NON-STEM COREQUISITES: MERGING CONTENT WITH ACTIVITY-BASED COURSES

Austin Community College

Colleen Hosking, Associate Professor

Kelly Greenwood, Associate Professor

Marisa Bjorland, Assistant Professor

COLLEGE MATH EXPRESS & STATISTICS EXPRESS

3 Credits Dev. Level + 3 Credits College-Level

Fully Integrated Curriculum

WHO TEACHES THESE COURSES?

Two instructors in one classroom

- One Dev. Math instructor*
  Responsible for ensuring:
  - Proper scaffolding of class material
  - Study skills covered as needed
- One College-Level instructor*
  Responsible for ensuring:
  - Testing at college-level

**Either instructor can lead instruction on any given topic*

WHO TAKES THESE COURSES?

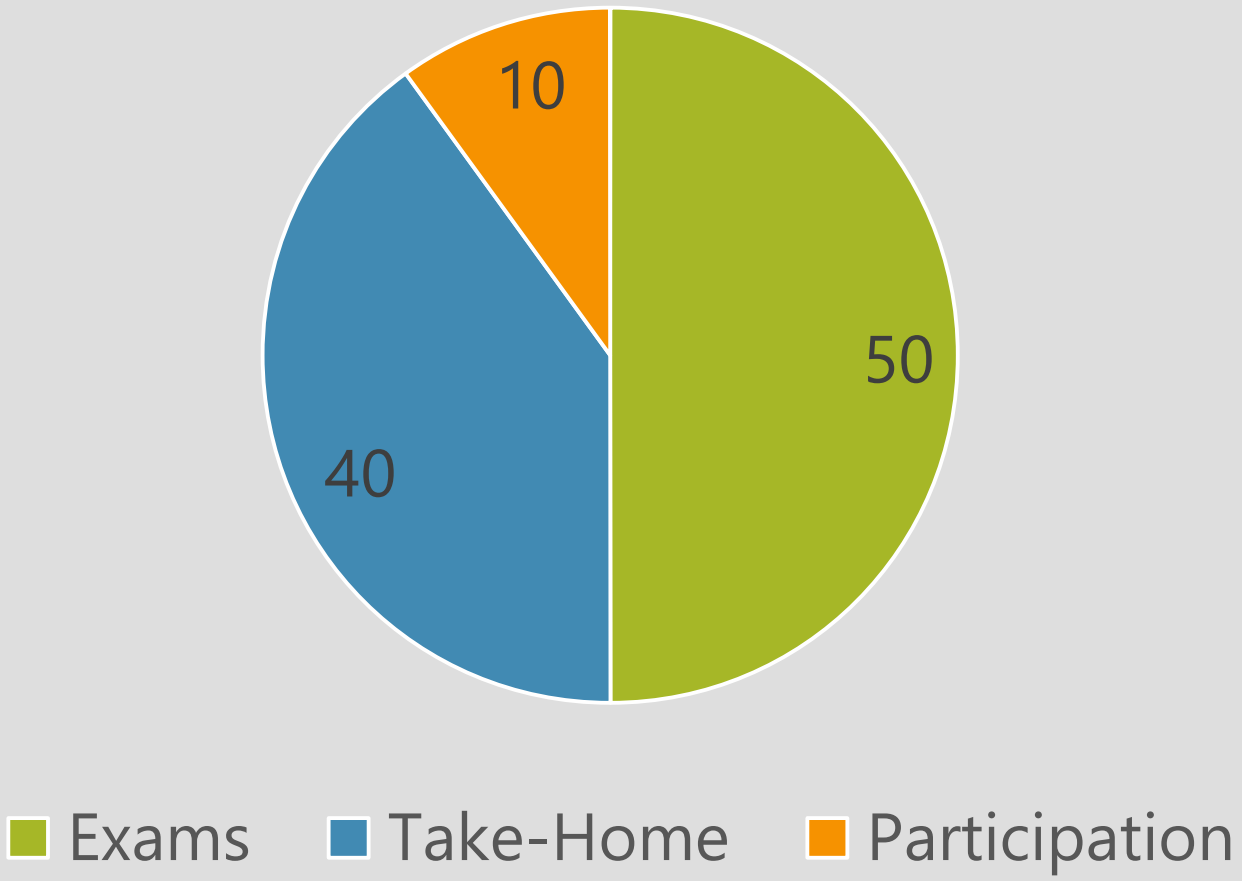
Students who require the particular non-STEM college-level math course for their degree plan and:

- Scored at the Elementary Algebra (~Algebra 1) level on the placement exam → Lower level dev. math students
- Any student who feels they need a more scaffolded and supported approach to the college-level non-STEM course

COURSE STRUCTURE

- ✓ Participation in daily collaborative activities
  - Scaffolded: MATD → MATH all in one activity
  - Collected or checked for a grade
- ✓ Working outside of class
  - HW due 1-3 times per week
    - Includes conceptual questions, skill checks, and college-level questions
    - Can be graded on completion
  - Additional written assignments every 1-1.5 weeks
    - College-level
    - Graded on correctness
- ✓ Exams
  - Written at college level, other than a few specific dev. math topics (~5% of total exam avg.)

DEVELOPMENTAL COURSE HAS MODIFIED WEIGHTING FOR GRADES



COLLEGE MATH WITH SUPPORT & STATISTICS WITH SUPPORT

1 Credit Dev. Level + 3 Credits College-Level

Support course for just-in-time help

WHO TEACHES THESE COURSES?

- One instructor for both courses, or
- A separate instructor for the support course
  - works closely with the instructor of the college-level course

WHO TAKES THIS COURSE?

Students who require the particular non-STEM college-level math course for their degree plan and:

- Scored at the Intermediate Algebra (~Algebra I1) level on the placement exam → Higher-level dev. math students
- Any student who feels they need extra support in the college-level course (perhaps a student who has previously been unsuccessful in the college-level course)

COURSE STRUCTURE

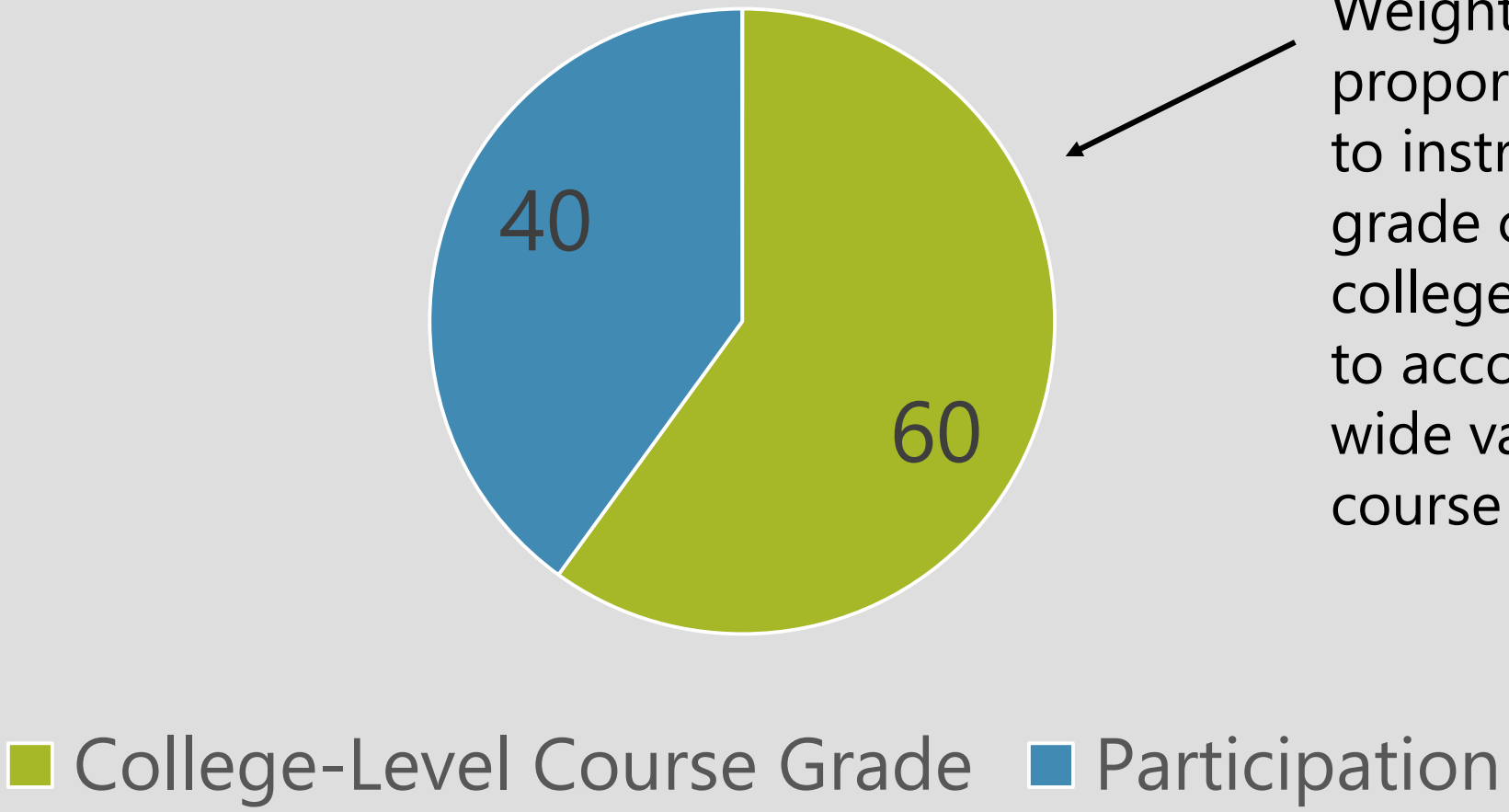
3 Credit College Course has mixed enrollment (Dev. + Traditional students)

- Run just like any other section of that course
- Grading and course policies adhere to the college-level course policies for that grade portion

Dev. math students then also attend the 1 LEH support course

- 25 mins x 2 days or 50 mins x 1 day each week of structured class time
- Instructors have a bank of “Preview” and “Review” suggestions to use as needed for their class
  - Mix of short worksheets and suggested review/practice problems
  - Students accountable for this material through note collection/binder checks
  - No additional assessments beyond what is done in college-level course

GRADING IN SUPPORT COURSE



Weighting proportional to instructor-chosen grade categories in college-level course to accommodate wide variation in course structures

CONTEMPORARY MATH COREQUISITE ACTIVITY

UNIT 1C: SETS & VENN DIAGRAMS

Unit 1C (Part 1) – Venn Diagrams & Logic

Students get acclimated to new concepts…

1. The purpose of logic is to determine if statements are true or false through symbolic calculations of logical ideas. A ***proposition*** is a sentence containing a single idea that is either true or false, but not both. Determine whether each of the following statements is a proposition. Explain why or why not.

   (a) Open the door. _____

   (b) The door is open. _____

   (c) This statement is false. _____

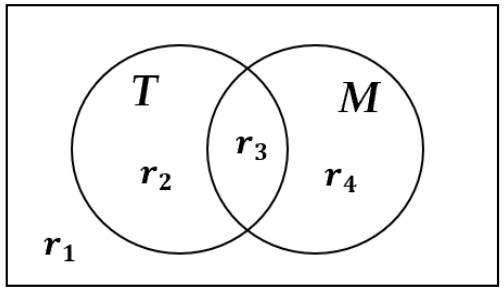
Unit 1C (Part 1) – Venn Diagrams & Logic

Layering & Scaffolding…

Let T = The set of students who were born in Texas.

M = The set of students who are multilingual.
(i.e. the set of students who speak more than one language)

Universe = 100 ACC Students



The students represented by regions r_1 and r_2 have been described below.
Write a detailed description of the students represented in r_3 and r_4 .

r_1 = Students who were not born in Texas and are not multilingual.

r_2 = Students who were born in Texas but do not speak more than one language.

r_3 = _____

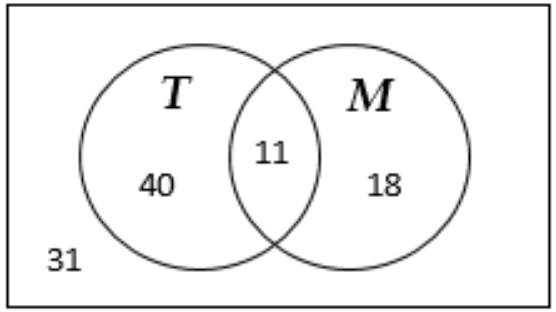
r_4 = _____

Unit 1C (Part 2) – Venn Diagrams & Counting

Practicing, deepening…

Let T = The set of students who were born in Texas.
M = The set of students who are multilingual.

Universe = 100 ACC Students



a. How many students were born in Texas? _____

b. How many students were not born in Texas? _____

c. How many students were born in Texas and speak more than one language? _____

Unit 1C (Part 3) – Venn Diagrams & Two-Way Tables

Practicing, deepening…

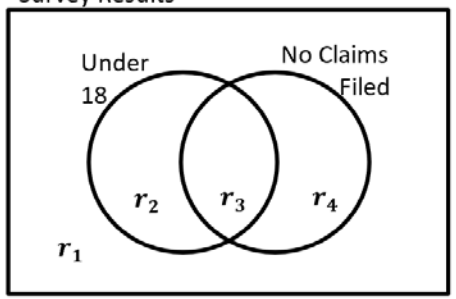
A car insurance company issued a monthly report showing the number of claims filed by clients broken down by age. The results are shown in the two-way table below.

	No Claims Filed	At Least One Claim Filed	Total
Under 18 years old	25	50	75
18 years old and Older	30	20	50
Total	55	70	125

The Venn diagram shown to the right can be used to display the information given in the table. →

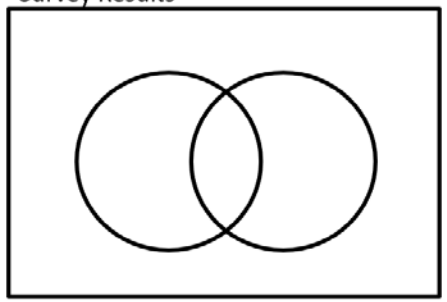
a. Use the number values given in the table to complete the Venn diagram shown below.

Survey Results



The Venn diagram shown in part (a) is only one of four possible Venn diagrams that can be used to display the data in the table. Create a new two-circle Venn diagram by re-labeling the sets, then use the new Venn diagram to display the same information given in the table in a way that looks different from the Venn diagram in part (a).

Survey Results



Full-out college-level problem solving…

13. Use the information given in the table below to create a two-way table and then use the two-way table to create a Venn Diagram.

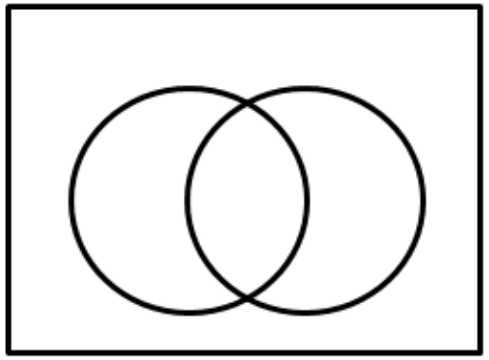
32	Applicants who don't have a high school diploma but do have 2 years of experience.
2	Applicants who don't have a high school diploma and have less than 2 years of experience.
18	Applicants who have both a high school diploma and 2 years of experience.
45	Applicants who have a high school diploma.

(a) Label each row and column, then complete the table based on the information given in the table above.

			Total
Total			

(b) Complete the Venn Diagram. Be sure to label each set.

Qualifications



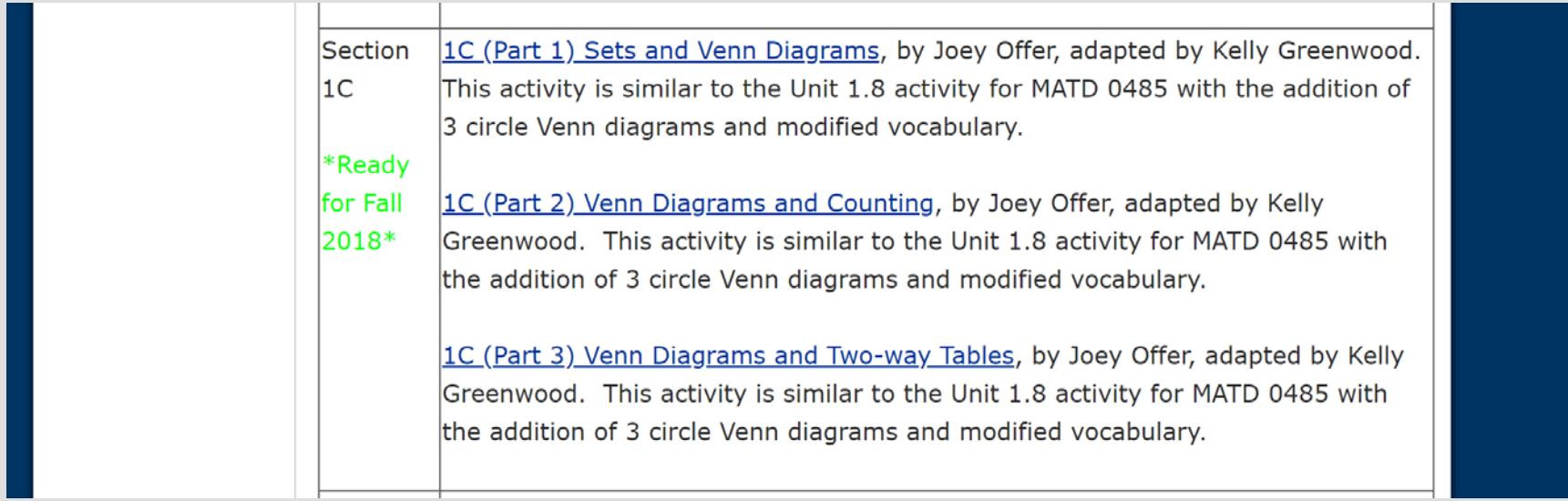
Note: There are 4 possible Venn diagrams.


Your turn!

ORGANIZING INSTRUCTOR RESOURCES

GROUP ACTIVITIES WEBSITE

- Grouped by section
- Includes a brief description + link to subpage



Section 1C *Ready for Fall 2018*	1C (Part 1) Sets and Venn Diagrams, by Joey Offer, adapted by Kelly Greenwood. This activity is similar to the Unit 1.8 activity for MATD 0485 with the addition of 3 circle Venn diagrams and modified vocabulary. 1C (Part 2) Venn Diagrams and Counting, by Joey Offer, adapted by Kelly Greenwood. This activity is similar to the Unit 1.8 activity for MATD 0485 with the addition of 3 circle Venn diagrams and modified vocabulary. 1C (Part 3) Venn Diagrams and Two-way Tables, by Joey Offer, adapted by Kelly Greenwood. This activity is similar to the Unit 1.8 activity for MATD 0485 with the addition of 3 circle Venn diagrams and modified vocabulary.

ACTIVITY SUBPAGE

- Starts with textbook correlation
- Quick access to activity PDF file
- Time estimate based on pilot semester

1C (Part 2) Venn Diagrams and Counting

Correlation: Section 1C (Part 2)

- Using Venn diagrams to count sets.
- Not covered: Two-ways tables. Covered in 1C (Pt 3) activity.

Prerequisites: Student need a basic understanding of set vocabulary and reading a Venn diagram prior to this activity. These topics are covered in 1C(Pt 1)Activity (PDF)

Materials needed: Copies of the handout. Download (PDF)

Approximate time for the activity: 45 minutes

Overview

This activity steps students through the process of using Venn diagrams to count sets.

ACTIVITY SUBPAGE

- Overview
- Before the Activity
- During the Activity (Instructor Key included here)
- After the Activity

Before the activity

Student need a basic understanding of set vocabulary and reading a Venn diagram prior to this activity. These topics are covered in Activity 1C (Part 1).

During the activity

Circulate the room, checking student work and answering questions, as needed.

Note for Question #2: There are two ways to solve this problem. Some students will use the total number of students given in the prompt (i.e. 80 students) and subtract the amounts for the three given regions to find the amount in the missing region. Other students will use the 35 total math students given in the question and subtract the 10 students shown in the overlap to answer the question. Both solutions are valid and have merit. It would be beneficial to have a group from each camp present their solution path to the class.

