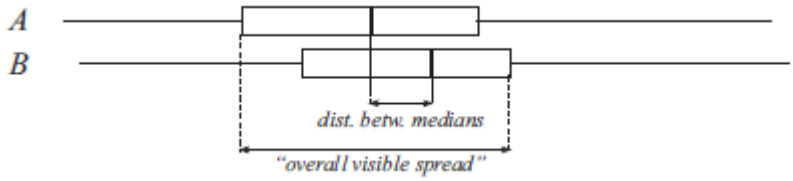
In general, the more a box plot is visually "shifted" from another box plot (little overlap) the more compelling the evidence might be for supporting a claim about a population. There are no clearly identified "rules" for making a claim whether or not one observed difference in say, the median, presents a large enough shift to make a claim of a difference in the population. Chris Wild (2011) provides a diagram which may prove useful for teachers when trying to teach this concept:

If there is no overlap, or only a very small overlap make the claim "*B tends to be bigger than A*" back in the populations



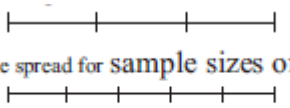
The ¾ - ½ Rule

If the median for one of the samples lies outside the box for the other sample, make the claim "*B tends to be bigger than A*" back in the populations.
(for sample sizes between 20 and 40 in each group)



Distance between medians as proportion of "overall visible spread"

Make the claim "*B tends to be bigger than A*" back in the populations if distance between medians is greater than about:



1/3 of overall visible spread for sample sizes of around **30**

1/5 of overall visible spread for sample sizes of around **100**

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It is important to note that analyzing median shift in visual plots is one step in interpreting a comparison. Students should look at additional factors, such as sample size, spread, the context of the comparison, and other summary statistics (mean, mean-absolute deviation) when interpreting data. In addition, the use of language that illustrates a level of uncertainty in the results (seems, tends, indicates, suggests, probably, likely, etc.) should be encouraged.

In this activity, students will conduct a statistical investigation comparing throwing accuracy with a dominant hand versus throwing accuracy with a non-dominant hand. Students will progress through the four-stage process for statistical inquiry. Questions throughout the activity are designed to activate inferential reasoning as students collect, analyze, and interpret their sample data.

Hand dominance, or handedness, can be loosely defined as an individual's preference for use of one hand, called the dominant hand. The dominant hand may be more "skilled" in performing fine motor activities and manual tasks. Handedness in individuals may be different for different tasks, such as writing or throwing. Also, individuals may be equally dexterous with both hands, a term known as ambidextrous.

It was once thought that a single gene was responsible for controlling handedness. Multiple genes that play a role in the orientation of internal organs may also affect handedness according to a 2013 study in the journal *PLOS Genetics*. However, scientists still have to concede that these genes only play a tiny role in handedness. In fact, handedness is such a complex trait, that there might be hundreds of genes involved, according to William Brandler, a genetics doctoral candidate at the University of Oxford, England. He also states that there are many environmental factors to consider. An element of chance may also play a role in an individual's hand preference for certain tasks. Since handedness is a complex trait, patterns of inheritance are also not easily identified. In fact, identical twins have been known to have opposite handedness from each other.

For this series of activities, it is assumed that students are already familiar with constructing boxplots using five-number summaries. Students should also have some basic understanding of calculating and interpreting descriptive statistics, such as the mean and mean–absolute deviation. Students may use statistical software, such as FATHOM, EXCEL, or graphing calculators to assist in analyzing the data sets if available.

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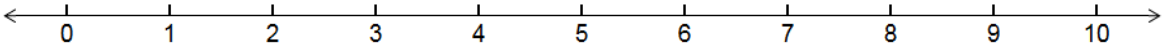
Activity 1: Target Practice

Advanced Preparation

- ☐ Using sentence strips or register tape, create two number lines (for dominant and non-dominant target hits) from 0 through 10, by ones, an interval of 3 inches apart to accommodate building a line plot using Post-it note sheets.



- ☐ Post the two number lines on a wall next to one another. Be sure to label one number line "Dominant Hand Target Hits" and the other number line "Non-dominant Hand Target Hits."
- ☐ Determine an area to set up targets. Teams of four students will be stationed at each target. Students may set up the target stations, or the teacher may choose to do the set up.
- ☐ Place the top of the target approximately 1.5 meters above the ground and secure to a wall using painter's tape.
- ☐ Measure two meters from the target away from the wall and place a strip of painter's tape to mark a throw line.

