Senior High School

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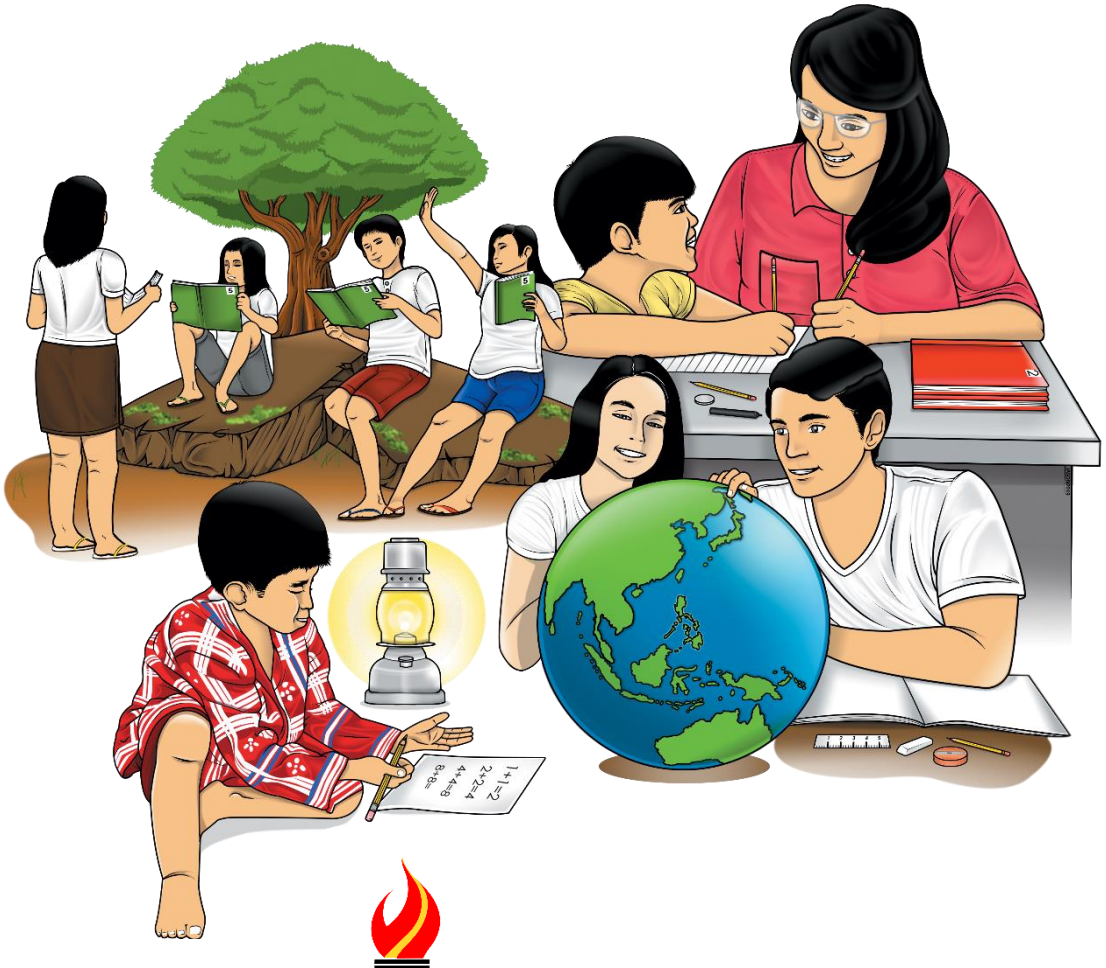
DEPARTMENT OF EDUCATION

Statistics and Probability

Quarter 4 – Module 1: Testing Hypothesis



ALTERNATIVE DELIVERY MODE
ADM

Statistics and Probability
Alternative Delivery Mode
Quarter 4 – Module 1: Testing Hypothesis
First Edition, 2021

Published by the Department of Education
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Undersecretary: Diosdado M. San Antonio

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Printed in the Philippines by _____

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

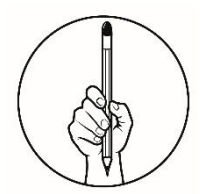
What I Need to Know

Hypothesis testing can allow us to measure data in samples to learn more about the data in populations that are often too large or inaccessible. We can measure a sample mean to learn more about the mean in a population. Here, we can either accept or reject our assumption using hypothesis testing. This ADM module in hypothesis testing will help you study the different concepts and steps in hypothesis testing as well as its application in real-life situations.