Note: Question #4 is a "Challenge Question" and can be skipped by slower groups or for sake of time.

Answer Key: Download (KEY)

After the activity

You may need to pull the class together as a whole to discuss and reinforce the ideas behind questions the class seemed to struggle with. Students usually need reinforcement on the distinction between 1(c) and 1(b), and the answers to #5. You may also want to discuss the different solutions paths for #2, or have groups present their solutions path (as discussed above under "During the Activity".)

STATISTICS COREQUISITE ACTIVITY

SECTION 2.3 MEASURES OF SPREAD

Students begin the section with an activity on mean and standard deviation, then move into an activity on the 95% rule and z-scores.

Activity – Understanding the Standard Deviation, Section 2.3

Numerical Summaries

We have learned that graphs are a great way to see the "big picture" for a data set at a glance. They give us a general idea of the shape, center, and variation. Once we have this big picture, statisticians often like to look more closely at the center and variation of the data set. They do this by finding **numerical summaries**, which are calculations that give numbers we can use to represent the center and variation of a data set.

Measure of Center: Mean

Mean (or arithmetic average) = $\bar{x}$

This is a measure of center, interpreted as the "typical value" of a data set.

Step 1: Find the *sum* of all the values in your list.
Step 2: Divide by *n*, the number of values in your list.

$$\bar{x} = \frac{sum}{n}$$

Standard Deviation = *s*

This is a measure of variation, the "typical distance" of a data value to the mean of the data set. The standard deviation represents distance so it is always nonnegative.

***We will use technology to calculate the standard deviation, or it will be provided. ***


Your turn!

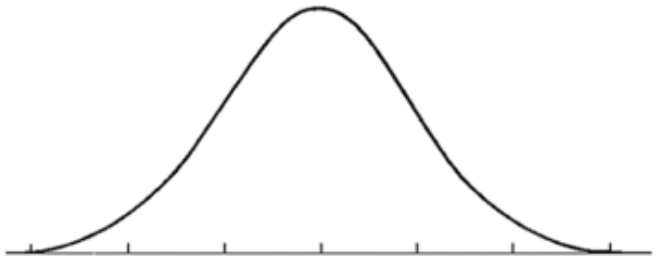
The 95% Rule, z-scores and Percentiles Activity

Getting an comfortable with standard deviation as a unit of measurement….

4. Suppose the heights of all men are approximately symmetric and bell-shaped with a mean of 70 inches and a standard deviation of 4 inches.

   a. Assume the tick marks are spaced a distance of 1 standard deviation apart. (Refer to Figure 2.18 on page 1.)

   Label the mean height, and the heights that are 1, 2, and 3 standard deviations above and below the mean.



Making the connection to z-scores….

5. In statistics, we will use the variable "z" to represent the number of standard deviations a data value is from the mean. We will call this value a **z-score.**

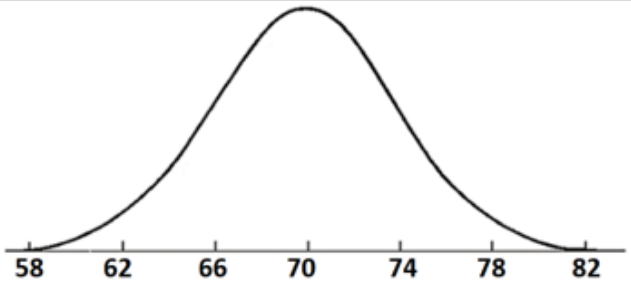
   a. The height 66 inches has a z-score of -1. Why?

   b. Find the z-scores for the following heights.

   78 inches: **z =** _____

   58 inches: **z =** _____

   70 inches: **z =** _____



CONCLUDING WITH A STATISTICS-LEVEL PROBLEM

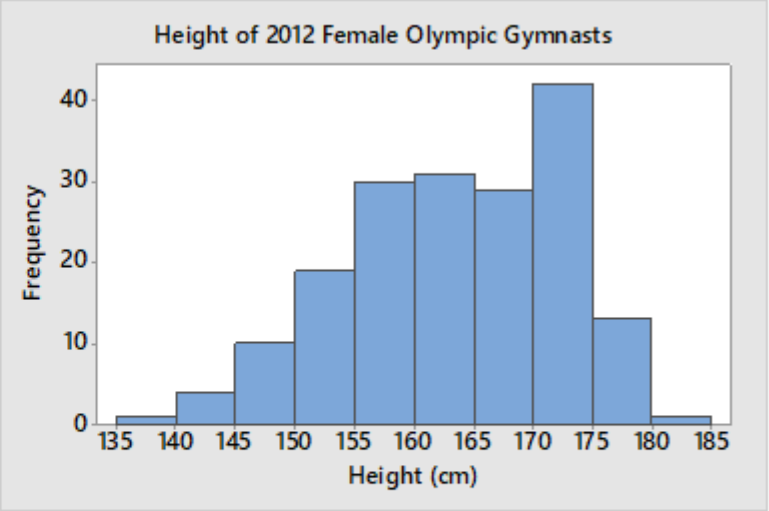
A **z-score** is the number of standard deviations a data value is from the mean. We calculate z as follows:

$$z = \frac{data\ value - mean}{standard\ deviation}$$

For **samples**, this looks like: $Z = \frac{x - \bar{x}}{s}$

For **populations**, this looks like: $Z = \frac{x - \mu}{\sigma}$

6. Recall the histogram from the beginning of our activity. Suppose one of these women was 170 cm tall.
   a. Calculate the z-score for her height. (The mean is 162.74 cm and the standard deviation is 9.30 cm.)



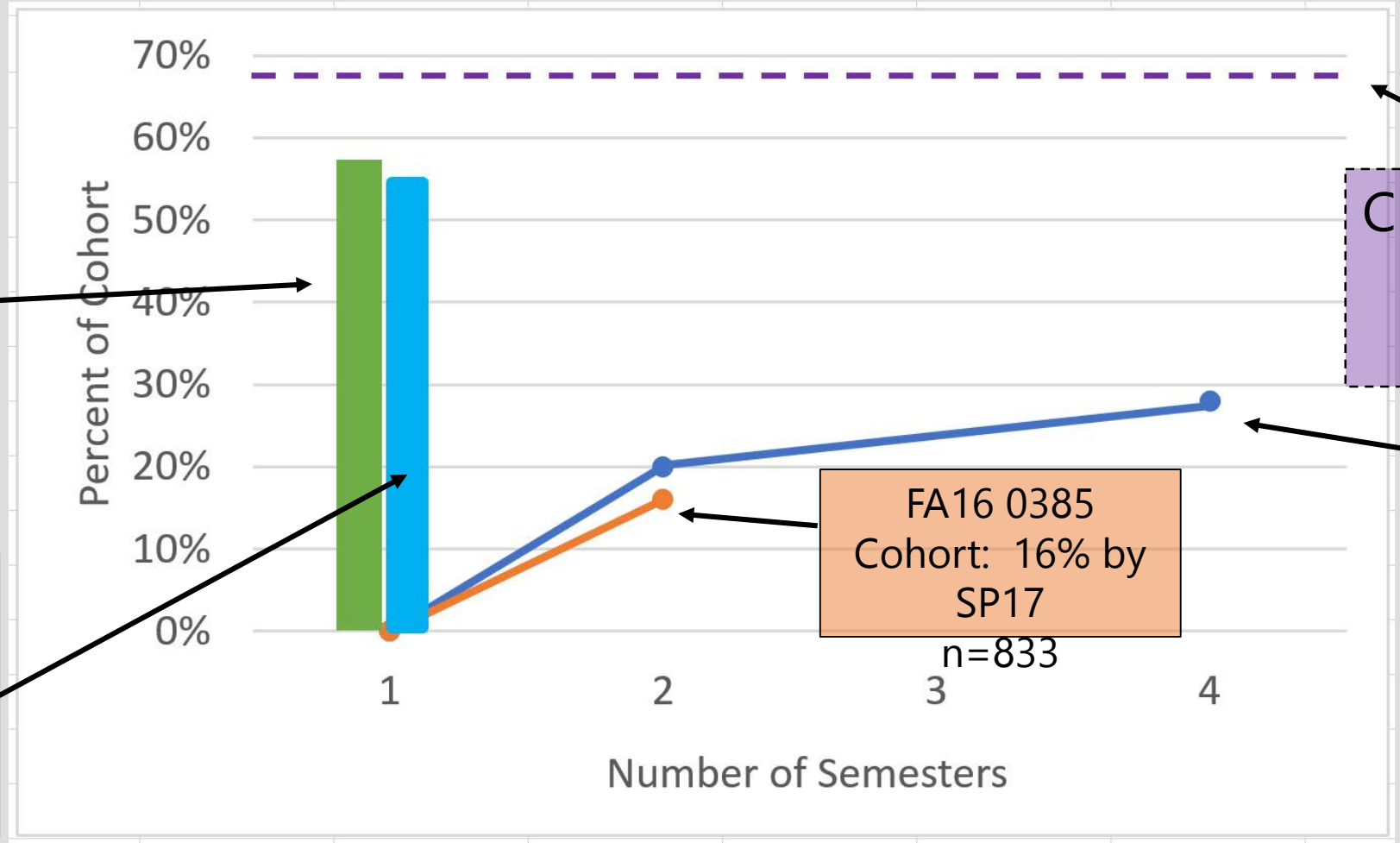
   b. Estimate her percentile: _____

   c. A male gymnast events in these same Olympics has the same height percentile as this woman.
   Does this indicate that they are the same height? Explain why or why not.

CHALLENGES & SUCCESS

Data from College Math Express pilot
Spring 2018

How long does it take non-STEM developmental students to pass a college-level math class?



CM Express Spring 2018: 58% (Projected) n=125

CM w/Support Spring 2018: 56% (Projected) n=90

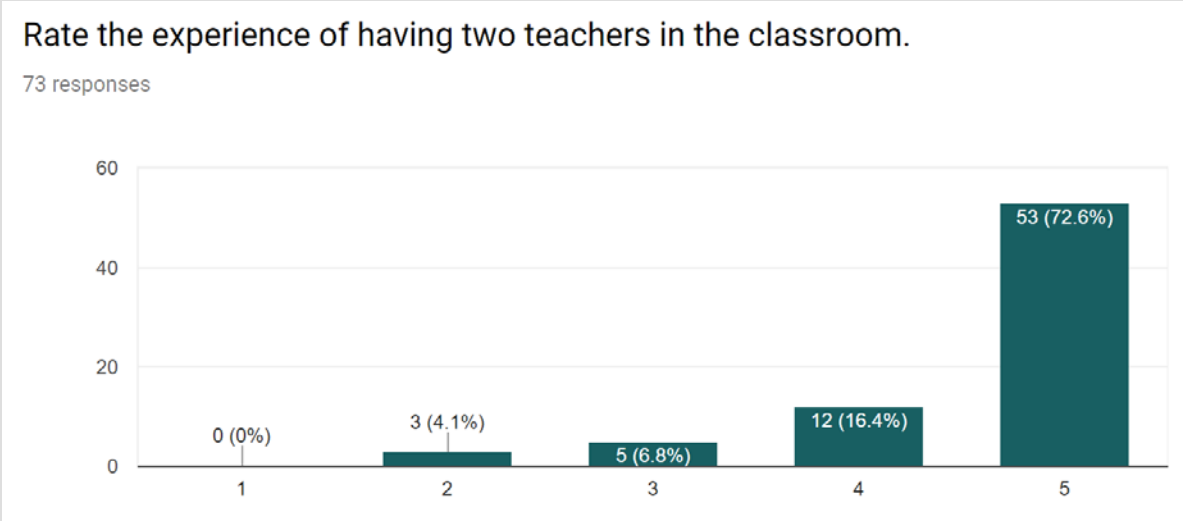
FA16 0385 Cohort: 16% by SP17 n=833

CM (non-coreq): 68% (FA17) n=1077

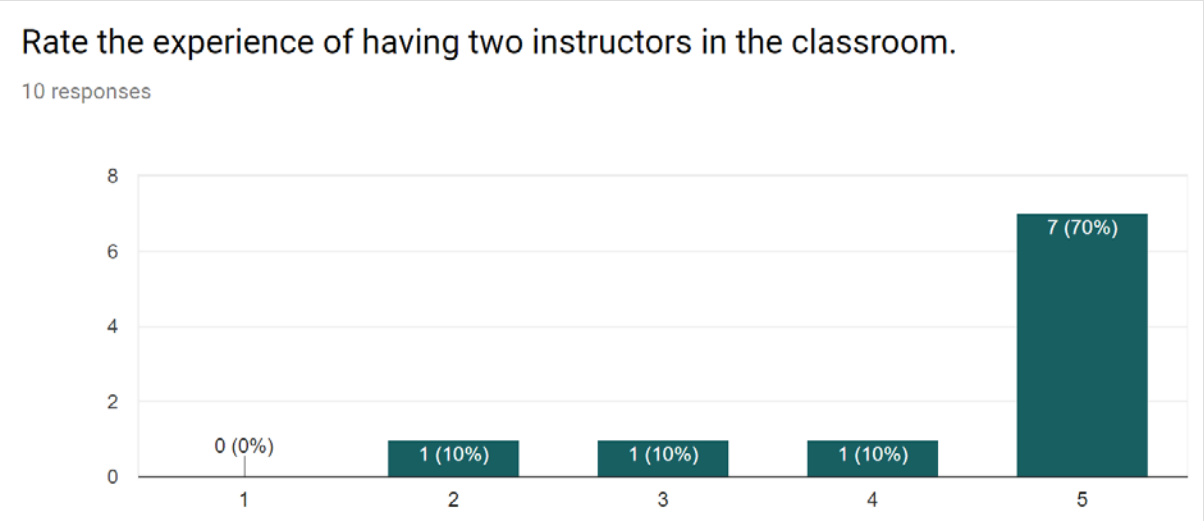
Fall 2015 0385 Cohort: 28% by SP17 n=701

TWO INSTRUCTORS IN THE CLASSROOM

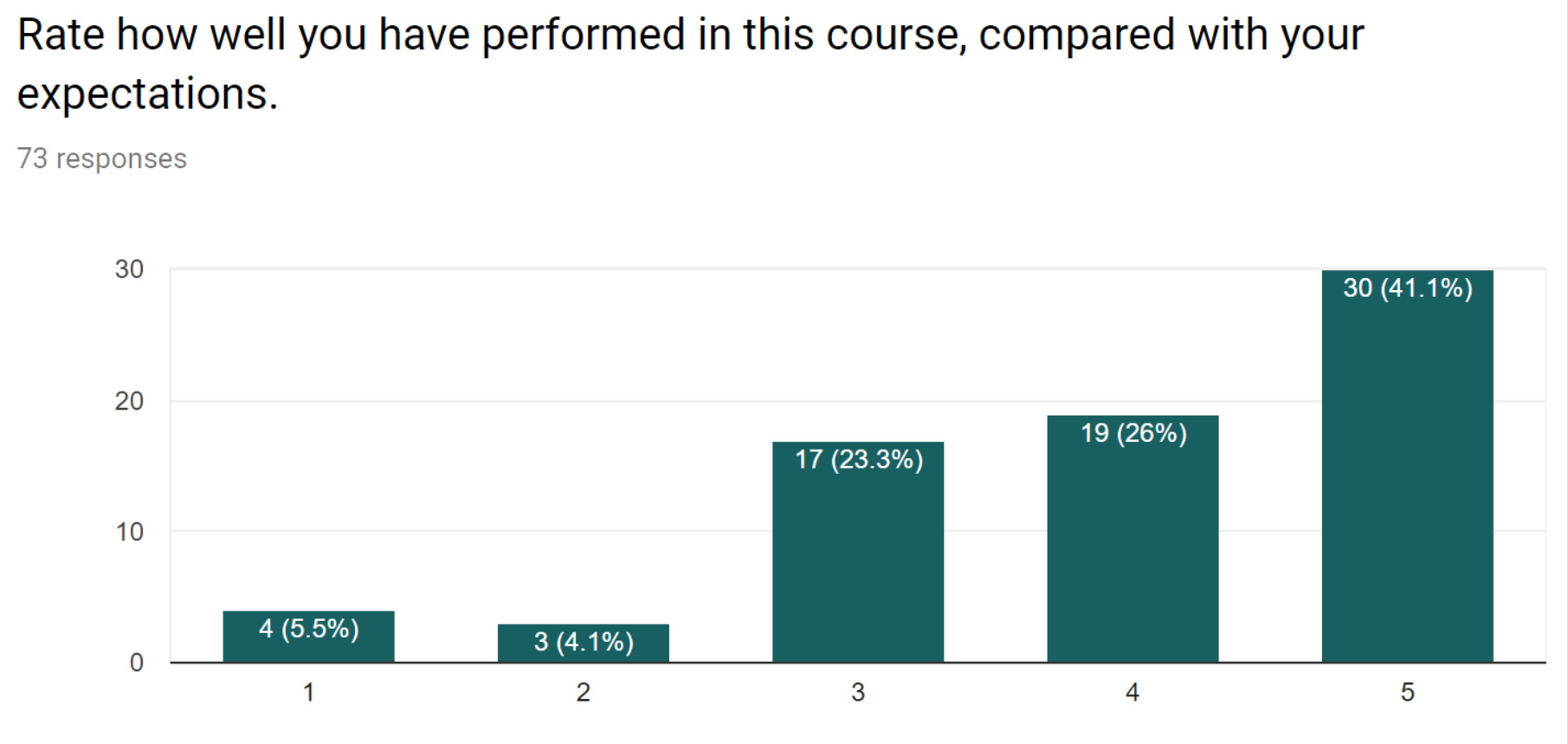
Average student rating 4.6 out of 5 (median = 5)



Average instructor rating 4.4 out of 5 (median = 5)



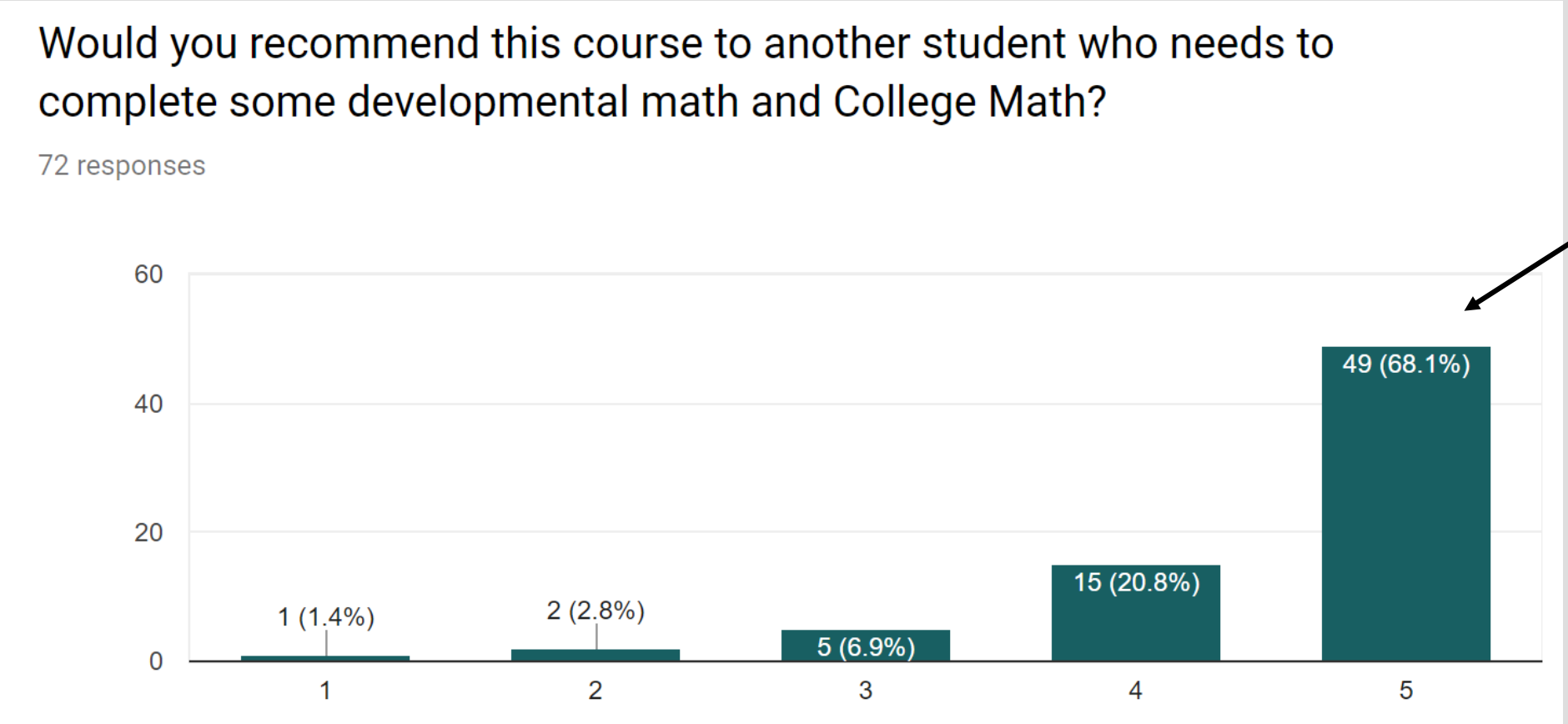
STUDENT PERFORMANCE AS COMPARED WITH THEIR EXPECTATION…



90% of students performed as well or better than they expected.