To begin the activity, ask students what they know about hand dominance. Inform students that they will be performing a statistical investigation comparing throwing accuracy at a target between the dominant and non-dominant hands.

Step 1: *Formulate statistical questions*.

For this activity, students are provided with the investigative question. They will have an opportunity to develop their own questions at the conclusion of the activity to direct further investigation. Pass out the student pages and select a student to read aloud the question that will be investigated. Discuss with students the following questions:

- ***Why is this a statistical question?*** [For a question to be considered statistical, we are anticipating variability in the responses.]

- ***What does the word "population" refer to?*** [Have students describe populations such as the United States, their state, their school, etc.]

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- ***What two "populations" are we interested in comparing with this investigation?*** [We are interested in comparing the distribution of target hits by middle-school students using their dominant hand to the distribution of target hits by middle-school students using their non-dominant hand. Note: we will explore the idea of evaluating the differences in target hit by subject (matched pairs) in the next part of the activity.]

- ***We will be sampling middle-school students in our classroom to test their throwing accuracy. Do you think that our classroom sample is a good representation of all middle-school students? Why or why not?*** [Student answers will vary, but lead them to a discussion about what biases might exist if the students in the class are the only ones sampled from the population.]

Step 2: *Collect data*.

Students will now be divided into teams of three or four students. Provide a foam ball, painter's tape, a meter stick, Post-it note sheets, marker, and paper target for each team. Allow students to complete Steps 1 – 7 on their student pages. Pause the class before data collection begins to ask the following questions:

- ***Where should everyone stand to throw the ball?***
- ***Should students throw "overhand" or "underhand" or does it matter?***
- ***Should everyone use their dominant hand first? Why or why not?***
- ***How might NOT using a random order affect the results?*** [Students should note through discussion that factors such as fatigue or the "learning" effect can impact the accuracy of the throws. Randomizing throwing hand order attempts to minimize these effects on the overall data.]
- ***What could we use to determine random order?*** [a coin or a double-sided chip]

Students should also discuss other variables which may impact their study.

Ask students to share their anticipated distributions for both the dominant and non-dominant hands. Discuss the features that may be present in each of the distributions. Before data collection begins, please be sure to stress with students that they are not competing against each other.

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Students can record the results of ten throws for two trials: one using the dominant hand and one using the non-dominant hand on Step 8 of the student pages. Allow students to complete Step 9, and then ask students to write their initials in the corner of two Post-it note sheets. Also, ask them to record their total target hits using the dominant hand on one note sheet and the number of total target hits using the non-dominant hand on another note sheet (Steps 10 and 11 on student pages).

Step 3: *Analyze data*

Students can now construct and comment upon both the line plots and the parallel box plots. Students should be introduced to constructing box plots in sixth-grade. If necessary, review the five-number summary (minimum value, quartile 1, median, quartile 3, and maximum value) for use in constructing box plots. Indicate to students that there are approximately the same number of target hit values in each section of the box plot, and that the median value represents the number of target hits below which half of the collected student data falls and above which the other half of the collected student data falls.

It is important to coach students through an overall analysis strategy that describes relevant features of the data.

1. Begin with a visual comparison. Students should note features such as overlap (how "much" of the two box plots are "on top" of each other), shift (usually of one distribution's median in relation to another) and unusual features such as clumps, gaps, or extreme values.
2. Next, look at numeric descriptors of the data sets, such as mean, median, or other summary statistics and observed values.
3. Have students comment on the spread of the data. Middle-school students can calculate a mean-absolute deviation using the individual data points on the line plot, or can calculate the interquartile range (IQR) using the box plots. Discuss with students that the range is, in general, not a good choice to describe the spread of a distribution since it is considered non-robust due to its influence by extreme values. However, it can be informally used to compare overall variability and overlap between the box plots.
4. Use "*I notice*" statements to describe features that can be seen, and "*I wonder*" statements to comment inferentially on the population of interest.
5. Make sure that students are comparing plots using the same scale.

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6. Using box plots, students should be aware that each "part" of the plot (left whisker, box to the left of the median, box to the right of the median, right whisker) represents about 25% of the data values collected.
7. When comparing shapes (using line plots) we are looking at the overall pattern of variability. Students should at this point compare the shape of the collected data to their predictions for the population distributions.
8. Describe unusual observations, gaps, and/or clusters in terms of the number of target hits. If there are potential values that have no observed measurement, discuss if this is a "gap", or could sample size play a role in not having a particular target hit observation. In other words, would we expect in the population of all middle-school students for someone to have anywhere from 0 to 10 target hits with either hand?