After going through this module, you are expected to:

1. define and illustrate the null hypothesis, alternative hypothesis, level of significance, rejection region, and types of errors in hypothesis testing;
2. identify the rejection and non-rejection regions and the critical values; and
3. differentiate Type I and Type II errors in claims and decisions.

Are you ready now to study hypothesis testing using your ADM module? Good luck and may you find it helpful.



What I Know

Choose the best answer to the given questions or statements. Write the letter of your answer on a separate sheet of paper.

1. It is a proposed explanation, assertion, or assumption about a population parameter or about the distribution of a random variable.
   a. Decision
   b. Statistics
   c. Probability
   d. Hypothesis

2. What is the statistical method used in making decisions using experimental data?
   a. Simple analysis
   b. Analytical testing
   c. Hypothesis testing
   d. Experimental testing

3. It is also the probability of committing an incorrect decision about the null hypothesis.
   a. Level of error
   b. Level of hypothesis
   c. Level of acceptance
   d. Level of significance

4. Which of the following describes an alternative hypothesis using two-tailed test?
   a. $H_a = 100$
   b. $H_a \neq 100$
   c. $H_a > 100$
   d. $H_a < 100$

5. In a one-tailed test, in which critical value listed below will the computed z of 2.313 fall in the acceptance region?
   a. 1.383
   b. 1.533
   c. 2.228
   d. 2.365

6. Which of the following would be an appropriate null hypothesis?
   a. The mean of a sample is equal to 75.
   b. The mean of a population is equal to 75.
   c. The mean of a sample is not equal to 75.
   d. The mean of a population is greater than 75

7. When is a Type I error committed?
   a. We reject a null hypothesis that is false.
   b. We reject a null hypothesis that is true.
   c. We fail to reject a null hypothesis that is true.
   d. We fail to reject a null hypothesis that is false.

8. When is a Type II error committed?
    a. We reject a null hypothesis that is true.
    b. We reject a null hypothesis that is false.
    c. We fail to reject a null hypothesis that is true.
    d. We fail to reject a null hypothesis that is false.

9. Which of the following is a Type I error?
    a. H_0 is true; reject H_0.
    b. H_0 is false; reject H_0.
    c. H_0 is true; fail to reject H_0.
    d. D. H_0 is false; fail to reject H_0.

10. Which of the following describes an alternative hypothesis in a left-tailed test?
    a. $H_a > 100$ b. $H_a < 100$ c. $H_a = 100$ d. $H_a \neq 100$

11. Which of the following must be used as the level of significance if we want a higher possibility of correct decision?
    a. 1% b. 5% c. 10% d. 25%

12. Which of the following would be an appropriate alternative hypothesis for one-tailed test?
    a. $H_a < 100$ b. $H_a = 100$ c. $H_a \geq 100$ d. $H_a \leq 100$

13. Using a left-tailed test, which of the following value of z falls in the rejection region where the critical value is – 1.725?
    a. – 1.700 b. – 1.715 c. – 1.724 d. – 1.728

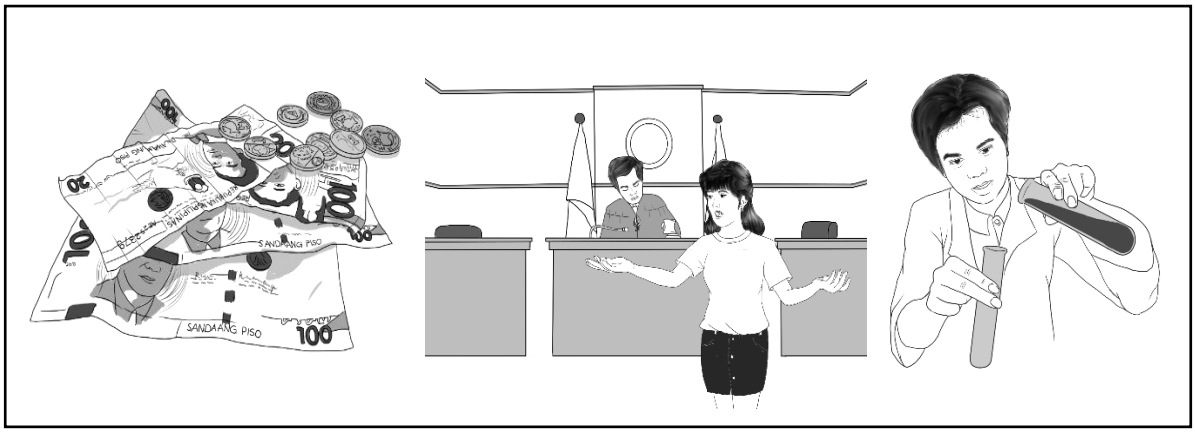
14. If the computed z-value is 2.015 and the critical value is 1.833, which of the following statements could be true?
    a. It lies in the rejection region, H_o must be rejected.
    b. It lies in the rejection region, we failed to reject H_o.
    c. It lies in the non-rejection region, H_o must be rejected.
    d. It lies in the non-rejection region, we failed to reject H_o.