41% reported performing “much better”.

STUDENT EXPERIENCE IN THE COURSE



68% of students "strongly recommend"

CHALLENGES

- Inexperience with using collaborative learning (Online Training)
- Insecurity with college-level content for some dev. math instructors
- Group pacing (monitoring group speed)
- Inadequate reading levels
- Writing complete sentences
- Team Teaching is hard!

RECOMMENDATIONS

- Fully integrate developmental math skills into college-level content
- Writing with your textbook in mind – it's their resource
- Use scaffolding on college-level content to help students achieve understanding through small steps
- Instructor website with activities & keys
- Ongoing mandatory trainings
- Faculty mentor/point-person
- Team Teaching training and planning recommendations

THANK YOU!

Colleen Hosking
Associate Professor
of Mathematics

cneroda@austincc.edu

Kelly Greenwood
Associate Professor
of Mathematics

kgreenwo@austincc.edu

Marisa Bjorland
Assistant Professor
of Mathematics

mseene@austincc.edu

1C (Part 1): Sets and Venn Diagrams

1. The purpose of logic is to determine if statements are true or false through symbolic calculations of logical ideas. A ***proposition*** is a sentence containing a single idea that is either true or false, but not both. Determine whether each of the following statements is a proposition. Explain why or why not.

   (a) Open the door. _____

   (b) The door is open. _____

   (c) This statement is false. _____

2. A ***compound statement*** contains several ideas combined together with "connectors." Examples of connectors we will study in this course are: NOT, AND, OR, and IF…THEN.

   (a) The statement below connects two simple statements with the connector AND:

   "To apply for a certain scholarship, the applicant must be a full-time student AND be employed full-time."

   True or False: To be eligible for the scholarship the applicant must meet both requirements. _____

   (b) Now consider the same simple statements combined with the connector OR:

   "To apply for a certain scholarship, the applicant must be a full-time student OR be employed full-time."

   True or False: To be eligible for the scholarship the applicant must meet both requirements. _____

   True or False: If an applicant meets both requirements he may still apply for the scholarship. _____

   (c) In everyday conversation, we use what is called the *exclusive "*OR" that implies we can do one or the other but not both. However, in mathematics we use what is called the ***inclusive* "OR"** which implies we can do one or the other or both. Determine whether each of the following statements uses an exclusive "OR" or an inclusive "OR."

   - You can pay me now OR you can pay me later. _____
   - A job description says applicants must have a high school diploma OR two years of experience. _____

3. A **set** is a collection of individual objects, called **members**. Sometimes we describe a set of objects verbally, and other times we descry be a set by listing all the individual members of the set inside a set of braces.

   The following sets are equivalent: $T =$ The set of U.S. states that begin with the letter T.
   $T =$ { Texas, Tennessee }

   Note: We typically use a capital letter to name a set, and we separate the members of a set using commas.

   (a) Use set notation (braces) to list the members of the following set:

   $M =$ U.S. states that share a border with Mexico: $M =$ {Texas, Arizona, _____, _____ }

   (b) Sometimes it is inconvenient or impossible to list all the individual members of a set. In these cases we describe the set verbally or, in certain cases, we can list some of the members of the set and use three dots, called an **ellipse (…)**, to indicate the list continues in the same basic manner.

   Write the set A, the letters in the English alphabet, using an ellipse (…): $A =$ { A, B, C, … _____ }

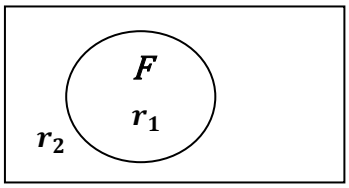
Venn Diagrams

4. English philosopher John Venn began developed the idea of using circles inside of a rectangle to examine relationships between sets of objects with certain traits. The large rectangle represents "the universe" and the circles inside the rectangle represent well-defined sets created by propositions.

   Say we survey 500 ACC students and ask them whether or not they meet the course load requirement to be labeled as a full-time student. In this case "the universe" is the 500 ACC students that participated in the survey and we will label circle F as the set of students that self-identified as full-time students.

   Note: Drawing one circle inside of the rectangle creates two regions: The region inside the circle (which we will distinguish as r_1), and the region outside the circle (which we will distinguish as r_2).

Universe = 500 ACC Students



Describe what each of the following sets represents in the context of the given scenario.

r_1 = _____

r_2 = _____

Disjoint Sets vs Overlapping Sets

Venn diagrams can be used to compare two sets. Consider the universe "Texas residents" and following pairs of sets:

Pair 1:		**Pair 2:**
$R =$ Self-identify as Republicans	Vs	$R =$ Self-identify as Republicans
$D =$ Self-identify as Democrats		$V =$ Registered Voters

5. One of the pairs of sets shows an example of **disjoint sets** because the sets have no members in common. The other pair of sets shows an example of **overlapping sets** because the sets share some of the same members.

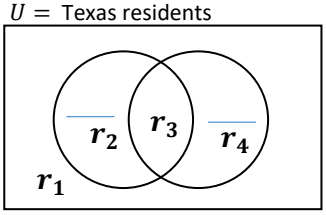
   (a) Which pair of sets are **disjoint** (Pair 1 or Pair 2)? _____
   Why are they disjoint sets?

   (b) Which pair of sets are **overlapping** (Pair 1 or Pair 2)? _____
   Why are they overlapping sets?

6. **Use the letters R, D, or V**, defined above in the set descriptions for Pair 1 and Pair 2, **to <u>label</u>** the following Venn diagrams and describe the members in each region of the Venn diagram.

   (a) **Overlapping Sets**

   $U =$ Texas residents



   r_1 = _____

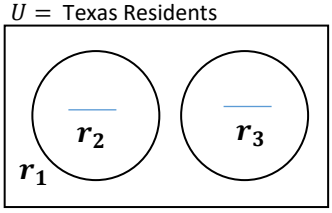
   r_2 = _____

   r_3 = _____

   r_4 = _____

   (b) **Disjoint Sets**

   $U =$ Texas Residents



   r_1 = _____

   r_2 = _____

   r_3 = _____

Now consider a survey given to 100 ACC Northridge students that asked the following questions:

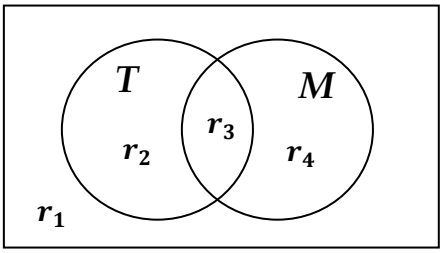
(1) Were you born in Texas? (2) Do you speak more than one language?

The sets in the Venn Diagram shown below represent the questions asked above. If someone responds "yes" to one of the questions, then they are in the given set (i.e. inside the related circle).

Let T = The set of students who were born in Texas.

M = The set of students who are multilingual.
(i.e. who speak more than one language)

Universe = 100 ACC Students



7. The students represented by regions r_1 and r_2 have been described below. Write a detailed description of the students represented in r_3 and r_4 .

r_1 = Students who were not born in Texas and are not multilingual.

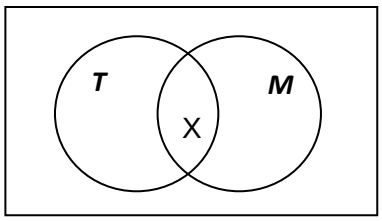
r_2 = Students who were born in Texas but do not speak more than one language.

r_3 = _____

r_4 = _____

8. Use an "X" to mark the region(s) of the Venn diagram that represent the described set, then use the **symbols** *T* and/or *M* along with any necessary connectors (AND, OR, or NOT) to represent the set. Part (A) has been completed for you.

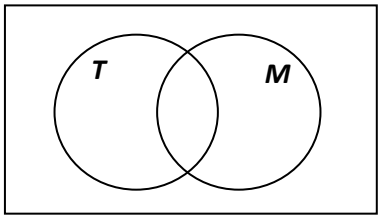
A. The set of natural-born Texans who speak more than one language.



Symbols:

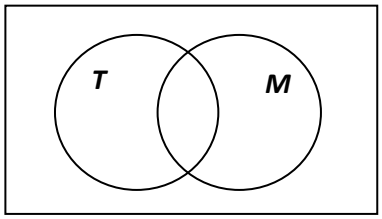
T* AND *M

B. The set of students born in Texas who speak only one language.



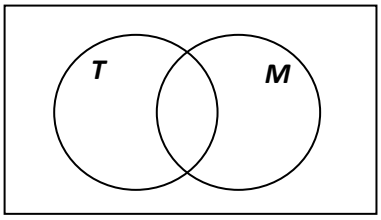
Symbols:

C. The set of multi-lingual students who were not born in Texas.



Symbols:

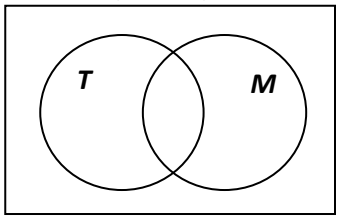
D. The set of students who were born in Texas or speak more than one language.



Symbols:

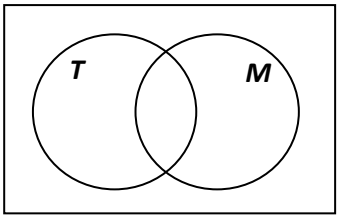
For (E) and (F), place an "X" in the region(s) represented by the symbols and write a sentence that describes the students in the region(s) you marked.

E. **NOT (*T* or *M*)**



Description:
The set of students who…

F. **NOT (*T*)**



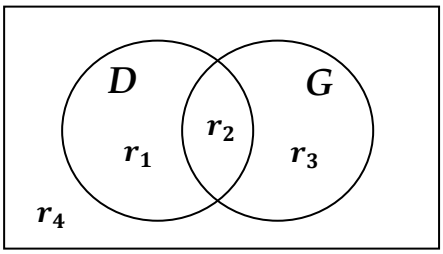
Description:
The set of students who…

9. We often see two simple statement connected as an IF…THEN statement. Explore the relationship between the following sets in parts (A) and (B), then think about the sets as an IF…THEN statement in part (C).

Universe: Domesticated Pets
D: Dogs
G: Golden Retrievers

(A) Consider the following Venn diagram. What does each region represent? Note: One region will be empty.

Universe = Domesticated Pets



r_1 = _____

r_2 = _____

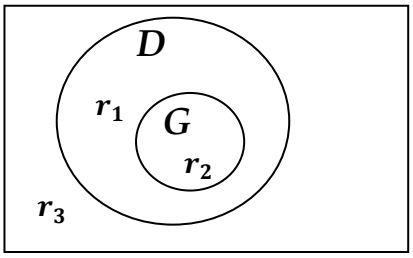
r_3 = _____

r_4 = _____

Which region is empty? _____. Why?

(B) Now consider the Venn diagram shown below using the same sets *D* and *G.* What does each region represent?

Universe = Domesticated Pets



r_1 = _____

r_2 = _____

r_3 = _____

Definition of Subset: For the sets *D* and *G*, we say that ***G* is a <u>subset</u> of *D*** because every member of set *G* is also a member of set *D* (i.e. *G* is a subset of *D* because every golden retriever is also a dog).

(C) The subset Venn diagram in 9(B) represents an **IF…THEN** scenario. Propositions of this type are called **conditional propositions** because they propose something is true based on the condition that something else is true. We phrase an IF…THEN scenario as: " If _given condition(s)_ , then _conclusion_."

In the case of "dogs" and "Golden Retrievers" we can say: "If a pet is a golden retriever (given condition), then it is a dog (conclusion)."

Look back at the Venn diagram in part 9(B). The sets are represented by nested circles. Which statement is represented by the innermost circle: the "given condition" or the "conclusion?"

The _____ is the set represented by the innermost circle.
(given condition/conclusion)

(D) Are the following statements logically the same? (yes or no) _____. Explain:

Statement 1: "If a pet is a golden retriever, then it is a dog"

Statement 2: "If a pet is a dog, then it is a golden retriever."

10. Consider the following sets: Universe = Written Works, F = Fiction Books, H= Harry Potter Series

(A) Use the symbols F and H to complete the sentence: _____ is a subset of _____.

(B) Draw a Venn diagram to represent the relationship between F and H.

(C) Describe the relationship between the sets using an **If…Then** statement.

---

11. Draw a Venn diagram to represent the sets in the following statement:

If an animal is a whale, then it is a mammal.

---

12. Draw a Venn diagram to represent the following sets
$Universe =$ College Graduates, $S =$ Degree in Science, $F =$ Females with Degrees

---

13. Draw a Venn diagram to represent the following sets:
$Universe =$ Written Works, $F =$ Fiction Books, $N =$ Non-Fiction Books.

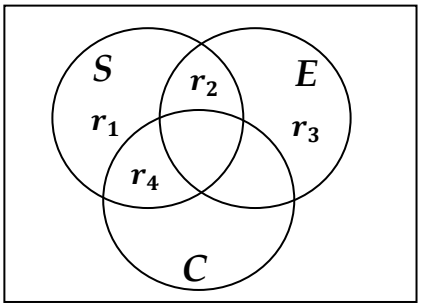
Three-Set Venn Diagrams

Venn diagrams can also be used to organize relationships between three sets of data that may overlap. A three-circle Venn diagram create 8 distinct regions.

14. Consider the following survey: 300 ACC students were surveyed and asked the following questions.

Are you a full-time student? (currently enrolled in 12+ hours)
Are you currently employed full-time? (40+ hours per week)
Are you a parent of a child/children 18 years old or younger?

Universe = 300 ACC Students



The results of the survey can be organized in the Venn diagram shown to the right, where:

S = The set of full-time students.

E = The set of students with full-time jobs.

C = The set of students that have children 18 years old or younger.

The students represented by regions r_1 and r_2 have been described for you below.

(A) **Write a detailed description** for students represented by r_3 and r_4.

(B) Use the descriptions given below in r_5 - r_8 to locate and **label these regions in the Venn diagram**.

$r_1 =$ Full-time students who do not have full-time jobs and who do not have children 18 years old or younger.

$r_2 =$ Full-time students who work full-time but do not have children 18 years old or younger.

$r_3 =$ _____

$r_4 =$ _____

$r_5 =$ Full-time students who work full-time and have children 18 years old or younger.

$r_6 =$ Students who work full-time and have children 18 years old or younger but are not enrolled full-time.

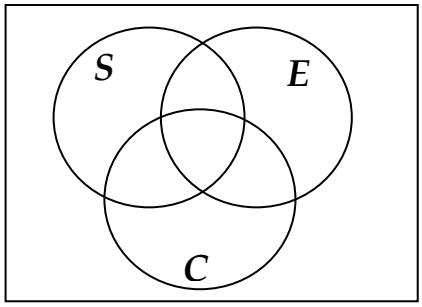
$r_7 =$ Students who have children 18 years old or younger but are not enrolled full-time and do not work full-time.

$r_8 =$ Students who are not enrolled full-time, do not work full-time and do not have children 18 years old or younger.

Place an "X" in the region(s) that contains the following student:

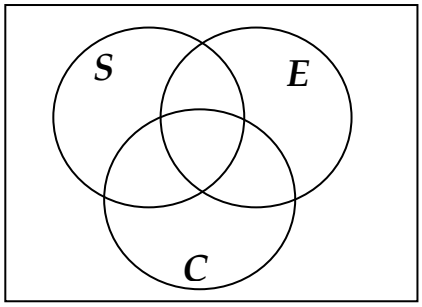
(C) Mary, a part-time student, currently works part-time and is a single mother to daughter, Maya (age 6).

Universe = 300 ACC Students



(D) Rocco is currently unemployed. He is not a parent and is in enrolled in 15 credit hours.

Universe = 300 ACC Students



1C (Part 2): Venn Diagrams and Counting

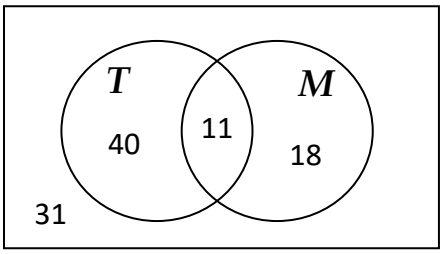
1. Consider a survey given to 100 ACC Northridge students that asked the following questions:

   (1) Were you born in Texas? (2) Do you speak more than one language?

   The sets in the Venn diagram shown below represent the questions asked above. If someone responds "yes" to one of the questions, then they are in the given set (i.e. inside the related circle).

   Let T = The set of students who were born in Texas.
   M = The set of students who speak more than one language.

   Universe = 100 ACC Students



   Answer the following:

   a. How many students were born in Texas **and** speak more than one language? _____

   b. How many students were born in Texas? _____

   c. How many students were not born in Texas? _____

   d. How many students were born in Texas and speak only one language? _____

   e. How many students were born in Texas or speak more than one language? _____

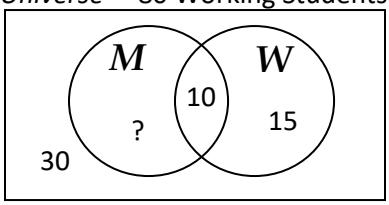
---

2. A survey was given to a group of 80 students who both work and go to school. The survey asked the following questions: (1) Are you currently enrolled in a math course?, (2) Do you work full-time?

   Some of the results of the survey are shown in the Venn diagram below.

   Let: M = The set of students enrolled in a math course.
   W = The set of students who work full-time.

   Universe = 80 Working Students



   Answer the following:

   If 35 students are currently enrolled in a math course, how many of those students work part-time?

3. Use the following table to fill in the number of students for each region of the Venn diagram shown below.

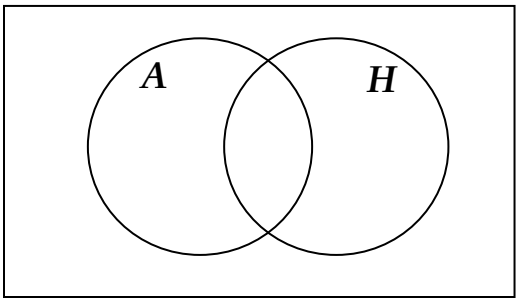
Number of Students	Description
12	Didn't make an A and didn't do the homework.
1	Made an A but didn't do all of the homework.
6	Total number of students who made an A on Test 1.
7	Total number of students who completed all of the homework.

In the Venn diagram shown to the right:

$A =$ Students who made an A on Test 1

$H =$ Students who completed all Test 1 related homework assignments

Universe = Students in this Section of MATH 1332



4. *Challenge Question:* In a group of 120 students: 75 students are enrolled in a math course, 65 students are enrolled in an English course, and 20 students are enrolled in neither. How many students are enrolled in both a math course and an English course? Draw a Venn diagram to help you organize the given information.

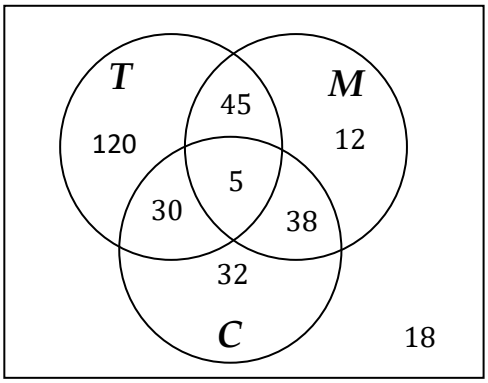
5. The Venn diagram below shows the results of a survey given to 300 ACC students, where:

$T =$ The set of students who were born in Texas.