As students are progressing through the analysis of the data, the use of Post-it notes can help to reinforce the distinction between the sample being analyzed and the connection to what is "happening" back in the population of interest. Encourage students to write on Post-its "*I notice…*" statements about the calculated statistics, visual observations, etc. that are characteristics of the **sample** data that students generated. Then, "*I wonder…*" statements can be written on separate Post-it sheets to infer about the effect of handedness on throwing accuracy back in the **population** of all middle-school students. Encourage students to comment on both "typical" values and on the variability in the data.

Step 4: *Interpret results*

After the data have been analyzed, students are now asked to make a decision on the original investigation question:

> **Do target hits by middle-school students using their dominant hand tend to be greater than target hits using their non-dominant hand when throwing a foam ball at a target 2 meters away?**

Use of the claim-evidence-reasoning framework is encouraged for students to write their conclusion. There are two possible claims for this problem:

- ***There is (some, strong, weak, etc.) evidence that the dominant hand is more accurate when throwing at a target than the non-dominant hand for middle-school students.***

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- *There does not seem to be any difference between dominant and non-dominant hands when throwing at a target for middle-school students.*

The claim written by students should provide an answer to the question and should include reference to the population of interest. At this level, students may also present a claim in favor of the non-dominant hand such as the one below:

- *There is (some, strong, weak, etc.) evidence that the non-dominant hand is more accurate when throwing at a target than the dominant hand for middle-school students).*

When writing claims, students should be coached to use language that illustrates the uncertainty of the claim. Use of the table presented in the Introduction section on "making the call" by Chris Wild may be useful at this point if students are struggling with how supportive their evidence is for a particular claim. Students can draw upon the evidence gathered during analysis to provide "pieces" of evidence that support the claim. Students should provide a reason linking the evidence to the claim, and should comment on if this reasoning makes sense in light of what we "know" about throwing accuracy in general. Encourage students to also think about alternative explanations for the results in terms of variables that might not have been considered initially when setting up the experiment.

Debrief Activity 1:

- *If a new sample was collected with students of another class, would you expect the plots to look the same or different than the ones our class generated?* [Students may have difficulty with this question, but should infer that if the difference is due to handedness then the differences should show up in another sample even if the exact distribution is different.]

- *Do you think our class is representative of the population of all middle-school students? Why or why not?* [To be truly representative, a random sample would need to be drawn from the population of interest.]

- *What effect could this have on our claim?* [Drawing conclusions about all middle-school students based on the sample data from

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the class may not be valid.]

- ***Did you expect the throwing accuracy to be greater with the dominant hand before the class started the experiment? Do you think this expectation impacted the results in any way?*** [Direct students here to acknowledge that this bias may in some way impact how a subject throws at the target.]

- ***How convincing is the evidence we gathered in support of the claim that throwing accuracy is greater with the dominant hand than with the non-dominant hand?*** [In other words, when comparing the overall visual impression, shift, overlap, summary statistics, spread, shape, individual values of interest, and gaps/clusters, does the difference observed seem big enough to make a claim that throwing accuracy with the dominant hand is greater than throwing accuracy with the non-dominant hand.]

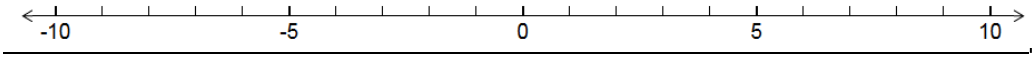
- ***Can we make claims about the throwing accuracy of the general population? Why or why not?*** [Since we did not include younger or older people in our study, but only used middle-school students, we cannot make a claim about the throwing accuracy of the general population.]

- ***Can you think of a different way of looking at the data which might give a better overall picture of throwing accuracy?*** [Since the same individual threw the ball at the target using both treatments (dominant and non-dominant hands), we could look at the difference between the two values.

Activity 2: What's the Difference?

Advanced Preparation

Using sentence strips or register tape, create a number lines (for differences in dominant and non-dominant target hits) from -10 through +10, by ones, an interval of 3 inches apart to accommodate building a line plot using Post-it note sheets. This number line is labeled "Difference Between Dominant and Non-Dominant Hand Target Accuracy."



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To begin Activity 2, each student should consult their data gathered in Activity 1 and perform the following calculation:

TARGET HITS DOMINANT HAND – TARGET HITS NON-DOMINANT HAND

It is appropriate at this time to ask students why we can calculate the differences. Students should realize that one subject (student) performed both experimental treatments. Thus, the difference data removes the "skill factor" variable from consideration and focuses the data on the differences.

