

**1. Author names, date last updated**

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**2. Target Audience**

9-12 grade; Developmental mathematics

**3. Instructional Objectives**

Use the following codes to identify the standards.

**NCTM Standards**

Strand	Code
Algebra	A
Geometry	G
Measurement	M
Data Analysis and Probability	D
Problem Solving	P
Reasoning and Proof	RP
Communication	CM
Connections	CN
Representations	R

**TEKS**

(Grade level).(Knowledge and skills number)(TEK)

Example: 6.11 C

**Texas CCRS**

(Key Content).(Organizing Component).(Performance Expectation)

Example: III.A.2

**Mathematics Learning Objectives**

At the end of this lesson, students will be able to	NCTM Standards	TEKS	Texas CCRS
Determine if data are categorical or quantitative	D,R	_____	VI.B.1, VI.B.2
Graph categorical and quantitative data	D	_____	VI.B.3
Calculate mean, median, and mode	D	_____	VI.B.3
Determine the impact to mean and median on skewed data	D	_____	VI.B.1
Critically evaluate a few perspectives of college and career readiness of their peers and themselves	CN	_____	VI.C.1,VI.C.2

**4. Rationale – Why is the lesson important and appropriate to the learners?**

This lesson plan is designed to strengthen quantitative reasoning, statistical numeracy, and statistical reasoning skills. These are life skills that all individuals need to be able to read, analyze, or present data and graphs. For high school students preparing for their endeavors into postsecondary education or vocational careers, these skills are critical to their success after high school. Many employers complain that their employees cannot read and analyze data. This is true of high school and college graduates. Most employers need their

employees to have strong quantitative reasoning, statistical numeracy, and statistical reasoning skills in order to help their businesses be more productive and profitable. Many college degrees require at least one statistics course in their degree plan. Plus, many college departments find students need stronger graphing and data analyzing skills sets.

**5. Materials** – Materials needed by the teacher and the student.

- a. Teacher: Lesson plan, hand outs, calculators
- b. Each student: Worksheets, calculator, blank sheets of paper to draw graphs, ruler
- c. For each group: set of colored pencils/markers.

**6. Lesson Type** – Direct teach, Guided reading, Guided Inquiry, etc.

Guided Inquiry using experiential learning model introduced by David Kolb in 1984.

**7. Organizational Decisions** – Whole group, small group, cooperative groups, independent, etc.

Whole group, cooperative learning, individual work.

**8. Motivation/Focus/Anticipatory Set** – students are motivated and interested

Students are motivated and interested because the data collected has relevance to them and their future. Most students will find that no matter what career they choose to pursue, some postsecondary education will be required. Vocational jobs usually require some type of certification or licensing. Students usually realize that to be promoted and earn a higher wage, education will be required.

**9. Procedures** – What will teacher/students be doing? Explanations/modeling, logical sequencing, appropriate questioning. Script as much as possible (indicate direct questions to students in red, indicate projected student answers in blue, all other notes should be in black).

- a. Two or three classes preceding the day this lesson plan will be taught.  
On (the date that the lesson plan will be taught) ,we are going to review data, graph it, and analyze it. Hand out the Student Survey found below in this lesson plan. Before we can start this work, there is a homework assignment due the (date the lesson plan will be taught). Each student is required to give this Student Survey to at least 10 students here at our high school. Also. all students are required to read the handout, Some Statistical Definitions. by (the date that the lesson plan will be taught).
- b. Class that immediately precedes this lesson plan: Need to administer the Pre-Test that is found below in this document.
- c. Lesson Plan:  
Introduction  
People or professional organizations collect data for various reasons.  
Health – how widespread are cases of flu in Texas or in the United States  
Education – performance of schools on TAKS; dropout rates

Politics - conduct surveys to determine presidential approval ratings

Marketing - TV viewership ratings

Government - 2010 Census to realign the seats in the House of Representatives by the population of each state.