$M =$ The set of students who are multilingual. (i.e. Students who speak more than one language)

$C =$ The set of students who have traveled to a country outside of the United States.

Universe = 300 ACC Students



Answer the following:

(A) How many Texas-born students are multi-lingual and have traveled outside the United States? _____

(B) How many students are multi-lingual? _____

(C) How many students speak only one language? _____

(D) How many students are multi-lingual and have traveled to another country? _____

(E) How many students are either multi-lingual or have traveled to another country? _____

1C (Part 3): Venn Diagrams and Two-Way Tables

1. A survey is given in a class. According to the table below, what question(s) were asked on the survey?

2. Describe each category (A, B, C, D).
   The first one is done for you.

	Has a dog	**Does not have a dog**	**Total**
Has a cat	A	B	E
Does not have a cat	C	D	F
Total	G	H	

(a) Students in group A: *have both a dog and a cat.*

(b) Students in group B: _____

(c) Students in group C: _____

(d) Students in group D: _____

(e) What information does section E give us? _____

(f) What information does section H give us? _____

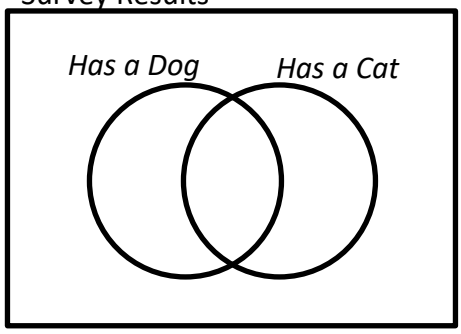
---

3. Here is the same table, with some numbers filled in. Complete the table.

	Has a dog	**Does not have a dog**	**Total**
Has a cat	8	4	
Does not have a cat	12		
Total		10	

4. Use the table to complete the Venn diagram.

Survey Results



Answer the questions in complete sentences.

5. How many have *only* a cat? _____

6. How many do not have a cat? _____

7. How many have a dog? _____

8. How many have a cat or a dog? _____

9. How many have neither pet? _____

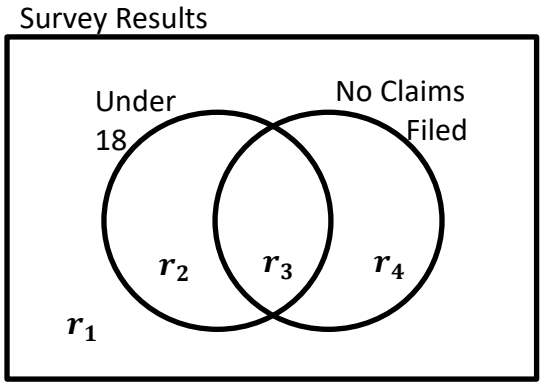
10. How many students were surveyed?_____

11. A car insurance company issued a monthly report showing the number of claims filed by clients broken down by age. The results are shown in the two-way table below.

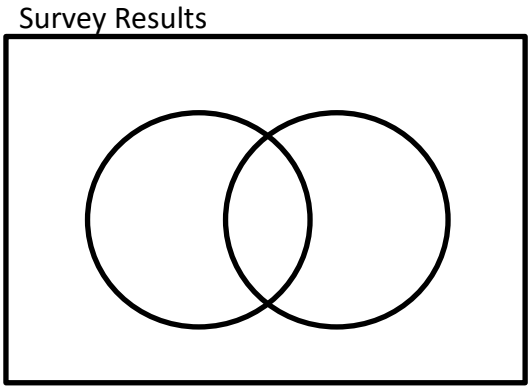
	No Claims Filed	At Least One Claim Filed	Total
Under 18 years old	25	50	75
18 years old and Older	30	20	50
Total	55	70	125

The Venn diagram shown to the right can be used to display the information given in the table.

a. Use the number values given in the table to complete the Venn diagram shown below.



b. The Venn diagram shown in part (a) is only one of four possible Venn diagrams that can be used to display the data in the table. Create a new two-circle Venn diagram by re-labeling the sets, then use the new Venn diagram to display the same information given in the table in a way that looks different from the Venn diagram in part (a).



---

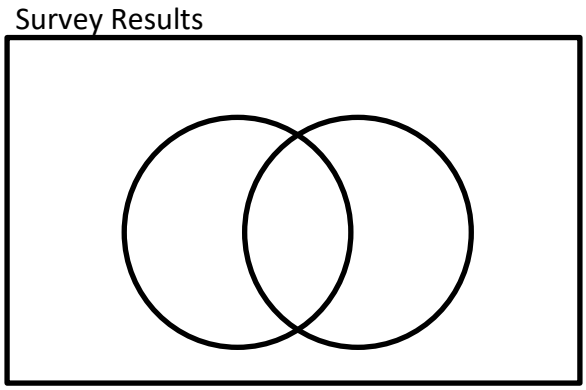
12. A survey was given to a group of parents asking how many hours they work for wages in a typical week. Each parent self-identified as either a mother or a father. Some of the results are filled in the two-way table below.

a. Complete the table.

	Works more than 40 hours	Works 40 hours or less	Total
Mothers	11	10	
Fathers	15		
Total		22	

HINT: The labels for each circle should come from the row/column titles. The label for one circle should come from the row titles and the label for the other circle should come from the column titles.

b. Complete the Venn diagram by labeling each circle and using the Venn diagram to display the data given in the table.



13. Use the information given in the table below to create a two-way table and then use the two-way table to create a Venn Diagram.

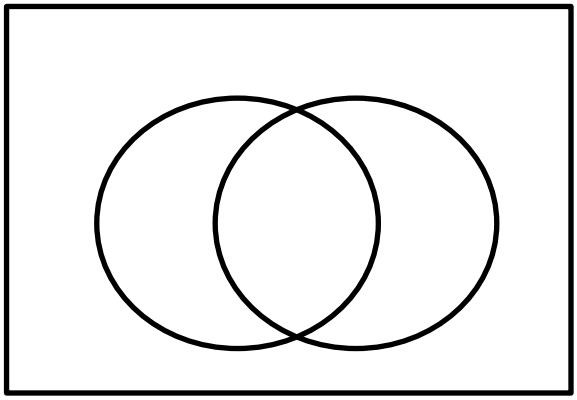
32	Applicants who don't have a high school diploma but do have 2 years of experience.
2	Applicants who don't have a high school diploma and have less than 2 years of experience.
18	Applicants who have both a high school diploma and 2 years of experience.
45	Applicants who have a high school diploma.

(a) Label each row and column, then complete the table based on the information given in the table above.

			Total
Total			

(b) Complete the Venn Diagram. Be sure to label each set.

Qualifications



Note: There are 4 possible Venn diagrams.

---

14. In a trial of a new allergy medicine, 120 people were given the medicine and 80 people were given a placebo. Of those given the medicine, 90 showed improvement in their allergy symptoms. Of those given the placebo, 20 did not show improvement.

a. In the space below, make a two-way table summarizing the results.

b. In the space below, make a Venn diagram from the table created in part (a).

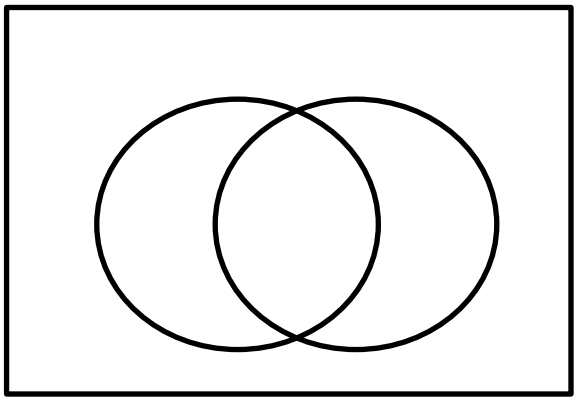
c. How many people who received the medicine did **<u>not</u>** see an improvement in their allergy symptoms? _____

d. How many people who received the placebo saw improvement in their allergy symptoms? _____

(a)

			Total
Total			

(b) Allergy Medicine Trial



1C (Part 1): Sets and Venn Diagrams

Key

1. The purpose of logic is to determine if statements are true or false through symbolic calculations of logical ideas. A ***proposition*** is a sentence containing a single idea that is either true or false, but not both. Determine whether each of the following statements is a proposition. Explain why or why not.

   (a) Open the door. This is not a proposition because it is neither true nor false. The statement is a command.

   (b) The door is open. This is a proposition because it can be either true or false, but not both.

   (c) This statement is false. This is not a proposition because it is simultaneousouly true and false.

2. A ***compound statement*** contains several ideas combined together with "connectors." Examples of connectors we will study in this course are: NOT, AND, OR, and IF…THEN.

   (a) The statement below connects two simple statements with the connector AND:

   "To apply for a certain scholarship, the applicant must be a full-time student AND be employed full-time."

   True or False: To be eligible for the scholarship the applicant must meet both requirements. TRUE

   (b) Now consider the same simple statements combined with the connector OR:

   "To apply for a certain scholarship, the applicant must be a full-time student OR be employed full-time."

   True or False: To be eligible for the scholarship the applicant must meet both requirements. FALSE

   True or False: If an applicant meets both requirements he may still apply for the scholarship. TRUE

   (c) In everyday conversation, we use what is called the *exclusive* "OR" that implies we can do one or the other but not both. However, in mathematics we use what is called the ***inclusive* "OR"** which implies we can do one or the other or both. Determine whether each of the following statements uses an exclusive "OR" or an inclusive "OR."

   - You can pay me now OR you can pay me later. exclusive "OR"
   - A job description says applicants must have a high school diploma OR two years of experience. inclusive "OR"

3. A **set** is a collection of individual objects, called **members**. Sometimes we describe a set of objects verbally, and other times we descry be a set by listing all the individual members of the set inside a set of braces.

   The following sets are equivalent: $T =$ The set of U.S. states that begin with the letter T.
   $T =$ { Texas, Tennessee }

   Note: We typically use a capital letter to name a set, and we separate the members of a set using commas.

   (a) Use set notation (braces) to list the members of the following set:

   $M =$ U.S. states that share a border with Mexico: $M =$ {Texas, Arizona, California, New Mexico }

   (b) Sometimes it is inconvenient or impossible to list all the individual members of a set. In these cases we describe the set verbally or, in certain cases, we can list some of the members of the set and use three dots, called an **ellipse (…)**, to indicate the list continues in the same basic manner.

   Write the set A, the letters in the English alphabet, using an ellipse (…): $A =$ { A, B, C, … Z }

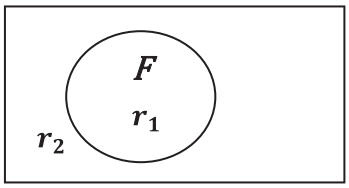
Venn Diagrams

4. English philosopher John Venn began developed the idea of using circles inside of a rectangle to examine relationships between sets of objects with certain traits. The large rectangle represents "the universe" and the circles inside the rectangle represent well-defined sets created by propositions.

   Say we survey 500 ACC students and ask them whether or not they meet the course load requirement to be labeled as a full-time student. In this case "the universe" is the 500 ACC students that participated in the survey and we will label circle F as the set of students that self-identified as full-time students.

   Note: Drawing one circle inside of the rectangle creates two regions: The region inside the circle (which we will distinguish as r_1), and the region outside the circle (which we will distinguish as r_2).

Universe = 500 ACC Students



Describe what each of the following sets represents in the context of the given scenario.

r_1 = The set of full-time students.

r_2 = The set of students that are NOT enrolled full-time.

Disjoint Sets vs Overlapping Sets

Venn diagrams can be used to compare two sets. Consider the universe "Texas residents" and following pairs of sets:

Pair 1:		**Pair 2:**
$R =$ Self-identify as Republicans	Vs	$R =$ Self-identify as Republicans
$D =$ Self-identify as Democrats		$V =$ Registered Voters

5. One of the pairs of sets shows an example of **disjoint sets** because the sets have no members in common. The other pair of sets shows an example of **overlapping sets** because the sets share some of the same members.

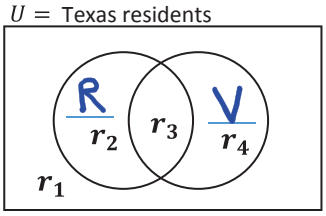
   (a) Which pair of sets are **disjoint** (Pair 1 or Pair 2)? Pair 1
   Why are they disjoint sets?
   A resident cannot identify as a Republican and Democrat simultaneously.

   (b) Which pair of sets are **overlapping** (Pair 1 or Pair 2)? Pair 2
   Why are they overlapping sets?
   Some registered voters may identify as Republicans.

6. **Use the letters R, D, or V**, defined above in the set descriptions for Pair 1 and Pair 2, **to <u>label</u>** the following Venn diagrams and describe the members in each region of the Venn diagram.

   (a) **Overlapping Sets**

$U =$ Texas residents



Texas residents who are...

r_1 = not registered and not Republican

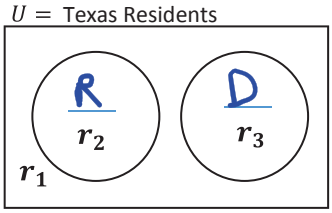
r_2 = Republicans that are NOT registered to vote

r_3 = Republicans that are registered to vote

r_4 = registered to vote, but are NOT Republican

   (b) **Disjoint Sets**

$U =$ Texas Residents



r_1 = Tx residents who are neither Republican nor Democrate

r_2 = Tx residents who are Republican

r_3 = Tx residents who are Democrats

Now consider a survey given to 100 ACC Northridge students that asked the following questions:

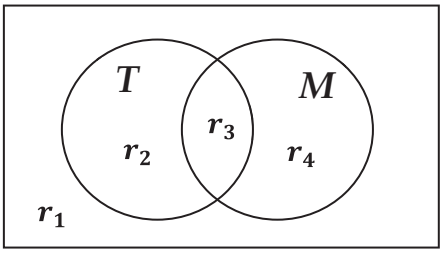
(1) Were you born in Texas? (2) Do you speak more than one language?

The sets in the Venn Diagram shown below represent the questions asked above. If someone responds "yes" to one of the questions, then they are in the given set (i.e. inside the related circle).

Let T = The set of students who were born in Texas.

M = The set of students who are multilingual.
(i.e. who speak more than one language)

Universe = 100 ACC Students



7. The students represented by regions r_1 and r_2 have been described below. Write a detailed description of the students represented in r_3 and r_4 .

r_1 = Students who were not born in Texas and are not multilingual.

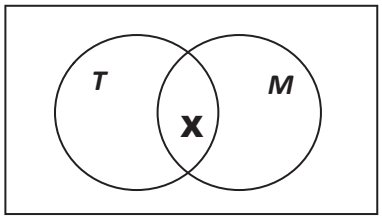
r_2 = Students who were born in Texas but do not speak more than one language.

r_3 = Students who were born in Texas AND speak more than one language.

r_4 = Students who speak more than one language but were NOT born in Texas.

8. Use an "X" to mark the region(s) of the Venn diagram that represent the described set, then use the **symbols** *T* and/or *M* along with any necessary connectors (AND, OR, or NOT) to represent the set. Part (A) has been completed for you.

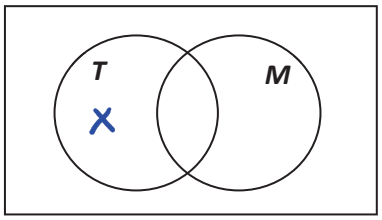
A. The set of natural-born Texans who speak more than one language.



Symbols:

T* AND *M

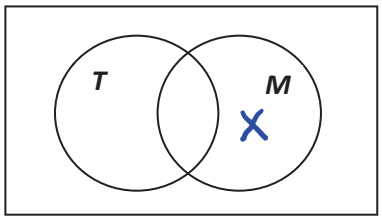
B. The set of students born in Texas who speak only one language.



Symbols:

T AND NOT M

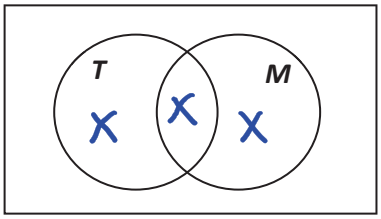
C. The set of multi-lingual students who were not born in Texas.



Symbols:

M AND NOT T

D. The set of students who were born in Texas or speak more than one language.

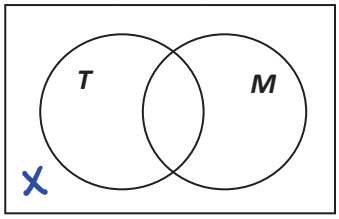


Symbols:

T OR M

For (E) and (F), place an "**X**" in the region(s) represented by the symbols and write a sentence that describes the students in the region(s) you marked.

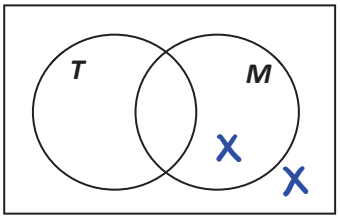
E. **NOT (*T* or *M*)**



Description:
The set of students who...

were not born in Texas and speak only one language.

F. **NOT (*T*)**



Description:
The set of students who...

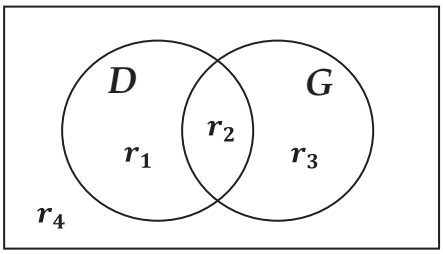
were NOT born in Texas

9. We often see two simple statement connected as an IF…THEN statement. Explore the relationship between the following sets in parts (A) and (B), then think about the sets as an IF…THEN statement in part (C).

Universe: Domesticated Pets
D: Dogs
G: Golden Retrievers

(A) Consider the following Venn diagram. What does each region represent? Note: One region will be empty.

Universe = Domesticated Pets



r_1 = dogs that are not Golden Retrievers

r_2 = dogs that are Golden Retrievers

r_3 = Golden Retrievers that are not dogs.

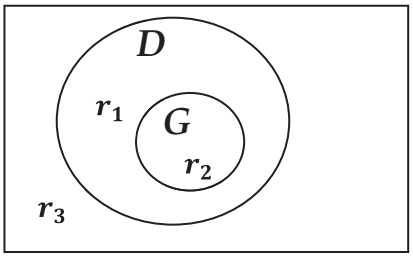
r_4 = pets that are neither Golden Retrievers nor dogs.

Which region is empty? r_3. Why?

It is not possible for a Golden Retriever to not also be a dog.

(B) Now consider the Venn diagram shown below using the same sets *D* and *G*. What does each region represent?

Universe = Domesticated Pets



r_1 = dogs that are not Golden Retrievers

r_2 = dogs that are Golden Retrievers

r_3 = pets that are not dogs

Definition of Subset: For the sets *D* and *G*, we say that ***G* is a <u>subset</u> of *D*** because every member of set *G* is also a member of set *D* (i.e. *G* is a subset of *D* because every golden retriever is also a dog).

(C) The subset Venn diagram in 6(B) represents an **IF…THEN** scenario. Propositions of this type are called **conditional propositions** because they propose something is true based on the condition that something else is true. We phrase an IF…THEN scenario as: " If _given condition(s)_ , then _conclusion_."

In the case of "dogs" and "Golden Retrievers" we can say: "If a pet is a golden retriever (given condition), then it is a dog (conclusion)."

Look back at the Venn diagram in part 8(B). The sets are represented by nested circles. Which statement is represented by the innermost circle: the "given condition" or the "conclusion?"

The given condition (given condition/condition) is the set represented by the innermost circle.

(D) Are the following statements logically the same? (yes or no) No. Explain:

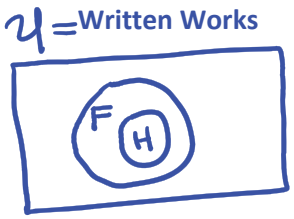
Statement 1: "If a pet is a golden retriever, then it is a dog" TRUE

Statement 2: "If a pet is a dog, then it is a golden retriever." FALSE

10. Consider the following sets: Universe = Written Works, F = Fiction Books, H= Harry Potter Series

(A) Use the symbols F and H to complete the sentence: __H__ is a subset of __F__.

(B) Draw a Venn diagram to represent the relationship between F and H.



