

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## VARIABILITY AND SAMPLING COMMON CORE ALGEBRA II



Data is everywhere. It's in our newspapers, it's in our science classes, it shows up in economics, medicine and anywhere else that **variability** occurs. Variability is simply the property of **outcomes** being different. The tools of statistics are designed to **explain this variability**.

There are many types of variability. It is good to understand these sources in order to minimize the ones that we are not studying.

**Exercise #1:** The following types of variability can change uniformity of a data set. For each give an example from any field.

- (a) **Observational or Measurement Variability:** Variability that is introduced due to either our measuring instruments not being precise enough or differences in how two different people read the measurement.
- (b) **Natural Variability or Inter-Individual Variability:** Variability that accounts for the fact that members of a populations are simply different.
- (c) **Induced Variability:** This type of variability is in marked contrast to natural. It occurs because we have assigned our population or sample to two or more **treatment** groups and then observe the variability between the groups.
- (d) **Sample Variability:** This is the type of variability that occurs when we take multiple **samples** from a **population** randomly. These samples will be different due to the randomness of the sampling process.

Remember, through all of our work in this unit, we are really trying to explain the variability of data within either a population or a sample and then using this to determine if the variability can be attributed to one of the factors above to the exclusion of the others.



There are many different situations in which we collect data. They have important differences and all of them depend on **randomization** in one way or another.

**Exercise #2:** The three major types of ways to collect data are described below. Give an example of each and explain how **randomization** is part of each method. Randomization is used primarily to eliminate variability caused by some type of **bias**.

(a) **Surveys:** Collections of data from a population where variability is not induced by treatments but by the sample itself (sampling variability).

(b) **Observational Studies:** Collections of data from a population where assignment of individuals from the population into **treatment groups** is **not** under the control of those performing the study.

(c) **Experimental Studies:** In experimental studies individuals are assigned randomly to treatment groups in order to determine the effect of the treatment on the variability of the data. In these cases, the assignment, although random, is under the control of those performing the study.

Random sampling is critical for being able to minimize variability due to **sampling bias**. Random sampling can be done using a variety of different techniques. Simple random sampling can be accomplished using a random number table.

**Exercise #3:** A list of 10 people's heights, in inches, is shown below.

Person #	1	2	3	4	5	6	7	8	9	10
Height	70	68	60	75	65	69	58	62	66	63

(a) Randomly select five heights from this list by using the random number table that goes with this lesson. Choose a random spot in the table and move down the column. Select the first digit of each number. If you get a repeat, eliminate and keep going. If you get a 0, use this as the 10.

(b) Calculate the **sample mean** to the nearest tenth. Compare to others in the class. What type of variability is being introduced through this process?



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**VARIABILITY AND SAMPLING**  
**COMMON CORE ALGEBRA II HOMEWORK**

**APPLICATIONS**

1. Scientists randomly select ten groups from a population of men over 50 years old. They calculate the mean weights of each of these groups. The variability between these means can be best attributed to

(1) measurement variability      (3) induced variability

(2) natural variability      (4) sampling variability

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2. Max and Daniel are measuring the amount of time it takes for a ball to roll down a ramp at different heights. For each trial, both Max and Daniel take turns rolling the ball and working the stop watch. They do this in order to quantify which of the following sources of variability?

(1) measurement variability      (3) induced variability

(2) natural variability      (4) sampling variability

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3. Which of the following scenarios would be an attempt to quantify induced variability?

(1) a phone survey of political preferences during election season

(2) multiple random samples of products from an assembly line to check for defects

(3) random assignment of people to a control group and a group taking a drug to lower cholesterol

(4) recording the variability in the measurement of a soil sample's weight by the same machine

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4. Which of the following research questions would involve collecting data through a survey?

(1) Watching people exit a grocery store to see the percent who use reusable bags.

(2) Assigning people to two groups to see the effect of a particular amount of sleep.

(3) Calling people on the telephone to see if they will be voting in the upcoming election.

(4) Dropping salt cubes into two different liquids to determine which dissolves faster.

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5. In which of the following cases would an observational study be necessary as compared to an experimental study?

(1) The study of how increased nutrient levels affect plant growth.

(2) The study of how educational levels affect median household income.

(3) The study of how a vaccine affects the percent of mice that get a particular disease.

(4) The study of how noise level affects the sleep patterns of volunteers in a sleep study.

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6. In an experimental study, a lab wanted to divide volunteers into two groups to determine the effect of a particular phone app to help make people more punctual (on time). The 50 volunteers in the study will be assigned to either a group of 25 who use the app for a week or a group of 25 who do not use the app. The participants were asked to come to a lab to receive the app (or not) at 10:00 am on a Monday. Answer the following questions:

(a) Why would those performing the study *not* want to assign the participants in the two treatments (groups) based on who showed up to the study session first?

(b) Propose a way to use a random number table to generate a simple random selection that eliminates the bias that you discussed in part (a).

7. Two groups of subjects were divided in an experimental study. One group was given a drug to help speed up their metabolism and result in weight loss. The other group was given a **placebo** (a pill that looks identical to the one given to the other group, but without the weight loss drug). After a month of the experiment, the weight loss of each individual in each of the two groups were measured. In general, people in the group who took the metabolism drug did lose more weight, although there were differences in the amount each lost. There are two main types of variability occurring in this study. Describe each type below in the context of this study.

Induced Variability

Natural Variability

## REASONING

8. If you were trying to conduct a survey of political preferences for likely voters in an upcoming election and decided to dial 1,000 randomly generated land-line phone numbers (not cell), why might this still introduce **bias** into the sampling?



## RANDOM NUMBER TABLE

89679	74452	58378	56038	05793
68479	31125	30744	92830	81733
54958	34875	26881	95459	05001
09728	86396	44698	00445	54666
49645	05086	43332	07908	10593
97742	58396	05140	74052	42483
60394	75922	71275	85120	29034
36606	75808	63047	96796	99834
24656	44208	95016	79816	14185
99387	64057	29448	78761	90544
85213	94939	36368	06737	30994
01727	01497	49402	88141	58513
57535	40645	17498	85894	03705
29613	07446	68202	19465	79334
74042	64704	75418	80166	50113
05561	96960	41774	27701	26791
13709	71189	29285	16286	67827
57752	35321	45784	58222	99383
87272	68090	81526	13161	80735
28664	27875	78093	30888	92618
85995	57330	24519	17238	34929
19402	86361	97351	89230	84306
25335	15291	13878	89663	82143
19631	14030	58249	22092	10967
29731	65359	83185	55700	09254
12342	51338	50542	47077	99987
81333	34849	35289	04468	60304
14825	35419	03873	09164	25581
47865	82527	72916	69732	62153
46246	21019	29652	36296	80016
88454	58304	64450	39653	54792
18412	23667	49507	75752	66366
08044	32980	67699	00755	82771
03017	69707	56600	37524	58097
62259	24785	87969	53877	77589
25294	83064	13116	40659	90535
76449	44295	97098	18216	46682
73964	06143	86782	34176	21466
63960	70532	19083	87598	70803
89628	99681	41047	35674	88642