15. If the computed z-value is – 1.290 and the critical value is – 2.571, which of the following statements could be true?
    a. It lies in the rejection region, H_o must be rejected.
    b. It lies in the rejection region, we failed to reject H_o.
    c. It lies in the non-rejection region, H_o must be rejected.
    d. It lies in the non-rejection region, we failed to reject H_o

Lesson 1 Testing Hypothesis

Have you at a certain time asked yourself how you could possibly decide to put a business in place and gain your expected profit? Or wonder if a judge in a trial could have given a wrong decision in determining who's guilty? Or think if your classmates' average weights differ significantly among your age? Or imagine how a newly discovered medicine is being tested for human treatment?

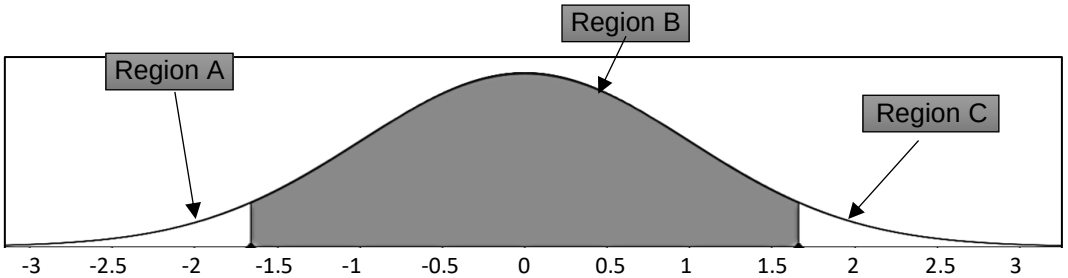
This lesson will help you make sound decisions in dealing with these situations



What's In

Activity 1: Where Am I Now?

Identify the region where each of the given values falls.



1. $t = 1.95$ _____
2. $t = 0.15$ _____
3. $t = -1.45$ _____
4. $t = -2.4$ _____
5. $t = 2.73$ _____

Answer the following questions.

1. Are you familiar with the shape of the curve used in Activity 1?
2. What is the name of that curve?
3. In what type of distribution is this kind of curve used?
4. How were you able to locate in which region the given value falls?
5. What mathematical concepts did you apply in locating the region?

Notes to the Teacher

Check the student's level of readiness for the next topic. If she/he did not answer most of the items and the guide questions, you may provide another review activity about normal curve.

What's New

Activity 2: Keep Me Connected!

Analyze the situation below and answer the questions that follow.

According to a survey, the average daily usage of social media worldwide of global internet users amounts to 142 minutes per day. Sofia conducts her own survey among her friends to find out if their time spent on social media is significantly higher than the global survey.

Before her survey, she formulated the following claims:

Claim A: The average daily usage of social media of her friends is the same as the global average usage.

Claim B: The average daily usage of social media of her friends is higher than the global average usage.

The table shows Sofia's friends and their respective time spent on social media.

Friend's Name	***Minutes per Day Spent on Social Media***
Allen	132
Bryan	148
Ellen	165
Jake	157
Mindie	120
Shamsi	144
Candice	136
Dory	160
Mitch	185
Mila	173

Answer the following questions:

1. What statistical data is/are needed to prove which of Sofia's claims is accepted or rejected?
2. What is the average daily usage of social media of her friends? Compare it with the previous average usage.
3. Which of the two claims could probably be true? Why?
4. If Sofia computed the average daily internet usage of her friends to be higher than the global survey, do you think it would be significantly higher?
5. What is your idea of an average value being significantly higher than the global average value?
6. What do you think is the difference between simple comparison of data and hypothesis testing?

What is It

Hypothesis testing is a statistical method applied in making decisions using experimental data. Hypothesis testing is basically testing an assumption that we make about a population.

A **hypothesis** is a proposed explanation, assertion, or assumption about a population parameter or about the distribution of a random variable.