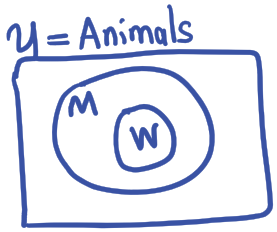
(C) Describe the relationship between the sets using an **If…Then** statement.

If a novel is in the Harry Potter series, then it is a work of fiction.

---

11. Draw a Venn diagram to represent the sets in the following statement:

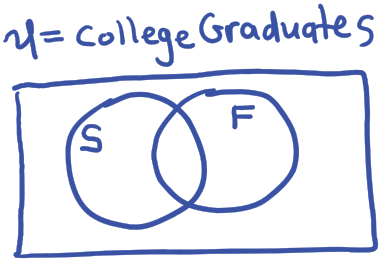
If $\underbrace{\text{an animal is a whale}}_{\text{Condition}}$, then $\underbrace{\text{it is a mammal}}_{\text{Conclution}}$.



Where: M = set of mammals
W = set of whales

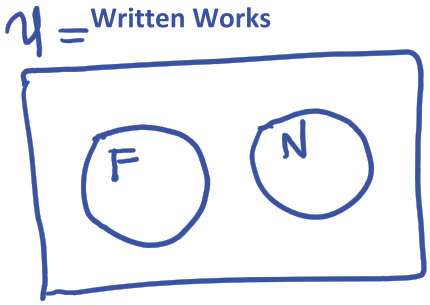
---

12. Draw a Venn diagram to represent the following sets
$Universe$ = College Graduates, S = Degree in Science, F = Females with Degrees



---

13. Draw a Venn diagram to represent the following sets:
$Universe$ = Written Works, F = Fiction Books, N = Non-Fiction Books.



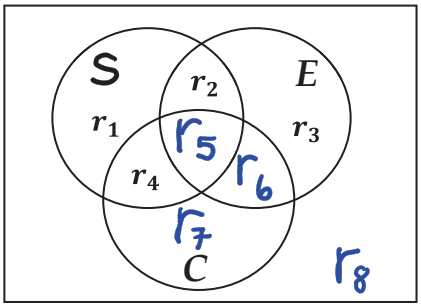
Three-Set Venn Diagrams

Venn diagrams can also be used to organize relationships between three sets of data that may overlap. A three-circle Venn diagram create 8 distinct regions.

14. Consider the following survey: 300 ACC students were surveyed and asked the following questions.

Are you a full-time student? (currently enrolled in 12+ hours)
Are you currently employed full-time? (40+ hours per week)
Are you a parent of a child/children 18 years old or younger?

Universe = 100 ACC Students



The results of the survey can be organized in the Venn diagram show to the right, where:

S = The set of full-time students.

E = The set of students with full-time jobs.

C = The set of students that have children 18 years old or younger.

The students represented by regions r_1 and r_2 have been described for you below.

(A) **Write a detailed description** for students represented by r_3 and r_4.

(B) Use the descriptions given below in r_5 - r_8 to locate and **label these regions in the Venn diagram**.

r_1 = Full-time students who do not have full-time jobs and who do not have children 18 years old or younger.

r_2 = Full-time students who work full-time but do not have children 18 years old or younger.

r_3 = students who work full-time but are not enrolled full-time and do not have chidren 18 years or younger.

r_4 = students enrolled full-time who have children ≤ 18 years old and who do not work full-time.

r_5 = Full-time students who work full-time and have children 18 years old or younger.

r_6 = Students who work full-time and have children 18 years old or younger but are not enrolled full-time.

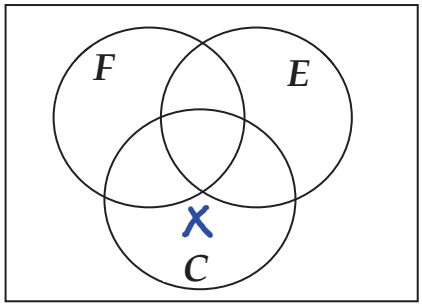
r_7 = Students who have children 18 years old or younger but are not enrolled full-time and do not work full-time.

r_8 = Students who are not enrolled full-time, do not work full-time and do not have children 18 years old or younger.

Place an "**X**" in the region(s) that contains the following student:

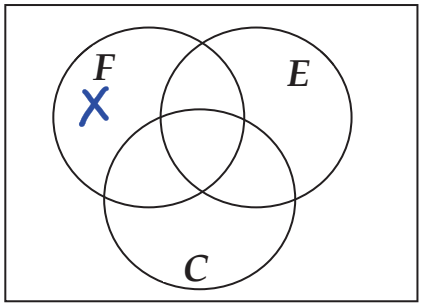
(C) Mary, a part-time student, currently works part-time and is a single mother to daughter, Maya (age 6).

Universe = 100 ACC Students



(D) Rocco is currently unemployed. He is not a parent and is in enrolled in 15 credit hours.

Universe = 100 ACC Students



1C (Part 2): Venn Diagrams and Counting

Key

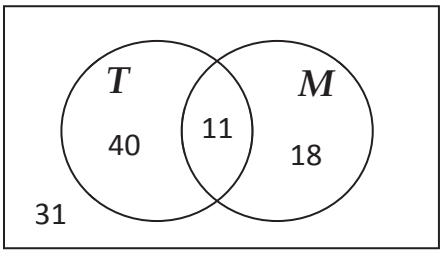
1. Consider a survey given to 100 ACC Northridge students that asked the following questions:

   (1) Were you born in Texas? (2) Do you speak more than one language?

   The sets in the Venn diagram shown below represent the questions asked above. If someone responds "yes" to one of the questions, then they are in the given set (i.e. inside the related circle).

   Let T = The set of students who were born in Texas.
   M = The set of students who speak more than one language.

Universe = 100 ACC Students



Answer the following:

a. How many students were born in Texas **and** speak more than one language? 11

b. How many students were born in Texas? $40+11=\boxed{51}$

c. How many students were not born in Texas? $31+18=\boxed{49}$

d. How many students were born in Texas and speak only one language? 40

e. How many students were born in Texas or speak more than one language? $40+11+18=\boxed{69}$

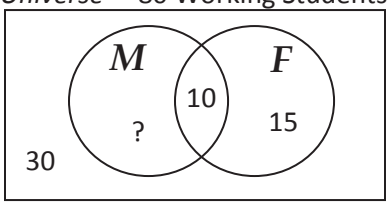
---

2. A survey was given to a group of 80 students who both work and go to school. The survey asked the following questions: (1) Are you currently enrolled in a math course?, (2) Do you work full-time?

   Some of the results of the survey are shown in the Venn diagram below.

   Let: M = The set of students enrolled in a math course.
   F = The set of students who work full-time.

Universe = 80 Working Students



Answer the following:

If 35 students are currently enrolled in a math course, how many of those students work part-time?

$$\begin{array}{r} 35 \\ -10 \\ \hline 25 \end{array}$$

There are 25 students who work and who are enrolled part-time in a math course.

3. Use the following table to fill in the number of students for each region of the Venn diagram shown below.

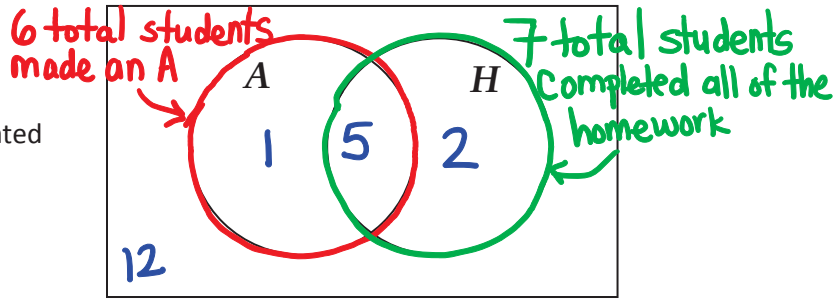
Number of Students	Description
12	Didn't make an A and didn't do the homework.
1	Made an A but didn't do all of the homework.
6	Total number of students who made an A on Test 1.
7	Total number of students who completed all of the homework.

In the Venn diagram shown to the right:

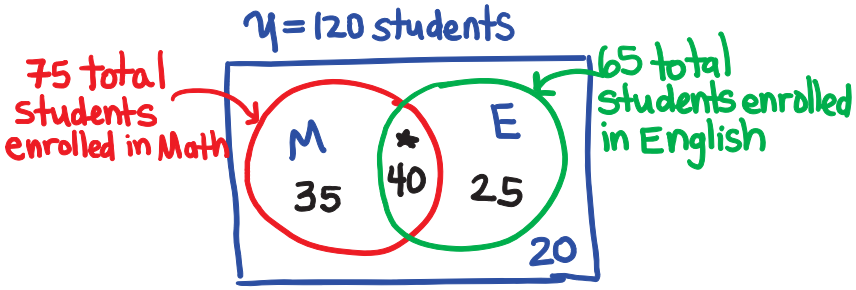
$A =$ Students who made an A on Test 1

$H =$ Students who completed all Test 1 related homework assignments

Universe = Students in this Section of MATH 1332



4. *Challenge Question:* In a group of 120 students: 75 students are enrolled in a math course, 65 students are enrolled in an English course, and 20 students are enrolled in neither. How many students are enrolled in both a math course and an English course? Draw a Venn diagram to help you organize the given information.



120 total
− 20 neither
100 students in remaining 3 regions (M or E)

75 Math
+ 65 English
140

this is 40 over the allotted 100 students, so there must be 40 students in the overlap, i.e. 40 students in both Math and English

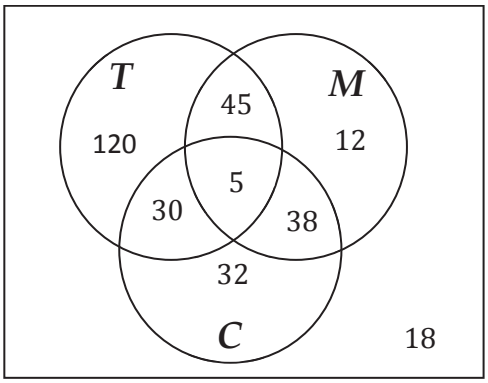
5. The Venn diagram below shows the results of a survey given to 300 ACC students, where:

$T =$ The set of students who were born in Texas.

$M =$ The set of students who are multilingual. (i.e. Students who speak more than one language)

$C =$ The set of students who have traveled to a country outside of the United States.

Universe = 300 ACC Students



Answer the following:

(A) How many Texas-born students are multi-lingual and have traveled outside the United States? 5

(B) How many students are multi-lingual? $\boxed{100}$ ← 45 + 38 + 12 + 5 = 100

(C) How many students speak only one language? $\boxed{200}$ ← 120 + 30 + 32 + 18 = 200

(D) How many students are multi-lingual and have traveled to another country? $\boxed{43}$ ← 38 + 5 = 43

(E) How many students are either multi-lingual or have traveled to another country? $\boxed{162}$

45 + 5 + 38 + 12 + 30 + 32 = 162

1C (Part 3): Venn Diagrams and Two-Way Tables

Key

1. A survey is given in a class. According to the table below, what question(s) were asked on the survey?

(1) Do you have a cat?

(2) Do you have a dog?

2. Describe each category (A, B, C, D). The first one is done for you.

	Has a dog	Does not have a dog	Total
Has a cat	A	B	E
Does not have a cat	C	D	F
Total	G	H	

(a) Students in group A: *have both a dog and a cat.*

(b) Students in group B: have a cat but not a dog.

(c) Students in group C: have a dog but not a cat.

(d) Students in group D: do not have a cat and do not have a dog.

(e) What information does section E give us? The total # of people that have a cat.

(f) What information does section H give us? The total # of people that do not have a dog.

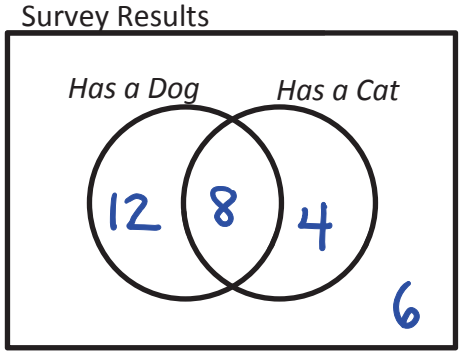
---

3. Here is the same table, with some numbers filled in. Complete the table.

	Has a dog	Does not have a dog	Total
Has a cat	8	4	12
Does not have a cat	12	6	18
Total	20	10	30

4. Use the table to complete the Venn diagram.

Survey Results



Answer the questions in complete sentences.

5. How many have *only* a cat? 4

6. How many do not have a cat? 18

7. How many have a dog? 20

8. How many have a cat or a dog? 24

inclusive "OR" (can have both)

9. How many have neither pet? 6

10. How many students were surveyed? 30

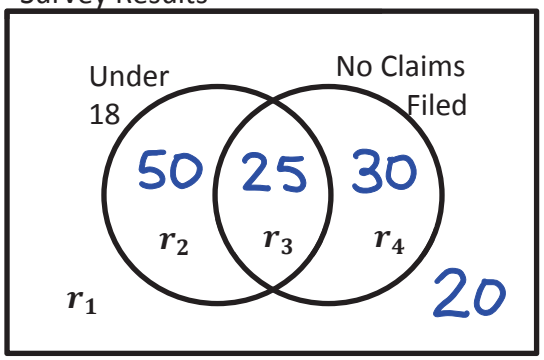
11. A car insurance company issued a monthly report showing the number of claims filed by clients broken down by age. The results are shown in the two-way table below.

	No Claims Filed	At Least One Claim Filed	Total
Under 18 years old	25	50	75
18 years old and Older	30	20	50
Total	55	70	125

The Venn diagram shown to the right can be used to display the information given in the table.

a. Use the number values given in the table to complete the Venn diagram shown below.

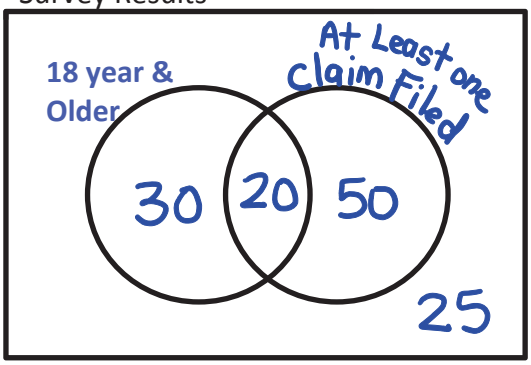
Survey Results



b. The Venn diagram shown in part (a) is only one of four possible Venn diagrams that can be used to display the data in the table. Create a new two-circle Venn diagram by re-labeling the sets, then use the new Venn diagram to display the same information given in the table in a way that looks different from the Venn diagram in part (a).

★ Answers may vary!

Survey Results



12. A survey was given to a group of parents asking how many hours they work for wages in a typical week. Each parent self-identified as either a mother or a father. Some of the results are filled in the two-way table below.

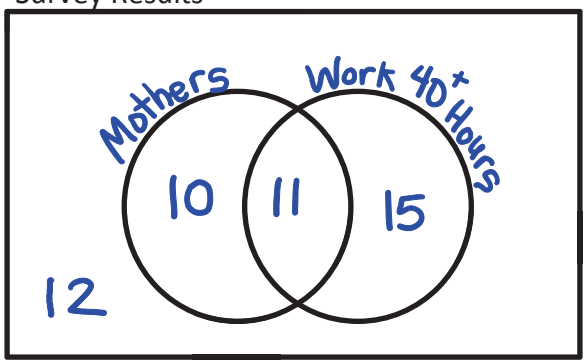
a. Complete the table.

	Works more than 40 hours	Works 40 hours or less	Total
Mothers	11	10	12
Fathers	15	12	27
Total	26	22	48

HINT: The labels for each circle should come from the row/column titles. The label for one circle should come from the row titles and the label for the other circle should come from the column titles.

b. Complete the Venn diagram by labeling each circle and using the Venn diagram to display the data given in the table.

Survey Results



13. Use the information given in the table below to create a two-way table and then use the two-way table to create a Venn Diagram.

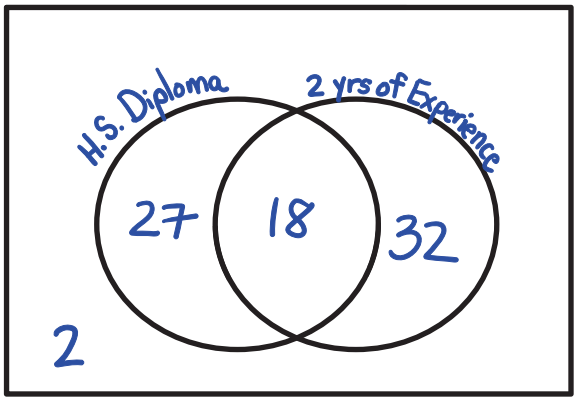
32	Applicants who don't have a high school diploma but do have 2 years of experience.
2	Applicants who don't have a high school diploma and have less than 2 years of experience.
18	Applicants who have both a high school diploma and 2 years of experience.
45	Applicants who have a high school diploma.

(a) Label each row and column, then complete the table based on the information given in the table above.

	High School Diploma	No H.S. Diploma	Total
Has 2 years of experience	18	32	50
Does not have 2 yrs experience	27	2	29
Total	45	34	79

(b) Complete the Venn Diagram. Be sure to label each set.

Qualifications



Note: There are 4 possible Venn diagrams.

---

14. In a trial of a new allergy medicine, 120 people were given the medicine and 80 people were given a placebo. Of those given the medicine, 90 showed improvement in their allergy symptoms. Of those given the placebo, 20 did not show improvement.

a. In the space below, make a two-way table summarizing the results.

b. In the space below, make a Venn diagram from the table created in part (a).

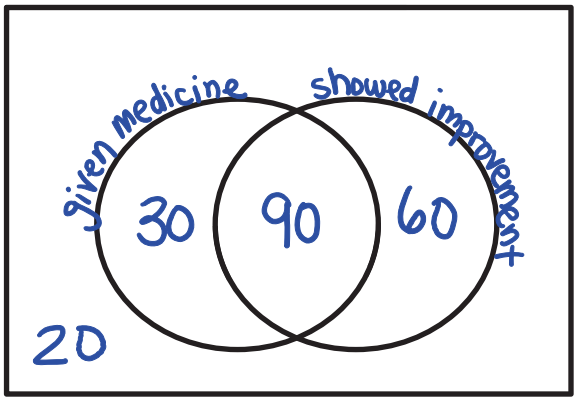
c. How many people who received the medicine did **not** see an improvement in their allergy symptoms? 30

d. How many people who received the placebo saw improvement in their allergy symptoms? 60

(a)

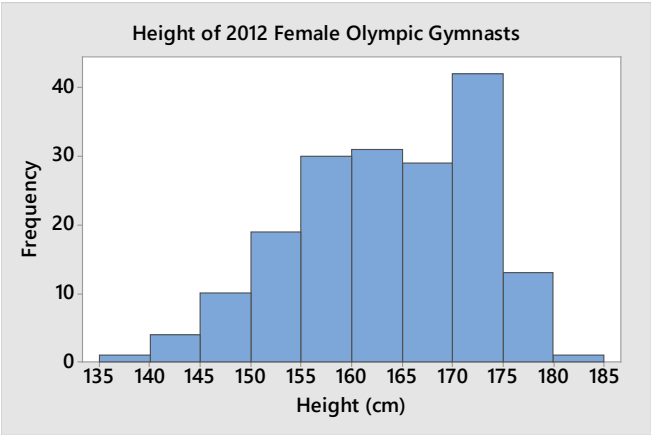
	showed improvement	did not show improvement	Total
given medicine	90	30	120
given placebo	60	20	80
Total	150	50	200

(b) Allergy Medicine Trial



2.3 The 95% Rule, z-Scores, and Percentiles

1. The heights of female gymnasts in the 2012 Olympics are shown in the histogram. The mean of these heights is 162.74 cm and the standard deviation is 9.30 cm.



   a. Mark the location of the mean on the horizontal axis. Draw vertical lines on your graph such approximately 95% of the data falls between your lines. (This is just a quick eyeball estimate.)

   b. Calculate the height that is one standard deviation below the mean and the height that is one standard deviation above the mean.