What are other examples of data that is collected and how it is used? Answers will vary.

Several days ago you were assigned to conduct a student survey. How did it go?

Answers will vary. Any surprises on the responses that you received? Do you think the responses were honest? Did the students take the survey seriously? Let students share their stories to all of the class.

Let's discuss the difference between categorical and quantitative data. What did learn from the reading assignment? Categorical is data that can be sorted by categories. Quantitative data is numeric data, where operations perform on the data makes sense. In other words, the average of the zip codes found in South Texas has no meaning or value. But, average of the height of the members of a soccer team does have meaning. What are some other examples? Answers will vary. Why do we distinguish between these two data types? Because when you reflect, analyze, and present the data, different techniques are required. Is the word data singular or plural? Plural.

What is the difference between population and sample from a data perspective?

Population is the total set of subjects of interest in a study. An example would be all the students in our high school. Sample is a subset of the population on which the study collects data. For the population example used above, a sample would be those students in our high school who took your individual survey or our class' collective survey results.

Let's talk about bias. What does bias mean when collecting data? When collecting data, the sample is considered bias if the sampling procedure tends to systematically over-represent or under-represent some portion of the population. Was there bias when you were collecting data? What kind of biases are there? There are three.

- Convenience sample - where subjects are chosen because they are easy to reach/collect data from
- Voluntary Response - where subjects volunteer to be in the sample which may lead to poor representation of some part of the intended population
- Non-Response - where some sampled subjects refuse to participate or fail to participate fully

Should we be concerned about bias with our class survey? How was your survey bias or not bias? Was there bias in the manner in which you conducted your survey? Yes. Class members may have obtained inputs from their friends. Students may not want to take it. Disproportion number of students from one grade is possible. Answers will vary.

Some of the data collected are indicators of student success or preparedness for life after high school. In particular, a student's success at a postsecondary school? Do you know what I mean when I say a postsecondary school? These are the schools many of you will attend such as a 2-year community college, a 4-year university, or a vocational school. Do you have any ideas which data were indicators of student success or preparedness for

postsecondary schools? Taking 4 years of math, taking AP classes, taking dual enrollment classes, taking college entrance exams (e.g. SAT and ACT tests), and study habits such as the number of hours doing homework and studying.

**Pass out the Handout: College Readiness Indicators.** If you look at this handout, whether or not you take AP classes or take dual enrollment courses affects your grade point average in college and whether or not you graduate from a 4-year university. Does taking AP classes in high school increase your chances of obtaining a bachelor's degree in 4 years? Yes. Let students discuss the differences between different AP exam scores. What percent of college graduates, who get a bachelor's degree in 4 years, took dual enrollment courses in high school? 24%. Look at the college GPAs for students who took AP classes and/or dual enrollment courses. What do you notice? Students who take AP courses or dual enrollment courses have higher GPAs than students who do not take either of these courses.

What do SAT and ACT exam scores tell us? Let students discuss the SAT and ACT information. Did you know that both the Texas Education Agency (TEA) and Texas Higher Education Coordinating Board (THECB) recommend that all high school students take 4 years of mathematics. Why do you think they made this recommendation?

Answers will vary.

*Activity: Group work - cooperative learning.*

Pass out the handout, Interpreting, Analyzing, and Graphing Data. Distribute some colored pencils/markers and several blank sheets of paper for each team. I want you to get into groups of 4 and discuss your findings. Use this worksheet to guide you through today's activities. Your grade today will be a team grade. Each member of the team will have assigned duties and their work will be included in the determination of the team grade. So, each member's work affects the grade of each team member. Thus, you need to review each other's work and verify that it was done correctly. We will have a class discussion during the last 10-15 minutes of class.

Walk around and help students divide into groups. Answer questions as they arise as the groups perform this activity.

NOTE: When the groups get to survey question 10, you may need to adjust the interval length of the histogram from 5 to a numeric value that better fits the data collected by the class. Make sure all groups use the same interval.