Students may write their result on a Post-it note sheet and add to a class plot of difference data. You may also choose to collect data by student in a table and have the students generate both a line plot and a box plot of difference data.

Engage students in a discussion of what features they would likely see on a line plot of differences, or on a box plot of differences. Since positive differences reflect more target hits using the dominant hand, students should look for a large percentage of differences that are positive compared to zero or negative differences.

Additional discussion can be had on which of the data displays was more useful in supporting the claim.

Provide student partner teams with a marker and some blank sentence strips. Ask students to generate additional questions that they could ask to follow up this investigation or to perform another investigation on the topic of handedness. Students may want to investigate the role of gender on throwing accuracy, look at accuracy and speed, test at two different throwing locations, etc.

Debrief Activity 2:

- *What might be an impact of repeating this experiment with the same subjects?* [Learning or training could occur skewing the results one way or the other.]

- *Can you "train" a non-dominant limb to perform more accurately? Why or why not?* [Studies are looking at training methods to increase ambidextrousness of athletes as it is hypothesized to provide a competitive advantage in some sports.]

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- *Do you think the pattern observed could have occurred by chance alone, or is there really a difference in throwing accuracy related to hand dominance?* [In other words, is the difference between dominant-hand throwing accuracy and non-dominant hand throwing accuracy so great that in other random samples from the population this difference would show up repeatedly. This would give us evidence to suggest that the difference is attributed to hand dominance.]

- *Can we conclude that the dominant hand is always more accurate than the non-dominant hand? Why or why not?* [If student difference data shows a zero or negative value, this statement cannot be made. In statistics, we realize that there is always some level of risk that we are drawing the wrong conclusion based upon the data.]

Conclusion:

As students experience the statistical inquiry process, it is desirable to provide students with opportunities to collect and analyze sample data. Also, opportunities should be provided for students to make statements both about the sample data and the population from which the sample data was chosen. Students should begin to differentiate between the two and begin to see the benefits and limitations of sampling. Analysis of a sample needs to go beyond simple point estimate, such as the mean or median, and needs to encompass a broader view of variability both within the sample and between samples. The use of "*I notice*…." statements advocated by Pfannkuch (2009) to describe what is seen in the samples and "*I wonder*…." statements to think about what might be happening in the population attempt to draw a distinction between descriptive and inferential thoughts. Discussion on the appropriateness of the sample selection and the idea behind random sampling can be introduced to middle-school students through "*What if…?*" questions related to taking another sample or comparing potential distributions of data gathered by another class. The big idea for students here is to realize that the sample generated by their class is but one of many possible samples. The key question for students to grapple with involves determining if information provided by the sample is due to this variation between samples, or if there really is something driving the differences observed.

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Extensions:

The following are additional questions that can be used as opportunities to engage students in informal comparative inference:

- Do female middle-school students have a higher "normal" body temperature than male middle-school students when read using a disposable thermometer?
- Is it easier for students to memorize words with meaning compared to words that are nonsense?
- Is there a difference between middle-school boys' standing vertical jump heights relative to standing reach and girls' standing vertical jump heights relative to standing reach?

Resources:

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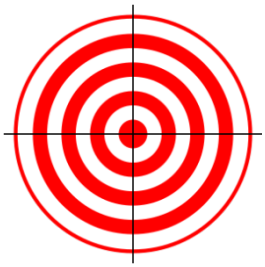
Zieffler, A., Garfield, J. B., delMas, R.,& Reading, C. (2008). A framework to support research on informal inferential reasoning. *Statistics Education Research Journal*, 7(2), 5-19. www. stat.auckland.ac.nz/serj

Statistical Question:

Do target hits by middle-school students using their dominant hand tend to be greater than target hits using their non-dominant hand when throwing a foam ball at a target 2 meters away?

Materials:

- 1 Target
- Post-it note sheets
- Painter's Tape
- 1 Foam Ball
- Meter stick
- Marker



Procedure:

1. Receive a target and foam ball from your teacher. Find a good location where you can throw the ball at the target placed against the wall.

2. Using a meter stick and some painter's tape, tape the target on a wall so that the top of the target is 1.5 meters above the floor.

3. Measure a distance of 2 meters from the wall in front of the target, and place a piece of tape to mark the throwing location.

4. Decide which hand is your dominant throwing hand. If you are unsure, how could you determine which hand is dominant for throwing?