      162.74 – 9.30 = _____ cm 162.74 + 9.30 = _____ cm

   c. Now calculate the heights that are **two** standard deviations from the mean. Mark these values on the horizontal axis.

   d. According to the raw data, 175 of the 180 female gymnasts had heights within **two** standard deviations of the mean. Calculate the percent of the women who had heights in this interval.

   e. Use the graph to fill in the blanks about the 95% rule:

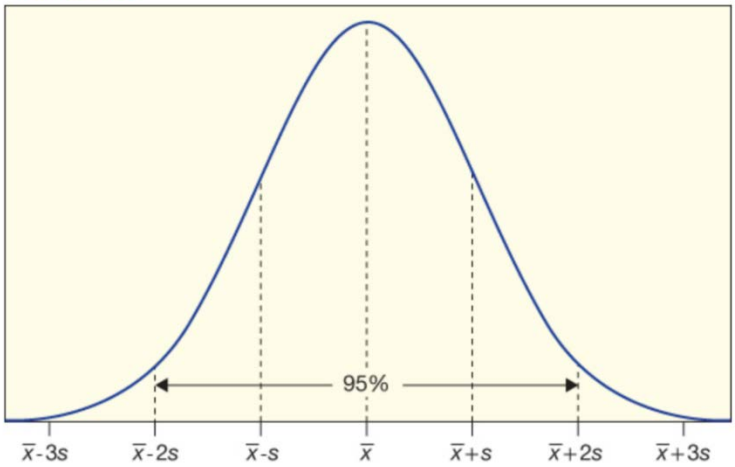
The 95% Rule

If a distribution of data is approximately symmetric and bell-shaped, about _____ % of the data should fall within two standard deviations of the mean.

How many standard deviations are between $\bar{x} - 2s$ and $\bar{x} + 2s$?

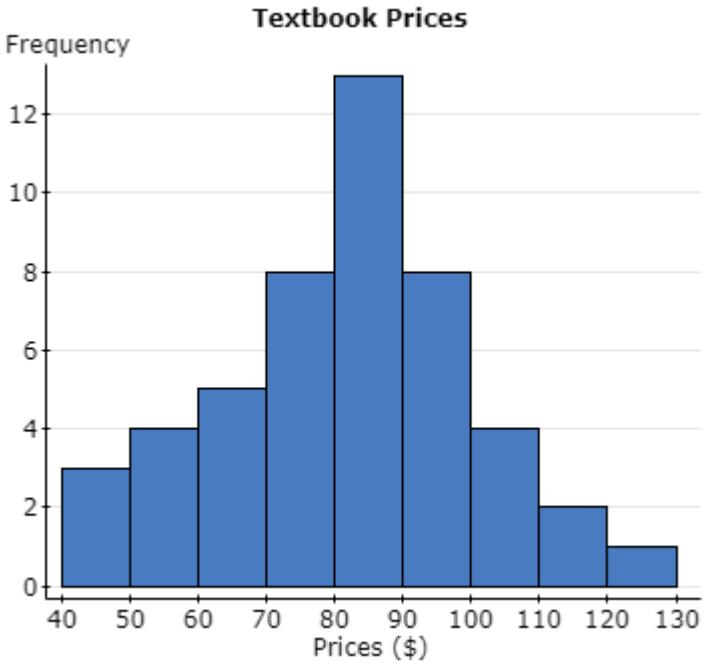
_____

Figure 2.18 *Most data are within two standard deviations of the mean*



(Graphic Source: *Statistics: Unlocking the Power of Data, by Lock, Lock, Lock, Lock, and Lock*)

2. Consider this histogram of a sample of textbook prices.



   a. Estimate the mean: _____
      Mark its location on the horizontal axis.

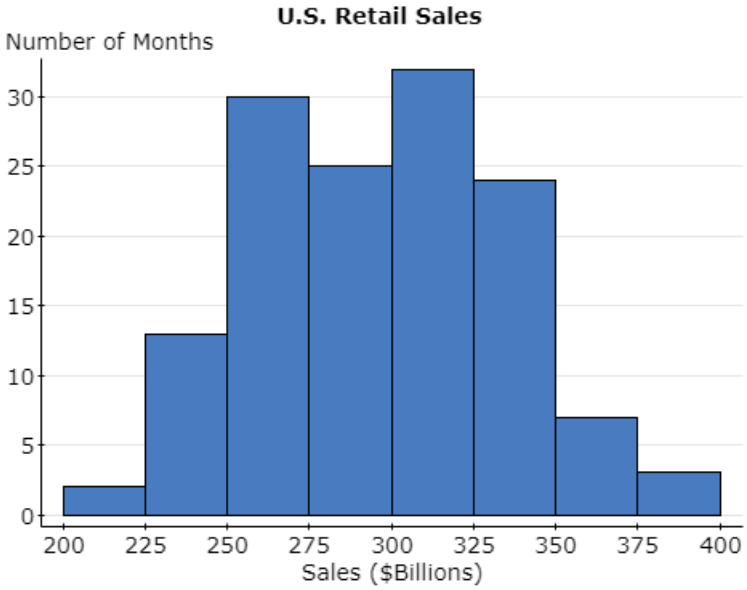
   b. Estimate an interval centered at your mean that contains approximately 95% of the data. Draw vertical lines on your histogram at these values.

      _____ to _____

   c. Since this distribution is roughly bell-shaped and symmetric, about 95% of the textbook prices fall within _____ standard deviations of the mean. (See page 1.)

      This tells us we can take the width of our interval in (b) and divide it by _____ to estimate the standard deviation. Use this method to estimate the standard deviation for textbook prices.

3. This distributions shows retail sales in the U.S. for the 136 months beginning January 2009.



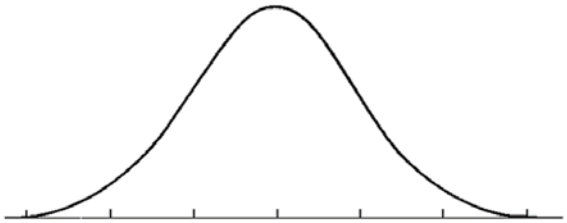
   a. Estimate the mean and standard deviation.

   b. Have one person in your group open StatKey. Go to **One Quantitative Variable** and choose "Monthly Retail Sales" from the drop-down list of data sets. How do the actual mean and standard deviation compare with your estimate?

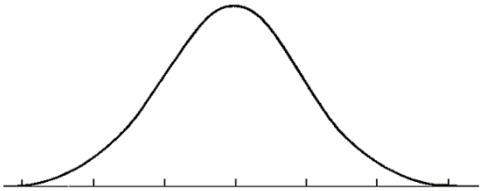
4. Suppose the heights of all men are approximately symmetric and bell-shaped with a mean of 70 inches and a standard deviation of 4 inches.

   a. Assume the tick marks are spaced a distance of 1 standard deviation apart. (Refer to Figure 2.18 on page 1.)

      Label the mean height, and the heights that are 1, 2, and 3 standard deviations above and below the mean.

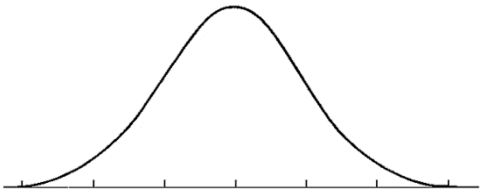


   b. About 95% of men have heights between _____ and _____ inches. Shade the area under the curve that represents these men.



   c. About what percent of men have heights *outside* the height interval in (b)? Shade the area under the curve that represents these men.

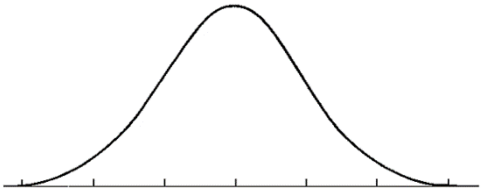
   d. About what percent of men are shorter than 62 inches? Shade the area under the curve that represents these men.



The **Pth percentile** is the value of the quantitative variable, like height, that is greater than P percent of the data.

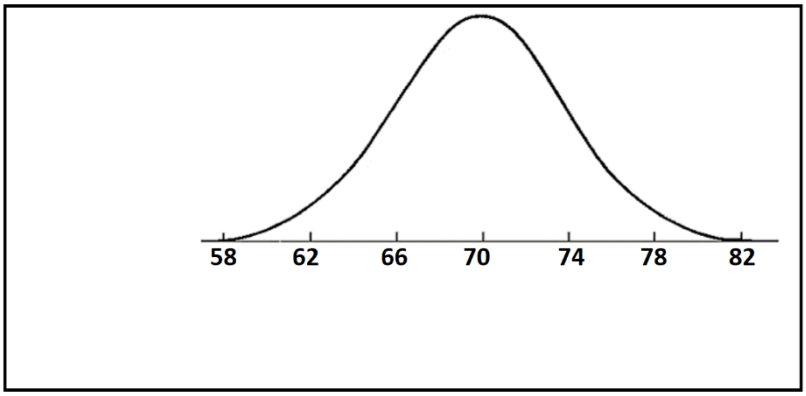
   e. Based on your answer for (d), men with heights of 62 inches therefore have a height in the _____ percentile.

   f. A man has a height in the 97.5th percentile. Shade an estimated area under the curve that represents this scenario. Then estimate the man's height.



5. In statistics, we will use the variable "z" to represent the number of standard deviations a data value is from the mean. We will call this value a **z-score.** Recall from the previous page that the heights of all men are approximately symmetric and bell-shaped with a mean of 70 inches and a standard deviation of 4 inches

   a. The height 66 inches has a z-score of -1. Why?



   b. Find the z-scores for the following heights.

      78 inches: **z =** _____

      58 inches: **z =** _____

      70 inches: **z =** _____

   c. Label the distribution above with the z-scores underneath their corresponding heights.

   d. Use the graph to estimate the z-score for a height of 68 inches: z ≈ _____

A **z-score** is the number of standard deviations a data value is from the mean. We calculate z as follows:

$$z = \frac{data\ value - mean}{standard\ deviation}$$

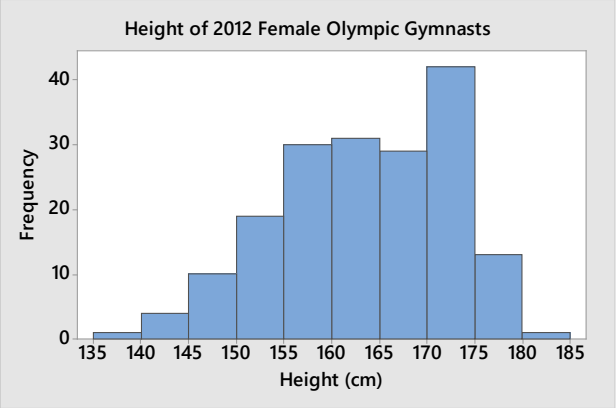
For **samples**, this looks like: $Z = \frac{x-\bar{x}}{s}$ For **populations**, this looks like: $Z = \frac{x-\mu}{\sigma}$

   e. Use the formula to verify the z-score you estimated in (5d).

Calculator Tip
Hit $\boxed{=}$ after subtracting.
Then divide.

6. Recall the histogram from the beginning of our activity. Suppose one of these women was 170 cm tall.

   a. Calculate the z-score for her height. (The mean is 162.74 cm and the standard deviation is 9.30 cm.)

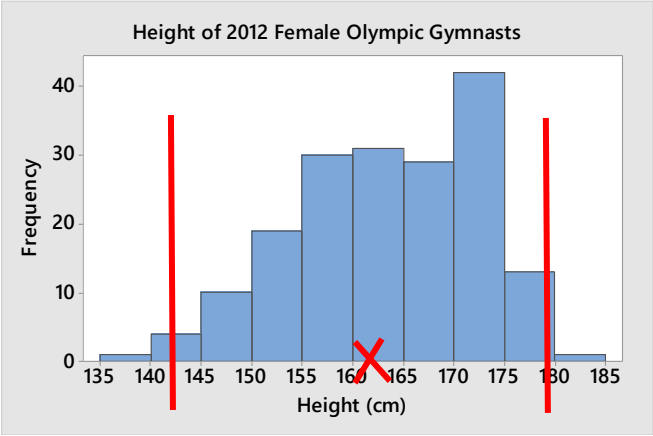


   b. Estimate her percentile: _____

   c. A male gymnast events in these same Olympics has the same height percentile as this woman.
      Does this indicate that they are the same height? Explain why or why not.

2.3 The 95% Rule, z-Scores, and Percentiles

1. The heights of female gymnasts in the 2012 Olympics are shown in the histogram. The mean of these heights is 162.74 cm and the standard deviation is 9.30 cm.



   a. Mark the location of the mean on the horizontal axis. Draw vertical lines on your graph such approximately 95% of the data falls between your lines. (This is just a quick eyeball estimate.)

   b. Calculate the height that is one standard deviation below the mean and the height that is one standard deviation above the mean.

   162.74 – 9.30 = ___153.44___ cm 162.74 + 9.30 = __172.04___ cm

   c. Now calculate the heights that are **two** standard deviations from the mean. Mark these values on the horizontal axis.

   two below: 162.74 – 2(9.30) = 144.14 cm
   two above: 162.74 + 2(9.30) = 181.43 cm

   d. According to the raw data, 175 of the 180 female gymnasts had heights within **two** standard deviations of the mean. Calculate the percent of the women who had heights in this interval.

$$p = \frac{175}{180} \approx 0.972 = 97.2\%$$

   e. Use the graph to fill in the blanks about the 95% rule:

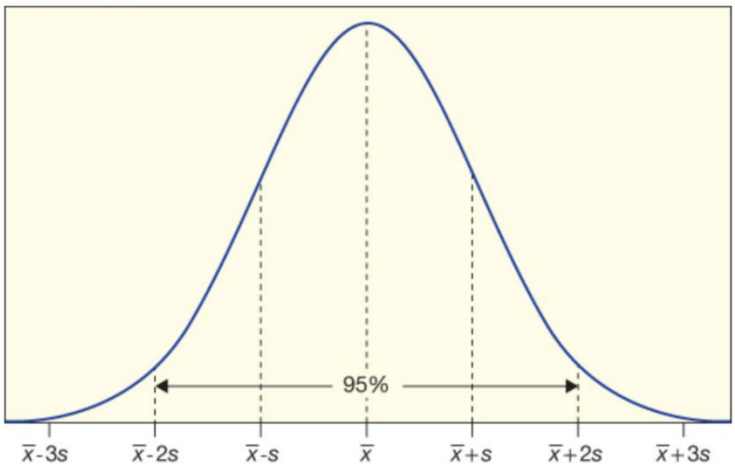
The 95% Rule

If a distribution of data is approximately symmetric and bell-shaped, about _95_ % of the data should fall within two standard deviations of the mean.

How many standard deviations are between $\bar{x} - 2s$ and $\bar{x} + 2s$?

__4__

Figure 2.18 *Most data are within two standard deviations of the mean*

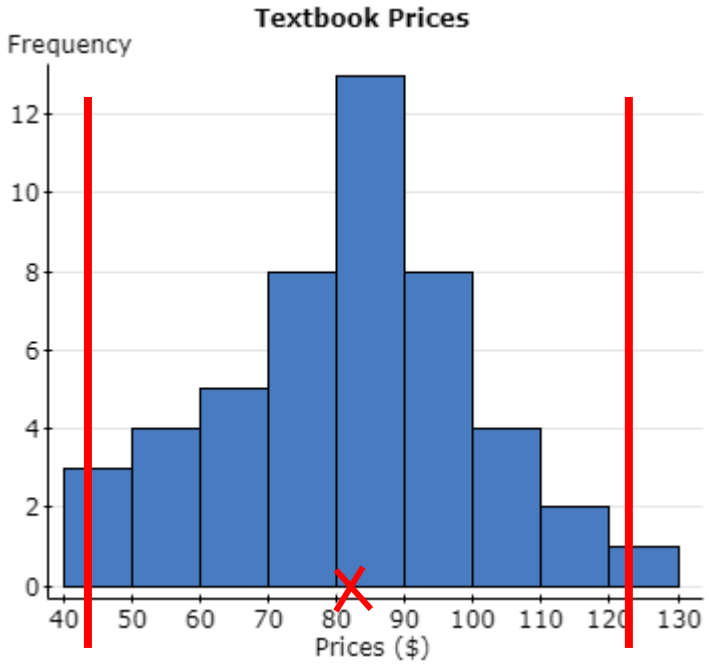


(Graphic Source: *Statistics: Unlocking the Power of Data, by Lock, Lock, Lock, Lock, and Lock*)

2. Consider this histogram of a sample of textbook prices.
   (Estimates will vary)
   a. Estimate the mean: ___$82____
      Mark its location on the horizontal axis.

   b. Estimate an interval centered at your mean that contains approximately 95% of the data. Draw vertical lines on your histogram at these values.

      ___$42__ to ___$122___



   c. Since this distribution is roughly bell-shaped and symmetric, about 95% of the textbook prices fall within _2__ standard deviations of the mean. (See page 1.)

      This tells us we can take the width of our interval in (b) and divide it by __4__ to estimate the standard deviation. Use this method to estimate the standard deviation for textbook prices.

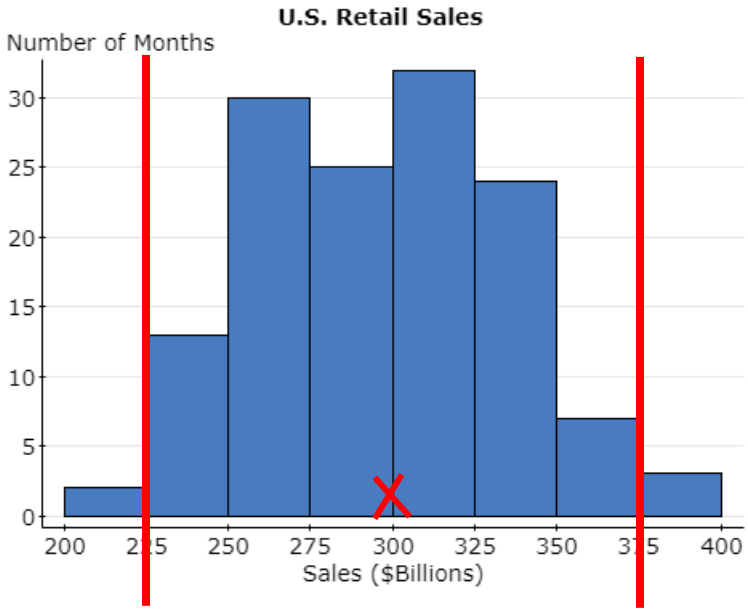
      122 – 42 = 80 and 80/4 = 20. Standard deviation ≈ 20

      (Answers may vary – some students may prefer to find the distance from one value to the mean and divide by 2 instead.)

3. This distributions shows retail sales in the U.S. for the 136 months beginning January 2009.
   a. Estimate the mean and standard deviation.
      mean ≈ $300 Billion

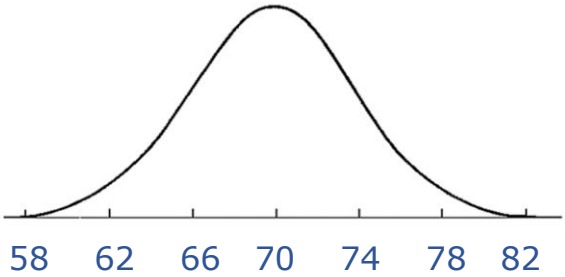
      $375b-$225b=$150 B
      one sdev = 150/4 = $37.5 B

   b. Have one person in your group open StatKey. Go to **One Quantitative Variable** and choose "Monthly Retail Sales" from the drop-down list of data sets. How do the actual mean and standard deviation compare with your estimate?
      $37.971 B

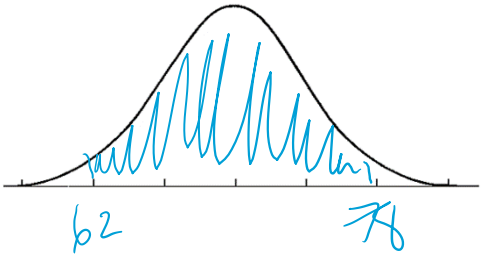


4. Suppose the heights of all men are approximately symmetric and bell-shaped with a mean of 70 inches and a standard deviation of 4 inches.

   a. Label the mean height, and the heights that are 1, 2, and 3 standard deviations above and below the mean.