As groups finish their worksheet activity, have the groups display their productions on by taping their graphs to a section of the blackboard and analyze of groups' work. When you complete the worksheet, I need for each group to tape their graphs to one section of the black(or white) board. Then I want each of you to walk around and review the other groups' graphs. Ask yourself if the graphs communicated the information as specified in the directions. But, be respectful of other student's work. The idea is to learn to read critically, communicate, and analyze data and graphs. Today we are all working on strengthening these skills. You can never be too good when it comes to these skills.

*When there is 15-20 minutes left in class.*

Bring the class back together for a whole group discussion. Discuss and summarize various group findings. What interesting findings did you discover? Answers will vary.

Which graphs seem to accurately display the findings of Survey Question 1? Which graphs may be misleading or possibly problematic? Answers will vary.

Which graphs seem to accurately display the findings of Survey Question 2? Which graphs may be misleading or possibly problematic? Answers will vary.

Which graphs seem to accurately display the findings of Survey Question 3? Which graphs may be misleading or possibly problematic? Answers will vary.

Which graphs seem to accurately display the findings of Survey Question 4? Which graphs may be misleading or possibly problematic? Answers will vary.

Which graphs seem to accurately display the findings of Survey Question 5? Which graphs may be misleading or possibly problematic? Answers will vary.

Which graphs seem to accurately display the findings of Survey Question 6? Which graphs may be misleading or possibly problematic? Answers will vary.

Which graphs seem to accurately display the findings of Survey Question 7? Which graphs may be misleading or possibly problematic? Answers will vary.

Which graphs seem to accurately display the findings of Survey Question 8? Which graphs may be misleading or possibly problematic? Answers will vary.

Which graphs seem to accurately display the findings of Survey Question 9? Which graphs may be misleading or possibly problematic? Answers will vary.

For survey question 10, we are going to combine all the groups' data.

- a. Calculate the mean, median, and mode of the combined group data. Does any group have a mean for Question 10 that is close to the mean that we just calculated? Or very different to this mean? Answers will vary.
- b. Build a histogram of the combined group data. Use the same interval length that was recommended to all the groups.
- c. How would you describe the shape of this graph? Answers will vary. Does this look like any group's graph? Answers will vary.
- d. From analyzing the answers to step a-c, what seems to be a better measure of the center of the data? The mean or the median? Answer is dependent on the data.
- e. Suppose we add one student to our Question 10 survey results, where the student stated that he/she spends 60 hours on homework and studying every week.
  - i. What is the effect to the mean and median of the data? Mean would increase. Median may or may not increase. Depends on the data. Mean is definitely impacted more than median. Why is mean impacted more than median? Mean always affected by any additional data. But since median is the center of a list of

sorted data it would become more sensitive only to the next number to the right of the old mean.

- ii. Change the histogram to reflect the additional student. How would we now describe the graph? Extreme far right side will have a short rectangle. This short rectangle on the far right cause the data to be skewed to the right. This skewness to the right explains the impact to the mean and median.
  - iii. From analyzing the answers to step i-ii above, what seems to be a better measure of the center of the data? The mean or the median? Did your previous answer change? Median would be a better measure of the center of the data.
  - iv. Data that are to the extreme left or right are called outliers. Outliers always impact the mean more than the median. So when we analyze data, we should always be aware of the minimum and maximum of any quantitative data that we collect.
- f. In regards to college readiness, most colleges will tell their students to expect three hours of homework for every hour of college courses that they are enrolled. So, if you are taking 12 hours of college courses, then you should expect 36 courses of homework and studying.

Pick up student productions from each team member. I just want to remind you that I will be giving all members of each team the overall team grade.

- 10. Closure** – Sums up the lesson and may occur at anytime during the lesson. Avoid “Administrative closure” ...put away books, line up, etc.