Record which hand is your dominant hand and which hand is your non-dominant hand below:

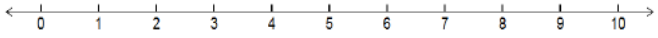
Dominant hand:	**Non-dominant hand:**

5. **PREDICT:** Will **our class** be more accurate hitting the target with the dominant hand or the non-dominant hand? _____ Why or why not?

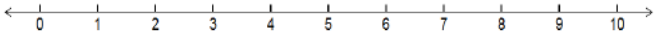
6. Your team will take turns throwing the ball 10 times each using each hand. Use a coin/colored chip to decide which hand should be used to throw first. Why might we want to randomize the order of the throwing hand?

7. Sketch possible shapes of the distributions of dominant-hand target hits vs. non-dominant hand target hits for the POPULATION in the space below:

Dominant Hand



Non-dominant Hand



8. Have a teammate record your data in the table below:

H = HIT the target; **M** = MISSED the target

THROWING Hand	1	2	3	4	5	6	7	8	9	10
DOMINANT										
NON-DOMINANT										

9. Summarize your personal data.

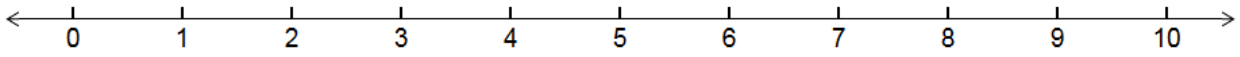
Do you think that your data is "typical" of other students in your class? ____
Why or why not?

10. Using a Post-it note sheet and a marker, record the **NUMBER OF TARGET HITS** using your dominant hand. Place your initials on this note sheet and add to the class line plot for **DOMINANT** target hits.

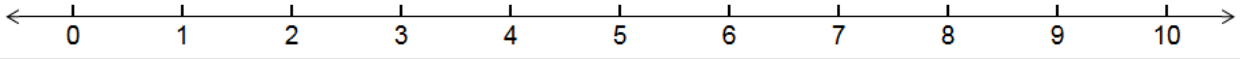
11. Use another Post-it note sheet and a marker to record the **NUMBER OF TARGET HITS USING YOUR NON-DOMINANT HAND**. Place your initials on this note sheet and add to the class line plot for **NON-DOMINANT** target hits.

12. With your team, describe both class line plots for your class sample data.

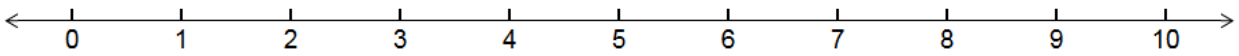
Dominant Hand



Non-dominant Hand



13. Using statistical software if available, create parallel boxplots of the number of target hits using dominant and non-dominant hands. Sketch the boxplots below.



14. **I notice…** (describe the main features in the sample plots above, including an overall visual comparison, the amount of shift and overlap, calculated summary statistics, interesting points, shape and spread)

15. **I wonder….** (describe what might be true about ALL middle-school students' target throwing accuracy)

Putting it all together…..

Claim

What "call" are you prepared to make about middle-schoolers throwing accuracy?

Evidence

What data or observations do you have to support your claim?

Reasoning

How does the data you used for evidence support your claim?

Discussion Questions:

1. How confident are you in your claim?

2. What others reasons might there be for observing a difference in the two distributions (or, no difference)?

3. If a different classroom conducted the same experiment, would you expect the plots to look the same or different? _____ Why?

4. Can we claim that the box plots represent the relationship in throwing accuracy between dominant and non-dominant hands in the general population? _____ Why or why not?

5. Can you think of a different way of looking at the data which might give a better overall picture of throwing accuracy?

Difference Data

Another way to look at collected target data is to calculate the individual difference between the number of target hits with the dominant hand and the non-dominant hand for each of the subjects in the investigation.

1. What does the term "subject" refer to in this investigation?

2. Why might we want to investigate the differences in target hits for each subject?

3. Complete the table below for the class data.

Student	Dominant Hand Target Hits	Non-dominant Hand Target Hits	Difference

4. What do **positive values** indicate in the difference column?

   negative values?

   zero?

5. Draw a line plot and a box plot of the difference data below. Be sure to label each plot and scale the number line appropriately.

6. If the dominant hand has a higher number of target hits indicating throwing accuracy, what features would show this on the difference line plot or box plot?

7. Do you think the difference data line plot and box plot provide more or less information to make a decision on handedness and throwing accuracy than the parallel boxplots that were generated first? _____ Why?

8. Do the difference data provide support for the claim stated using the parallel box plots? _____ Why or why not?

9. Can we conclude that dominant hands are always more accurate than non-dominant hand? ____ Why or why not?