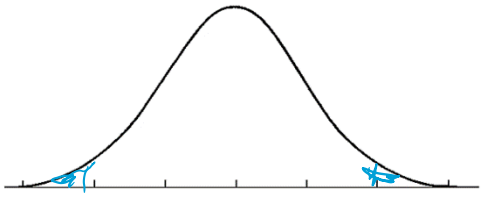


   b. About 95% of men have heights between _62_ and _78_ inches. Shade the area under the curve that represents these men.



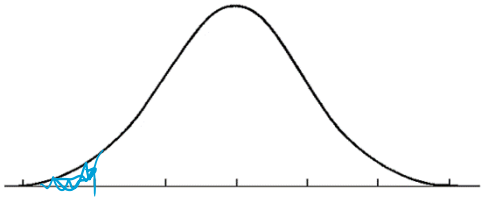
   c. About what percent of men have heights *outside* the height interval in (b)? Shade the area under the curve that represents these men.

   100 – 95 = 5%



   d. About what percent of men are shorter than 62 inches? Shade the area under the curve that represents these men.

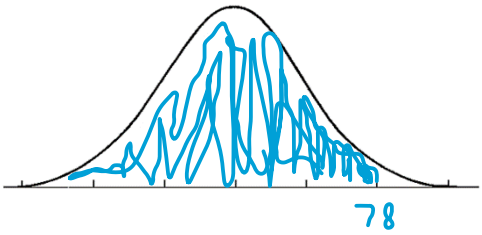
   5/2 = 2.5%



The **Pth percentile** is the value of the quantitative variable, like height, that is greater than P percent of the data.

   e. Based on your answer for (d), men with heights of 62 inches therefore have a height in the ___2.5th ____ percentile.

5. A man has a height in the 97.5th percentile. Shade an estimated area under the curve that represents this scenario. Then estimate the man's height.
   78 inches



6. In statistics, we will use the variable "z" to represent the number of standard deviations a data value is from the mean. We will call this value a **z-score.** Recall from the previous page that the heights of all men are approximately symmetric and bell-shaped with a mean of 70 inches and a standard deviation of 4 inches

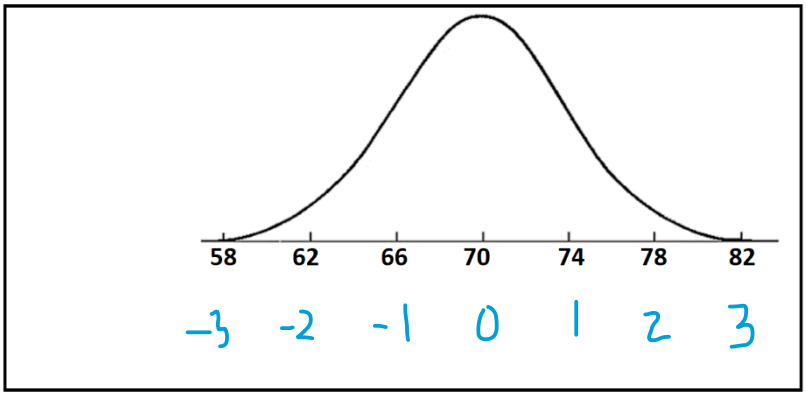
   a. The height 66 inches has a z-score of -1. Why?
   It is one standard deviation below the mean.

   b. Find the z-scores for the following heights.

   78 inches: **z =** __2__

   58 inches: **z =** __-3__

   70 inches: **z =** __0__



   c. Label the distribution above with the z-scores underneath their corresponding heights.

   d. Use the graph to estimate the z-score for a height of 68 inches: z ≈ ___-0.5_____

A **z-score** is the number of standard deviations a data value is from the mean. We calculate z as follows:

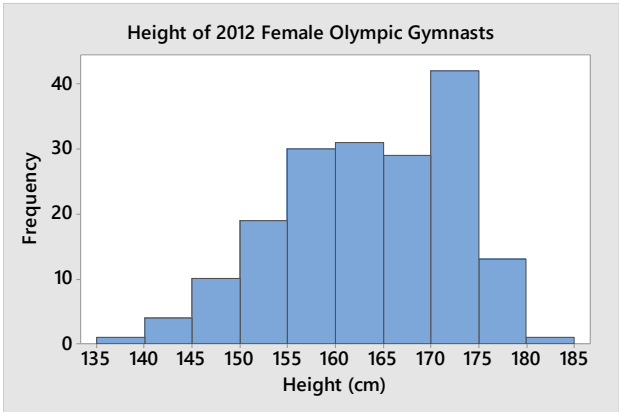
$$z = \frac{data\ value - mean}{standard\ deviation}$$

For **samples**, this looks like: $z = \frac{x - \bar{x}}{s}$ For **populations**, this looks like: $z = \frac{x - \mu}{\sigma}$

   e. Use the formula to verify the z-score you estimated in (5d).

$$z = \frac{68 - 70}{4} = \frac{-2}{4} = -0.5$$

7. Recall the histogram from the beginning of our activity. Suppose one of these women was 170 cm tall.



   a. Calculate the z-score for her height using the mean and standard deviation from Problem 1.

$$z = \frac{170 - 162.74}{9.30} = \frac{7.26}{9.30} \approx 0.78$$

   b. Estimate her percentile: _75th_

   c. A male gymnast events in these same Olympics has the same height percentile as this woman. Does this indicate that they are the same height? Explain why or why not.
   No. The distribution of heights for male gymnasts likely has a different mean and standard deviation. For example, the mean height for the male gymnasts might be 170cm (this woman's height). In that case a male gymnast in the 75th percentile would be taller than 170cm.

CME Unit Conversion Group Activity Answer key

The goal of the activity is to use dimensional analysis to convert units.

Introduction

- **Units** of a quantity describe what the quantity measures or counts.
  1. a) What units could you use if you were describing the distance from Austin to San Antonio? miles

     b) What units could you use if you are buying a house and you want to know how large it is? square feet

- We can describe units using words OR using an abbreviated form.
  Example: When you are driving a car, your speed is read as miles per hour (Words) and written as mi/hr (Abbreviated) (or mph).

  2. Based on the example, what math operation does the word "per" mean? divide
  3. Suppose you are buying some fabric. To calculate the unit price, you divide the price (in dollars) by the area (in square yards). The units are written as $\$/yd^2$.

     Write the units using words: dollars per square yard

     Note: "square" corresponds to a 2 exponent on the units. What exponent will you use for "cubic"? 3
  4. The flow rate of a river is 5000 cubic feet per second. Write the units in abbreviated form: $ft^3/sec.$

Unit Conversion

5. We know that 12 inches = 1 foot. This is an example of a **conversion factor** and can be written in three equivalent ways:

$$12 \text{ in} = 1 \text{ ft} \quad \text{or} \quad \frac{12\ in}{1\ ft} \quad \text{or} \quad \frac{1\ ft}{12\ in}$$

Notice that both fraction forms have a value in the numerator that is equal to the value in the denominator, so the fraction is equal to 1. These are called **unit fractions**.

- Write all three forms of the conversion factor we can use to convert between seconds and minutes.

$1\ min = 60\ sec.$ $\quad \frac{1\ min.}{60\ sec.}$ $\quad \frac{60\ sec.}{1\ min.}$

6. Let's convert 20 feet per minute to feet per second. **Choose the correct conversion factor from #5.** Include units.

Since the minutes are in the denominator in the amount given, where should they be in the conversion factor so that the minutes cancel?

Numerator

Numerator/Denominator

$$\frac{20\ \text{feet}}{1\ \cancel{\text{minute}}} \cdot \frac{1\ \cancel{min.}}{60\ sec.} = \frac{20}{60} = 0.\overline{3}\ ft./sec.$$

Check your work:

- ☑ Did you start with the given value as a fraction?
- ☑ Did your units cancel?
- ☑ Did you end up with the correct units?
- ☑ Did you include the correct units in your final answer?

Common Conversions:

1 foot (ft) = 12 inches (in)	2 cups (c) = 1 pint (pt)
1 yard (yd) = 3 feet (ft)	2 pints (pt) = 1 quart (qt)
1 mile (mi) = 5280 feet (ft)	32 fluid ounces (fl oz) = 1 quart(qt)
1 year (yr) = 365 days	4 quarts (qt) = 1 gallon (gal)
1 day = 24 hours (hr)	16 ounces (oz) = 1 pound (lb)
1 hour (hr) = 60 minutes (min)	2000 pounds (lb) = 1 ton

UCSC-Metric Conversions:

1 in = 2.540 cm
1 yd = 0.9144 m
1 mi = 1.6093 km
1 kg = 2.205 lb
1 qt = 0.9464 L
1 gal = 3.785 L

7. You plan to go to France, and you know the speedometer will be in kilometers per hour. You want to know what 60 miles per hour is in kilometers per hour.

   a. What speed are you asked to convert (the starting speed)? 60 mph

   b. What are the units you are asked to convert to? Km per hour

   c. Use the table to write down a conversion factor that might help convert from part a to part b. Write it in *three* forms.

   1 mile = 1.6093 km $\frac{1 \text{ mile}}{1.6093 \text{ km}}$ $\frac{1.6093 \text{ km}}{1 \text{ mile}}$

   d. Use the following steps to make the conversion. Round to one decimal place and include units.

   *Make sure students are filling in units in the conversion factors!

Write the amount given as a fraction:

$$\frac{60 \text{ miles}}{1 \text{ hour}} \cdot \frac{1.6093 \text{ km}}{1 \text{ mile}} = \frac{96.558}{1} = 96.6 \text{ km/hr.}$$

Multiply by the appropriate conversion factor so your units cancel.

Check your work:

- ☑ Did you start with the given value as a fraction?
- ☑ Did your units cancel?
- ☑ Did you end up with the correct units?
- ☑ Did you include the correct units in your final answer?

8. Toddlers can drink a lot of milk! In one year, a toddler drinks about 12 gallons of milk. How many liters is this? Round to one decimal place. **Note:** Here the given value isn't a fraction (no "per"). We make it a fraction by writing it over 1.

1 gal. = 3.785 L

$$\frac{12\ gal}{1} \cdot \frac{3.785\ L}{1\ gal.} \approx 45.42 \text{ or } \boxed{45.4\ L}$$

Check your work:

- ✓ Did you start with the given value as a fraction?
- ✓ Did your units cancel?
- ✓ Did you end up with the correct units?
- ✓ Did you include the correct units in your final answer?

---

9. **Practice.** Convert 16 liters to quarts. Round to one decimal place. 1 qt. = .9464 L

$$\frac{16\ L}{1} \cdot \frac{1\ qt.}{.9464\ L} \approx \frac{16}{.9464} \approx 16.90617 \text{ or } \boxed{16.9 \text{ quarts}}$$

---

10. In celebration of National Cookie Day, the residents at *Sesame Street* baked a gigantic cookie for one of the characters on the show, Cookie Monster. The cookie was 180 inches in circumference. How many yards is the circumference of the cookie?

a. What is the amount you are asked to convert? 180 inches

b. What are the units you are asked to convert to? yards

c. We are not given a conversion factor between inches and yards. Sometimes you will need to use more than one conversion factor in the problem. For example, we can convert inches to feet and then feet to yards.

Simplify the expression and find the answer:

$$\frac{180\ in}{1} \cdot \frac{1\ ft}{12\ in} \cdot \frac{1\ yd}{3\ ft} = \frac{180}{36} = \boxed{5\ yd}$$

What do you notice about the units? inches & feet cancel

Are the units you are being asked to covert to in the numerator or denominator? numerator

To Convert Units:

Given Amount (If not a fraction, write over a 1.)	×	Conversion Factor #1* Did units cancel?	×	Conversion Factor #2* Did units cancel?	=	Converted Amount Are you left with the desired units?

*** Use more conversion factors as needed and write them so that units cancel and you end up with the desired units.**

11. **Practice.** Convert 5 years to hours (neglecting leap years).

$$\frac{5\ years}{1} \cdot \frac{365\ days}{1\ year} \cdot \frac{24\ hours}{1\ day} = \boxed{43{,}800 \text{ hours}}$$

Currency Conversions: Refer to the Currency Exchange Rate Table* for Questions 12 - 15:

TABLE 2.1 Sample Currency Exchange Rates (January 2017)

Currency	Dollars per Foreign	Foreign per Dollar
British pound	1.221	0.8191
Canadian dollar	0.7586	1.318
European euro	1.058	0.9449
Japanese yen	0.008658	115.5
Mexican peso	0.04574	21.86

**Table 2.1 is from Bennett & Briggs "Using and Understanding Mathematics," 7th edition*

12. From the table, you get two different conversion factors between US dollars ($) and British pounds (GBP). In the "Dollars per Foreign" column, the number 1.624 gives the conversion factor:

$\$1.221 = 1\text{ GBP}$ OR $\frac{\$1.221}{1\text{ GBP}}$ Think: 1.221 dollars per 1 GBP.

What conversion factor comes from the number 0.8191 in the "Foreign per Dollar" column?

Think: 0.8191 $\boxed{\text{GBP}}$ (dollars or GBP) per 1 $\boxed{\text{dollar}}$ (dollars or GBP) **Conversion factor:** .8191 GBP = 1 dollar

13. Suppose you are travelling from the United States to Europe.
a) Use the table to write two different conversion factors between the European euro and US dollars.

$\boxed{\$1.058 = 1\text{ Euro}}$ or $\boxed{\$1 = .9449\text{ Euro}}$ (OR written as unit fractions)

b) How many euros is $200 worth?

$$\frac{\$200}{1} \cdot \frac{1\text{ Euro}}{\$1.058} =$$

14. Cantaloupes sell for 1.80 euros per kilogram in Belgium. What is the price in units of U.S. dollars per pound? Use the exchange rates in the table above and the conversion factor: 1 kg = 2.205 lb.

$$\frac{1.80\text{ euros}}{1\text{ kg}} \cdot \frac{1\text{ kg}}{2.205\text{ lb}} \cdot \frac{\$1.058}{1\text{ euro}} = \boxed{\$.86\text{ per pound OR 86 cents per pound}}$$

15. A 0.8-liter bottle of Mexican wine costs 100 pesos. At that price, how much would a half-gallon jug of the same wine cost in dollars? **Hint:** First find the price of wine in units of U.S. dollars per gallon. ← "$\frac{\text{money}}{\text{volume}}$"

$$\frac{100\text{ pesos}}{0.8\text{ L}} \cdot \frac{3.785\text{ L}}{1\text{ gal.}} \cdot \frac{\$0.04574}{1\text{ peso}} = \$21.64/\text{gal}$$

$\frac{1}{2}(\$21.64) = \boxed{\$10.82\text{ for a } \frac{1}{2}\text{ gal.}}$

CME Unit Conversion Group Activity

The goal of the activity is to use dimensional analysis to convert units.

Introduction

- **Units** of a quantity describe what the quantity measures or counts.
  1. a) What units could you use if you were describing the distance from Austin to San Antonio? _____

     b) What units could you use if you are buying a house and you want to know how large it is? _____

- We can describe units using words OR using an abbreviated form.
  Example: When you are driving a car, your speed is read as <u>miles per hour</u> (Words) and written as <u>mi/hr</u> (Abbreviated) (or mph).

  2. Based on the example, what math operation does the word "per" mean? _____

  3. Suppose you are buying some fabric. To calculate the unit price, you divide the price (in dollars) by the area (in square yards). The units are written as $\$/yd^2$.

     Write the units using words: _____

     Note: "square" corresponds to a 2 exponent on the units. What exponent will you use for "cubic"? _____

  4. The flow rate of a river is 5000 cubic feet per second. Write the units in abbreviated form: _____

Unit Conversion

5. We know that 12 inches = 1 foot. This is an example of a **conversion factor** and can be written in three equivalent ways:

   12 in = 1 ft or $\frac{12\ in}{1\ ft}$ or $\frac{1\ ft}{12\ in}$

   Notice that both fraction forms have a value in the numerator that is equal to the value in the denominator, so the fraction is equal to 1. These are called **unit fractions**.

   - Write all three forms of the conversion factor we can use to convert between seconds and minutes.

6. Let's convert 20 feet per minute to feet per second. **Choose the correct conversion factor from #5**. Include units.

   Since the minutes are in the denominator in the amount given, where should they be in the conversion factor so that the minutes cancel?

   _____
   Numerator/Denominator

$$\frac{20\text{ feet}}{1\text{ minute}} \cdot \underline{\qquad\qquad\qquad} =$$

Check your work:
- ☐ Did you start with the given value as a fraction?
- ☐ Did your units cancel?
- ☐ Did you end up with the correct units?
- ☐ Did you include the correct units in your final answer?

Common Conversions:

1 foot (ft) = 12 inches (in)	2 cups (c) = 1 pint (pt)
1 yard (yd) = 3 feet (ft)	2 pints (pt) = 1 quart (qt)
1 mile (mi) = 5280 feet (ft)	32 fluid ounces (fl oz) = 1 quart(qt)
1 year (yr) = 365 days	4 quarts (qt) = 1 gallon (gal)
1 day = 24 hours (hr)	16 ounces (oz) = 1 pound (lb)
1 hour (hr) = 60 minutes (min)	2000 pounds (lb) = 1 ton

UCSC-Metric Conversions:

1 in = 2.540 cm
1 yd = 0.9144 m
1 mi = 1.6093 km
1 kg = 2.205 lb
1 qt = 0.9464 L
1 gal = 3.785 L

7. You plan to go to France, and you know the speedometer will be in kilometers per hour. You want to know what 60 miles per hour is in kilometers per hour.

   a. What speed are you asked to convert (the starting speed)? _____

   b. What are the units you are asked to convert to? _____

   c. Use the table to write down a conversion factor that might help convert from part a to part b. Write it in *three* forms.

   d. Use the following steps to make the conversion. Round to one decimal place and include units.

Write the amount given as a fraction:

_____ • _____ =

Multiply by the appropriate conversion factor so your units cancel.

Check your work:

- ☐ Did you start with the given value as a fraction?
- ☐ Did your units cancel?
- ☐ Did you end up with the correct units?
- ☐ Did you include the correct units in your final answer?

8. Toddlers can drink a lot of milk! In one year, a toddler drinks about 12 gallons of milk. How many liters is this? Round to one decimal place. **Note:** Here the given value isn't a fraction (no "per"). We make it a fraction by writing it over 1.

$$\frac{12\ gal}{1} \cdot \underline{\qquad\qquad} \approx$$

Check your work:

- ☐ Did you start with the given value as a fraction?
- ☐ Did your units cancel?
- ☐ Did you end up with the correct units?
- ☐ Did you include the correct units in your final answer?

---

9. **Practice.** Convert 16 liters to quarts. Round to one decimal place.

$$\underline{\qquad\qquad} \cdot \underline{\qquad\qquad} \approx$$

---

10. In celebration of National Cookie Day, the residents at *Sesame Street* baked a gigantic cookie for one of the characters on the show, Cookie Monster. The cookie was 180 inches in circumference. How many yards is the circumference of the cookie?

    a. What is the amount you are asked to convert? _____

    b. What are the units you are asked to convert to? _____

    c. We are not given a conversion factor between inches and yards. Sometimes you will need to use more than one conversion factor in the problem. For example, we can convert inches to feet and then feet to yards.

    Simplify the expression and find the answer:

$$\frac{180\ in}{1} \cdot \frac{1\ ft}{12\ in} \cdot \frac{1\ yd}{3\ ft} =$$

    What do you notice about the units? _____

    Are the units you are being asked to covert to in the numerator or denominator? _____

To Convert Units:

Given Amount (If not a fraction, write over a 1.)	×	**Conversion Factor #1*** Did units cancel?	×	**Conversion Factor #2*** Did units cancel?	=	**Converted Amount** Are you left with the desired units?

*** Use more conversion factors as needed and write them so that units cancel and you end up with the desired units.**

11. **Practice.** Convert 5 years to hours (neglecting leap years).

Currency Conversions: Refer to the Currency Exchange Rate Table for Questions 12 - 15:

TABLE 2.4 Sample Currency Exchange Rates (February 2013)

Currency	Dollars per Foreign	Foreign per Dollar
British pound	1.624	0.6158
Canadian dollar	1.005	0.9950
European euro	1.320	0.7576
Japanese yen	0.0120	83.33
Mexican peso	0.07855	12.73

12. From the table, you get two different conversion factors between US dollars ($) and British pounds (GBP). In the "Dollars per Foreign" column, the number 1.624 gives the conversion factor:

    $\frac{\$1.624}{1\ GBP}$ Think: 1.624 dollars per 1 GBP.