So, is it interesting how many students are taking AP classes, taking the SAT and ACT tests, or enrolling in dual enrollment? Are they getting ready for life after high school? Answers will vary. Have you changed your mind regarding these opportunities? Answers will vary. Can you make changes now to get ready for college?

Post Test. Can be administered at the end of this class. Or given during the beginning of the next class.

- 11. Assessment** -- How you will determine if the students met the objective(s) of the lesson? This may be formal or informal.

Teacher can move from group to group as the groups are working on the activity and look to see if there are any problems concerning the lesson's objectives. Teacher can review the student productions collected from each team/group.

- 12. Modifications** – Optional activities to accommodate different ability levels. Remember to plan for the very bright student, as well as, the challenged.

- a. This plan could easily be modified for middle school mathematics classes. The survey needs to be changed to a topic that would be of interest to this age group. Consequently, reading material that accompanies the survey must be researched and provided to these classes.

- b. Pre-AP classes: Have students research the colleges or universities that they are interested in.
- Ask them to find out percentage of the students that enrolled at this college/university who took the SAT or ACT college entrance exams. What percentage received college credit via dual enrollment? What is a minimum SAT or ACT score specified by the university?
  - Look up tuition rates of various Texas state 4-year colleges from the website, [https://secure.its.txstate.edu/ir/irsurveys/vpaa/tuition\\_fee/results.php](https://secure.its.txstate.edu/ir/irsurveys/vpaa/tuition_fee/results.php)
  - Graph the tuition rates for Texas residents
- c. If your class' textbook has sections on statistical data, graphing, and/or bias, you may want to assign these sections as the reading assignment instead of the attached documents as part of the homework assignment.

## **Hand Out: Some Statistical Definitions**

### **Categorical Data**

A set of data where the measurement is on a nominal scale. (Nominal scales offer names or labels for certain characteristic.) The data is said to be categorical if the values or observations belonging to it can be sorted according to category. Each value is chosen from a set of non-overlapping categories. Examples of categorical data are hair color, favorite singer, state you were born in, etc.

### **Quantitative Data**

A set of data where the data has a numerical value. The data can be counted (such as 1, 2, 3, 4,... or 1999, 2001, 2002,... ) or the data can be measured (e.g. all the real numbers between 60 and 72 such as 60.001 or 62.345). The set of data does not include those numeric values where finding the average of the data or determining how far apart the numbers are makes no sense. Examples of the numeric data that is not quantitative are zip codes or area codes.

### **Bias**

When collecting data, bias is caused by a sampling procedure that tends to systematically over-represent or under-represent some portion of the population. There are three types of bias

- Convenience sample – where subjects or participants are chosen because they are easy to reach. Thus, it makes the process of collecting data quicker and easier.
- Voluntary Response – where subjects volunteer to be in the sample which may lead to poor representation of some part of the intended population.
- Non-Response – where some sampled subjects refuse to participate or fail to participate fully in the data collection process.

### **Population**

The total set of subjects of interest in a study. An example would be all the students in your high school.

### **Sample**

A subset of the population on which the study collects data. For the population example used above, a sample would be those students in your high school who took your survey.



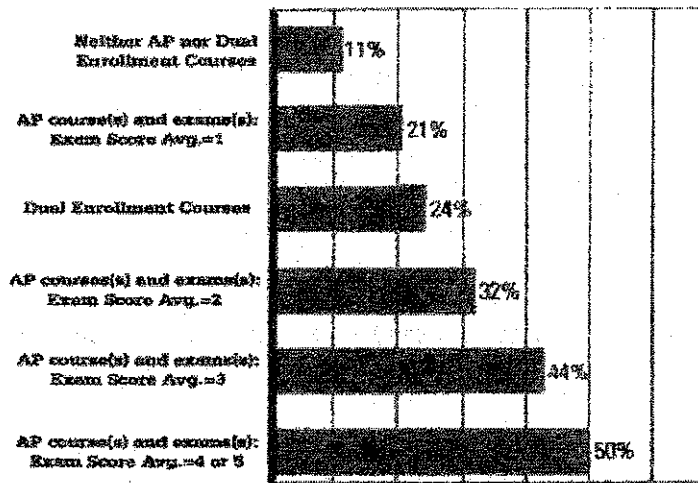
## Some Indicators of College and Career Readiness

### Advance placement classes and dual enrollment.

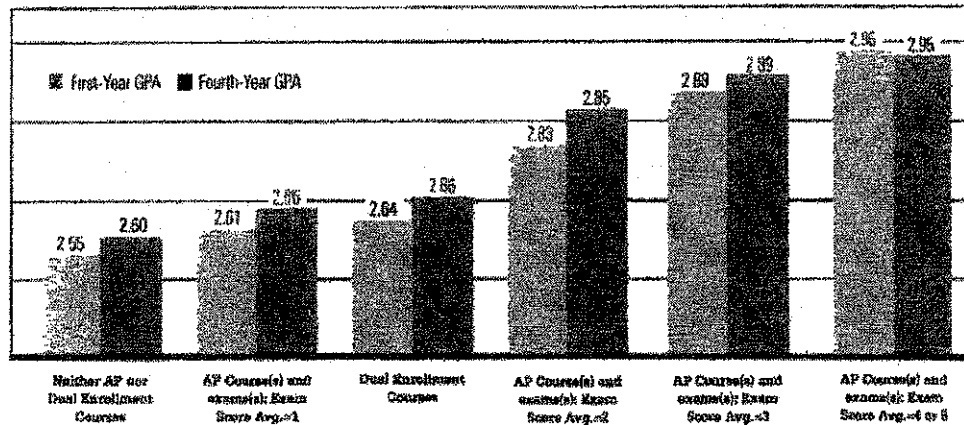
The following are charts that reflect the results of an extensive research study.

Source: College Board, (2009). <http://www.cbia.com/pod/documents/APDual.pdf>

**Percentage of Students with Varying AP and Non-AP Experiences Who Earn a Bachelor's Degree Within 4-Years**



**First-Year and Fourth-Year Average College GPAs of Students with Varying AP and Non-AP Experiences**



Advance Placement (AP) classes are college-level courses offered as a part of a high school curriculum. After a student successfully completes an AP course, he/she has the option to take an examination offered by the College Board. Each AP Exam score is a weighted combination of the student's score on the multiple-choice section and the free-response section. The final score is reported on a 5-point scale:

- 5 = extremely well qualified to receive college credit and/or placement
- 4 = well qualified to receive college credit and/or placement
- 3 = qualified to receive college credit and/or placement
- 2 = possibly qualified to receive college credit and/or placement
- 1 = no recommendation for receiving college credit and/or placement

Source: College Board. <http://professionals.collegeboard.com/highered/placement/ap/exam/grades>

Dual enrollment is a program that allows high school students to simultaneously earn academic college or career and technology credit towards a post secondary certificate or degree at a 2-year or 4-year college that will also count as credit toward a high school diploma. Dual enrollment courses are college courses. Students should understand that the amount of work necessary to succeed in dual enrollment courses may be greater than that of high school courses. In addition, dual enrollment courses become a part of a student's permanent college record and transcript. Students should check with their high school guidance counselor prior to enrolling in dual enrollment courses.

Source: South Texas College: <http://studentservices.southtexascollege.edu/de/>

SAT, ACT, and TAKS tests.

Per the Texas Education Agency: College-Ready Graduates: To be considered college-ready as defined by this indicator, a graduate must have met or exceeded the college-ready criteria on the TAKS exit-level test, or the SAT test, or the ACT test. The criteria for each are:

Subject	Exit-level TAKS		SAT		ACT
English/ Language Arts (ELA)	>= 2200 scale score on ELA test AND a "3"; or higher on essay	OR	>=500 on Critical Reading AND >=1070 Total	OR	>= 19 on English AND >= 23 Composite
Math	>= 2200 scale score on mathematics test	OR	>=500 on Math AND >=1070 Total	OR	>= 19 on Math AND >= 23 Composite

Source: Texas Education Agency: <http://ritter.tea.state.tx.us/perfreport/aecis/2010/glossary.html>

4 years of high school math.