    What conversion factor comes from the number 0.6158 in the "Foreign per Dollar" column?

    Think: 0.6158 _____ per 1 _____ . Conversion factor: _____
    dollars or GBP dollars or GBP

13. Suppose you are travelling from the United States to Europe.
    a) Use the table to write two different conversion factors between the European euro and US dollars.

    b) How many euros is $200 worth?

14. Cantaloupes sell for 1.80 euros per kilogram in Belgium. What is the price in units of U.S. dollars per pound? Use the exchange rates in the table above and the conversion factor: 1 kg = 2.205 lb.

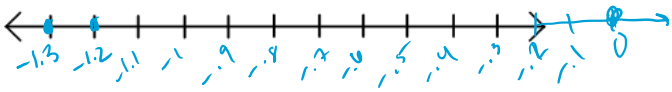
15. A 0.8-liter bottle of Mexican wine costs 100 pesos. At that price, how much would a half-gallon jug of the same wine cost in dollars? **Hint:** First find the price of wine in units of U.S. dollars per gallon.

Chapter 4 Intro: Graphing and Comparing Decimals Activity

The goal for this activity is to deepen your understanding of decimals.

Graphing and Comparing Decimals

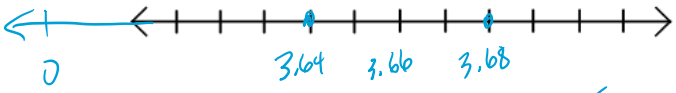
1. Graph –1.2 and –1.3 on the same number line. Mark 0 on the number line too.



   a) Place the < or > between the decimals. -1.2 ___>___ -1.3

   b) Write a decimal that is between -1.2 and -1.3 ___-1.25___

2. Graph 3.64 and 3.68 on the same number line. Mark 0 on the number line too.



   a) Place < or > between the decimals. 3.64 ___<___ 3.68

   b) Write a decimal that is between 3.64 and 3.68 ___3.65___

3. Place the < or > between 0.8930 and 0.8903. 0.8930 ___>___ 0.8903

4. Write a decimal that is between 0.32 and 0.321. ___0.3208___ 0.3200 0.3210

5. Which of the following numbers are less than 0.05? Circle all that apply.

   a) 0.130 b) 0.013 c) 0.0019 d) 0.0540 e) 0.008

6. Which number(s) in #5 are less than 0.01? ___0.0019, 0.008___

7. Which number(s) in #5 are less than 0.10? ___0.013, 0.0019, 0.0540, 0.008___

8. Write the decimals in order from least to greatest: 0.012, 0.001, 0.365, 0.085

   ___0.001___, ___0.012___, ___0.085___, ___0.365___

9. Which number is farther away from 0? -3.2 or -3.6? ___-3.6___ is farther from 0.

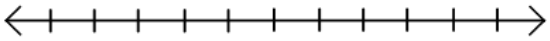
10. Which number is farther away from 0? 2.20 or -2.15? ___2.20___ is farther from 0.

Chapter 4 Intro: Graphing and Comparing Decimals Activity

The goal for this activity is to deepen your understanding of decimals.

Graphing and Comparing Decimals

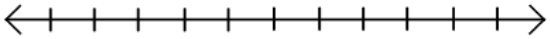
1. Graph –1.2 and –1.3 on the same number line. Mark 0 on the number line too.



   a) Place the < or > between the decimals. -1.2 _____ -1.3

   b) Write a decimal that is between -1.2 and -1.3 _____

2. Graph 3.64 and 3.68 on the same number line. Mark 0 on the number line too.



   a) Place < or > between the decimals. 3.64 _____ 3.68

   b) Write a decimal that is between 3.64 and 3.68 _____

3. Place the < or > between 0.8930 and 0.8903. 0.8930 _____ 0.8903

4. Write a decimal that is between 0.32 and 0.321. _____

5. Which of the following numbers are less than 0.05? Circle all that apply.

   a) 0.130 b) 0.013 c) 0.0019 d) 0.0540 e) 0.008

6. Which number(s) in #5 are less than 0.01? _____

7. Which number(s) in #5 are less than 0.10? _____

8. Write the decimals in order from least to greatest: 0.012, 0.001, 0.365, 0.085

   _____ , _____ , _____ , _____

9. Which number is farther away from 0? -3.2 or -3.6? _____ is farther from 0.

10. Which number is farther away from 0? 2.20 or -2.15? _____ is farther from 0.

4.1 (Part 3): How strong is the evidence?

Learning Outcomes:

- ☐ LO 4.1.4 Compare the strength of evidence that different samples have about the same hypotheses.

We look at the sample data to see whether we have evidence to support the alternative hypothesis claim. Some samples do not support the claim. Some only weakly support it. Some support it more strongly. In this activity, you will be comparing the strength of evidence from multiple samples.

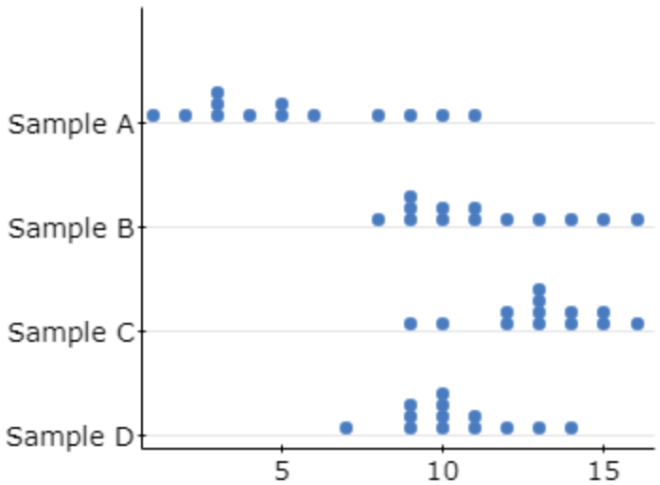
1. Suppose political science researchers are testing to see if Americans aged 18-35 are less likely to be registered to vote than those over 35. Review the following samples.

	Ages 18-35	**Ages 36 and up**
Sample A	12 registered out of 50	15 registered out of 50
Sample B	24 registered out of 50	35 registered out of 50
Sample C	29 registered out of 50	27 registered out of 50

   a. Which (if any) sample provides the <u>strongest evidence</u> for the claim? Explain your reasoning.
   B provides the strongest evidence.
   B is stronger than A since 24/50 compared with 35/50 is a bigger difference than 12/50 compared with 15/50.

   b. Which (if any) sample provides <u>no evidence</u> for the claim? Explain your reasoning.
   C provides no evidence since fewer 36+ people were registered.

2. A research team is testing to see if there is evidence that the population mean for number of hours exercised per week is greater than 10.



   a. Which (if any) sample provides the <u>strongest evidence</u> for the claim? Explain your reasoning.
   C is the strongest. It is centered around 13 while B and D are centered around 11 & 10, respectively.

   b. Which (if any) sample provides <u>no evidence</u> for the claim? Explain your reasoning.
   Sample A provides no evidence. Most of the values are lower than 10 and the center looks to be near 4. (Depending on where you estimate the center for Sample D, it might be centered too close to 10 to provide evidence for "greater than 10".)

3. Testing to see if there is evidence to refute the null hypothesis and support the alternative.

$$H_0: p = 0.25$$

$$H_a: p > 0.25$$

One sample statistic has been provided. Create a sample statistic for Sample B that shows stronger evidence for the alternative hypothesis and a sample statistic for Sample C that shows no evidence for the alternative hypothesis.

Sample A: $\hat{p} = \frac{9}{30}$

(stronger evidence) Sample B: $\hat{p} = \frac{20}{30}$

(no evidence) Sample C: $\hat{p} = \frac{3}{30}$

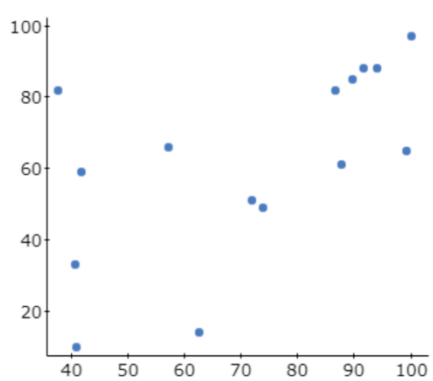
4. Educational researchers are testing to see if there is evidence of a positive correlation between exam grades and hours spent on homework. One sample has been provided.
   a. Write hypotheses for the test.

$$\boldsymbol{H_0: \rho = 0}$$

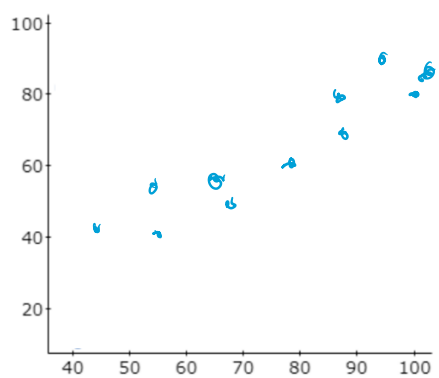
$$\boldsymbol{H_a: \rho > 0}$$

   b. Create a sample (B) that shows stronger evidence for the alternative hypothesis and a sample (C) that shows no evidence for the alternative hypothesis.

(negative or no correlation)

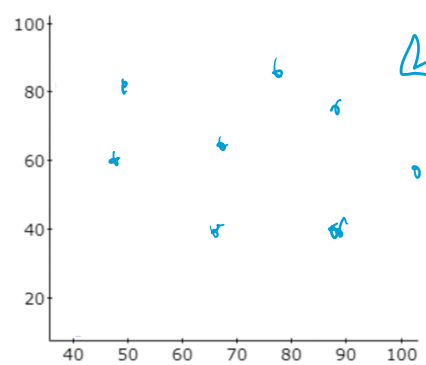


Sample A



Sample B

(stronger evidence)



Sample C

(no evidence)

4.1 (Part 3): How strong is the evidence?

Learning Outcomes:

- ☐ LO 4.1.4 Compare the strength of evidence that different samples have about the same hypotheses.

We look at the sample data to see whether we have evidence to support the alternative hypothesis claim. Some samples do not support the claim. Some only weakly support it. Some support it more strongly. In this activity, you will be comparing the strength of evidence from multiple samples.

1. Suppose political science researchers are testing to see if Americans aged 18-35 are less likely to be registered to vote than those over 35. Review the following samples.

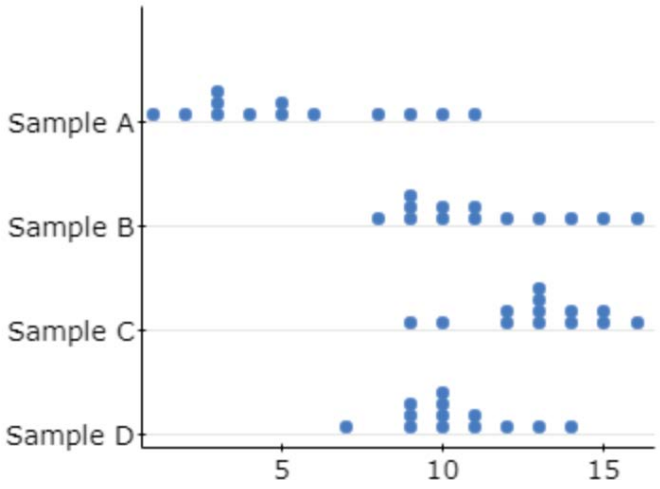
	Ages 18-35	**Ages 36 and up**
Sample A	12 registered out of 50	15 registered out of 50
Sample B	24 registered out of 50	35 registered out of 50
Sample C	29 registered out of 50	27 registered out of 50

   a. Which (if any) sample provides the <u>strongest evidence</u> for the claim? Explain your reasoning.

   b. Which (if any) sample provides <u>no evidence</u> for the claim? Explain your reasoning.

2. A research team is testing to see if there is evidence that the population mean for number of hours exercised per week is greater than 10.

   a. Which (if any) sample provides the <u>strongest evidence</u> for the claim? Explain your reasoning.



   b. Which (if any) sample provides <u>no evidence</u> for the claim? Explain your reasoning.

3. Testing to see if there is evidence to refute the null hypothesis and support the alternative.

$$H_0: p = 0.25$$

$$H_a: p > 0.25$$

One sample statistic has been provided. Create a sample statistic for Sample B that shows stronger evidence for the alternative hypothesis and a sample statistic for Sample C that shows no evidence for the alternative hypothesis.

Sample A: $\hat{p} = \frac{9}{30}$

(stronger evidence) Sample B:

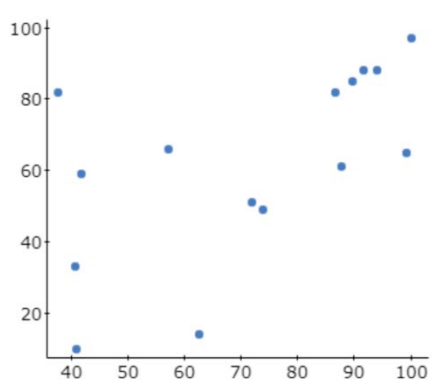
(no evidence) Sample C:

4. Educational researchers are testing to see if there is evidence of a positive correlation between exam grades and hours spent on homework. One sample has been provided.
   a. Write hypotheses for the test.

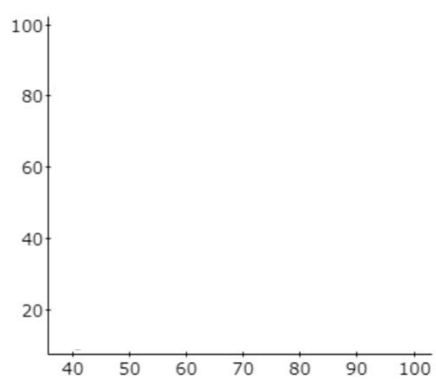
      $\boldsymbol{H_0}$:

      $\boldsymbol{H_a}$:

   b. Create a sample (B) that shows stronger evidence for the alternative hypothesis and a sample (C) that shows no evidence for the alternative hypothesis.

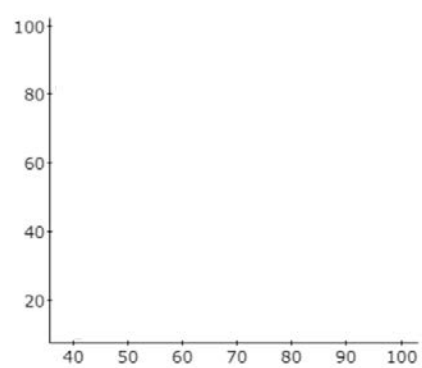


Sample A



Sample B

(stronger evidence)



Sample C

(no evidence)

Team Teaching Checklist

Corequisite Courses

Course Structure	Teaching Responsibilities
☐ Exams – Will you give them in class, Testing Center, or both? Exchange a copy of your typical exams and discuss exam style. ☐ Late work policy ☐ Participation – How will you grade this? (Binder checks, note collection, or daily visual checks?) ☐ How many points for each quiz, HW, exam? (Can decide later, but need to be consistent with each other.) ☐ How will you handle poor attendance/participation (i.e. enforcing the attendance requirement)? ☐ Other policies (use Master Syllabus as a guide) ☐ How will you communicate to debrief each class and plan for upcoming classes? (Meet before and/or after class? Email?) ☐ Discuss your teaching style – how do you teach and why is that important to you? How will you blend your styles and also incorporate collaborative activities?	☐ "Lead teacher" vs. "Support teacher" – Will you switch off, or keep one role for the duration of the semester? (This depends largely on the experience/comfort level of the developmental math instructor.) ☐ Describe the roles of the lead faculty and the roles of the support faculty during a particular activity. How will you handle the need, as perceived by the support faculty gleaned while listening to students, to address specific questions or misconceptions? ☐ How will you handle common disruptive behaviors? (coming late, leaving early, cell phones, talking over you, off-topic during activities, etc.) ☐ Who will put together the syllabus? ☐ Who will handle pre-requisite checks? ☐ Who will manage Blackboard (posting documents, activity keys, etc.)? ☐ Who will manage the online HW (if applicable)? ☐ How will you share grading? ☐ Who will make copies of activities?

Lead Instructor + Lead Instructor Model

Split the topics based on interest/comfort level. One idea is to switch off by chapter, so you will be lead for about half of each unit. The same instructor does not always have to do the first vs. second half of a unit.

When it is your turn to lead:

During Class	Outside of Class
• You will be the one to introduce each activity/topic and in charge of the wrap-up, summarizing the information for students. • Walk around while students are working in groups to answer questions. • Check in periodically with your teaching partner to see if either of you have noticed any common issues. It's usually best for the lead to address these with the group, but you can defer to your teaching partner if you think they have more insight on the issue.	It's important that problems be graded consistently. The easiest way to ensure that is for one instructor to be in charge of all grading (particularly Quiz & Exam problems) for a particular section/set of sections. If you do not choose to do that, it is a good idea to collaborate on rubrics for each quiz/exam question to maintain that consistency. For sections on which you are acting as the lead instructor, we recommend: • Make the copies of the activities • Post the class work activities & answer keys on Blackboard after class • Grade the quiz problems and grade/check HW (unless you've agreed your teaching partner will do this) • Grade the relevant problems on the exam for that same content but work together on the rubric for each exam problem first to ensure the same types of mistakes are deducted in the same way for the entire test. (Example: Units missing ok or -1?)

When it is your turn to support:

During Class	Outside of Class
• Walk around while students are working in groups to answer questions. Do not do other work (such as grading) during student work time. Your primary job is to help students during class. • Check in periodically with your teaching partner to see if either of you have noticed any common issues. It's usually best for the lead to address these with the group, but they can defer to you if you have more insight on the issue.	It's important that problems be graded consistently. The easiest way to ensure that is for one instructor to be in charge of all grading (particularly Quiz & Exam problems) for a particular section/set of sections. If you do not choose to do that, it is a good idea to collaborate on rubrics for each quiz/exam question to maintain that consistency. For sections on which you are acting as the support instructor, we recommend: • Work the activities ahead of time so you are prepared to help students during class. • Work the HW and quizzes to make sure you are prepared to help students outside of class. • Grade the quiz problems and grade/check HW (unless you've agreed your teaching partner will do this)

Lead Instructor + Support Instructor Model

We recommend this model if one instructor does not have experience teaching college-level math topics and/or is not comfortable sharing lead teaching duties on college-level topics.

Lead Instructor:

During Class	Outside of Class
• You will be the one to introduce each activity/topic and in charge of the wrap-up, summarizing the information for students. • Walk around while students are working in groups to answer questions. • Check in periodically with your teaching partner to see if either of you have noticed any common issues. It's usually best for the lead to address these with the group, but you can defer to your teaching partner if you think they have more insight on the issue. • As mutually agreed upon with your teaching partner, have them take the lead occasionally on topics with which they have teaching experience, particularly the developmental-level material or material that is similar to that in the non-STEM developmental course if they have taught that course.	It's important that problems be graded consistently. The best way to ensure this is to come up with grading rubrics with your teaching partner for quiz and exam problems (and any other written work that will be graded for correctness). We recommend lead instructors have the following responsibilities: • Plan coverage of each topic. Select activities and any needed supplemental material. Work through all activities, quizzes and homework before students are scheduled to begin work on them. • Send activities & other class materials to your support instructor ahead of time so they can work it through before class to be ready for students' questions • Grading quizzes • Share in exam grading

Support Instructor:

During Class	Outside of Class
• Walk around while students are working in groups to answer questions. Do not do other work (such as grading) during student work time. Your primary job is to help students during class. • Check in periodically with your teaching partner to see if either of you have noticed any common issues. It's usually best for the lead to address these with the group, but they can defer to you if you have more insight on the issue. • As mutually agreed upon with your teaching partner, take the lead occasionally on topics with which you have teaching experience.	It's important that problems be graded consistently. The best way to ensure this is to come up with grading rubrics with your teaching partner for quiz and exam problems (and any other written work that will be graded for correctness). We recommend support instructors have the following responsibilities: • Work activities before class so you are ready to answer student questions • Work all HW and quizzes before students are scheduled to begin work on them so you know how these topics will be assessed and can help students when they have questions • Making copies of all activities for students • Keeping Blackboard updated with activity files and answer keys • Grading HW • Share in exam grading