After reviewing multiple research studies, the recommendation from the Texas Education Agency and Texas Higher Education Coordinating Board is that all high school students take four years of high school mathematics in order to be better prepared for college or their careers.

## Worksheet: Interpreting, Graphing, and Analyzing Data

1. Discuss your findings with other group members. Write what similarities and differences were found?
2. For each survey question, classify the question as categorical or quantitative.

Question 1:	Question 6a:
Question 2:	Question 6b:
Question 3:	Question 7a:
Question 4:	Question 7b:
Question 5a:	Question 8:
Question 5b:	Question 9:
	Question 10:

3. Combine or merge each group member's survey results.
4. As a group to the following for questions 1 and 2.

Question 1. Graph the results of surveys. Make sure your graph(s) can answer the following questions. In other words, can another person look at your graphs and know the answers to the following questions:

- What percent of the survey participants are male? Or female?
- How many student participants are male? How many student participants are female?

Question 2.

- Graph the results of surveys. Make sure your graph(s) can answer the following questions. In other words, can another person look at your graphs and know the answers to the following questions:
  - What percent of the all the survey participants are in each grade?
  - What percent of the 9<sup>th</sup> graders are male? Female?
  - What percent of the 10<sup>th</sup> graders are male? Female?
  - What percent of the 11<sup>th</sup> graders are male? Female?
  - What percent of the 12<sup>th</sup> graders are male? Female?
- Measures of center.
  - Create a histogram of the number of students by grade,
  - Questions that the graphs will communicate.
  - How many survey participants are in 9<sup>th</sup> grade? 10<sup>th</sup> grade? 11<sup>th</sup> grade? 12<sup>th</sup> grade?

- What is the mean number data?
  - What is the mode?
  - What is the median?
5. The group now needs to review and graph the data from questions 3-9. Merge all team members' survey results. Split up questions 3-9 between team members, so that this exercise is shared among the team members.

For each question 3 through 9, do the following:

Question 3: Create graphs so that the answers to the following questions can easily be determined.

- What percentage of the students are enrolled in each type of math course?
- Which course has more girls enrolled in it? Which course has more boys enrolled in it?
- What percent of the students are in regular classes? What percent of the students are in pre-AP classes? What percent of the students are in AP classes?

Question 4: Create graphs so that the answers to the following questions can easily be determined.

- What math class are seniors taking this semester?
- Combining 9<sup>th</sup>, 10<sup>th</sup>, and 11<sup>th</sup> grade students together, what math classes is this group of students planning to take their senior year? How many students choice each the different type of math classes?
- Separating 9<sup>th</sup>, 10<sup>th</sup>, and 11<sup>th</sup> grade students into their own groups, what math classes do these groups plan to take? How many students choice each the different type of math classes?

Question 5:

- Create graphs so that the answers to the following questions can easily be determined.
  - What percentage of students are taking or are planning take to AP classes?
  - What percentage of males and females are planning or are taking AP classes?
  - What percentage are students taking or planning to take AP classes by grade?
- Measures of center.
  - Create a histogram of the number of AP classes students plan to complete before they graduate from high school.
  - Questions that the graphs will communicate.
    - How many students will be taking 1 AP class before graduating high school? 2 AP classes? 3 AP classes? 4 AP classes? Etc. How many plan to take no AP classes?
    - What is the mean of the data? What is the mode? What is the median?

Question 6: Create graphs so that the answers to the following questions can easily be determined.

- What percentage of students are taking or planning to take the SAT exam?
- What percentage of males and females are taking or planning to take the SAT exam?
- By grade, what percentage are students taking or planning to take the SAT exam?

Question 7: Create graphs so that the answer to the following questions can easily be determined.

- What percentage of students are taking or planning to take the ACT exam?
- What percentage of males and females are taking or planning to take the ACT exam?
- By grade, what percentage are students taking or planning to take the ACT exam?

Question 8: Create graphs so that the answer to the following questions can easily be determined.

- What percentage of students are taking or planning to enroll in dual enrollment courses?
- What percentage of males and females are taking or planning to enroll in dual enrollment courses?
- By grade, what percentage are students taking or planning to enroll in dual enrollment courses?

Question 9: Create graphs so that

- A person can tell what students plan to do after they graduate from high school using percentages.
- Create a graph by grade of what students plan to do after they graduate from high school using percentages.

6. Question 10: all team members need to do the following together.

- g. Calculate the mean, median, and mode of the combined group data.
- h. Build a histogram of the combined group data. Use an interval length recommended by the teacher when building the histogram.
- i. Describe how your graph looks. Does it look like one tall skinny hill? Does it have two hills? Is the height of all the rectangles approximately the same?

## **College and Career Readiness**

Did you know that the data we collected gives us some indications of whether or not high school students are ready or prepared for college? Or how successful high school students may be in college?

### **Question**

**Pre-/Post-Tests (20 questions)**  
(answers are in bold-face)

1. Which of the following is a statistical classification of data?

- a) **categorical**      b) alphabetical      c) ascending      d) chronological

2. If a student conducts a survey on the average number of text messages sent by a student on a daily basis. This statistical data is

- a) not useful      b) **quantitative**      c) categorical      d) ascending

3. Zip codes are quantitative data (true or false).      True      **False**

4. The decision of yes or no on whether or not a student takes AP courses is categorical data (true or false).      **True**      False

5. If one wanted to graph the number of high school students taking Advance Placement courses by grade, one could use which of the following graphs,

- a) scatter plot      b) histogram      c) box plot      **d) pie chart**

6. When graphing categorical data, which graph would not be the correct selection

- a) histogram      b) stem-n-leaf      **c) bar chart**      d) line graph

7. For a collection of grades given out to a English I class, the numeric grades of A, B, C, and F, can be plotted on the following

- a) stem-n-leaf      b) pie chart      **c) histogram**      d) parabola

8. No matter how simple the data may appear to be, it can always be graphed such that the information on the graph is misread (true or false).

- True**      False

9. Which of the following are not measures of center in statistics?

- a) mean      b) median      **c) middle**      d) mode

10. Mean is calculated by taking the sum of all the data and dividing the sum by the total number of observations.

- True**      False

11. You can only calculate median if you have an odd number of observations (true or false).

- True      False



12. Mean, median, and mode can sometimes be equal.

**True**            **False**

13. If one did a survey of annual family incomes in Laredo, which would be a better measure of center,

a) mean            **b) median**        c) mode

14. If a student collected the average number of text messages that students send daily and one student responded 100,000 (a large outlier). Will the data be skewed left or right?

a) Left            **b) Right**

15. In a sample of data for the price of homes in Laredo, someone recorded the price of one home to be zero. Is the data skewed to the right or skewed to the left? **Right**    Left

16. When data is skewed right, the mean and median both increase by the same amount (true or false).            a) True            **b) False**

17. Do high school students need to take four years of math to be better prepared for college (even if the students are planning to major in English)? **Yes**    No

18. Which of the following exams are not indicators of college readiness of high school students?

a) ACT            b) SAT            **c) TEKS**            d) TAKS

19. Dual enrollment courses do not give a student credit for a college course. They just allow high students to take college courses in the evening. **True**    **False**

20. Which of the following is not an indicator of how well a high student will perform in college?

- a) AP with an exam score of 1
- b) AP with an exam score of 5
- c) Taking dual enrollment courses
- d) None of the above.**