Here are the examples of questions you can answer with a hypothesis test:

- Does the mean height of Grade 12 students differ from 66 inches?
- Do male and female Grade 7 and Grade 12 students differ in height on average?
- Is the proportion of senior male students' height significantly higher than that of senior female students?

Key Terms and Concepts Used in Test Hypothesis

The Null and Alternative Hypothesis

- ✓ The *null hypothesis* is an initial claim based on previous analyses, which the researcher tries to disprove, reject, or nullify. It shows no significant difference between two parameters. It is denoted by H_o.
- ✓ The *alternative hypothesis* is contrary to the null hypothesis, which shows that observations are the result of a real effect. It is denoted by H_a.

Note: You can think of the null hypothesis as the current value of the population parameter, which you hope to disprove in favor of your alternative hypothesis.

Take a look at this example.

The school record claims that the mean score in Math of the incoming Grade 11 students is 81. The teacher wishes to find out if the claim is true. She tests if there is a significant difference between the batch mean score and the mean score of students in her class.

Solution:

Let μ be the population mean score and $\bar{x}$ be the mean score of students in her class.

You may select any of the following statements as your null and alternative hypothesis as shown in Option 1 and Option 2.

Option 1:

H_o: The mean score of the incoming Grade 11 students is 81 or $\mu = 81$.
H_a: The mean score of the incoming Grade 11 students is not 81 or $\mu \neq 81$.

Option 2:

H_o: The mean score of the incoming Grade 11 students has no significant difference with the mean score of her students or $\mu = \bar{x}$.
H_a: The mean score of the incoming Grade 11 students has a significant difference with the mean score of her students or $\mu \neq \bar{x}$.

Now, it's your turn!
Based on the first claim of Sofia in Activity 2 that "the average daily usage of social media of her friends is the same as the global average usage", formulate two hypotheses about the global average usage (μ) and the average usage of her friends ($\bar{x}$) on the blanks provided below.

H_o: _____
H_a: _____

You can verify your answer below and start working on the next activity.

H_o: The average daily usage of Sofia's friends is the same as the global average usage.
H_a: The average daily usage of Sofia's friends is not the same as the global average usage.

Here is another key term you should know!

Level of Significance

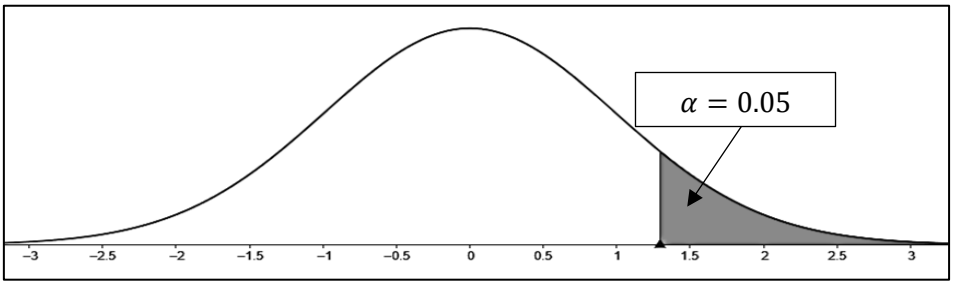
- ✓ The *level of significance* denoted by *alpha* or **α** refers to the degree of significance in which we accept or reject the null hypothesis.
- ✓ 100% accuracy is not possible in accepting or rejecting a hypothesis.
- ✓ The significance level α is also the probability of making the wrong decision when the null hypothesis is true.

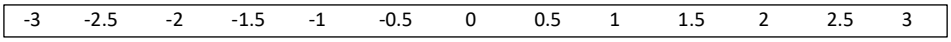
Do you know that the most common levels of significance used are 1%, 5%, or 10%?

Some statistics books can provide us table of values for these levels of significance.

Take a look at this example.

Maria uses 5% level of significance in proving that there is no significant change in the average number of enrollees in the 10 sections for the last two years. *It means that the chance that the null hypothesis (H_o) would be rejected when it is true is 5%.*





$\alpha = 0.05$ is actually the area under the normal curve within the rejection region.

It's your turn!

If Sofia used a 0.10 level of significance, what are the chances that she would have a wrong conclusion if the two values have no significant difference?

Here is another key term you should know!

Two-Tailed Test vs One-Tailed Test

- ✓ When the alternative hypothesis is two-sided like H_a: $\mu \neq \mu_0$, it is called two-tailed test.
- ✓ When the given statistics hypothesis assumes a *less than or greater than* value, it is called one-tailed test.

Here are some examples.

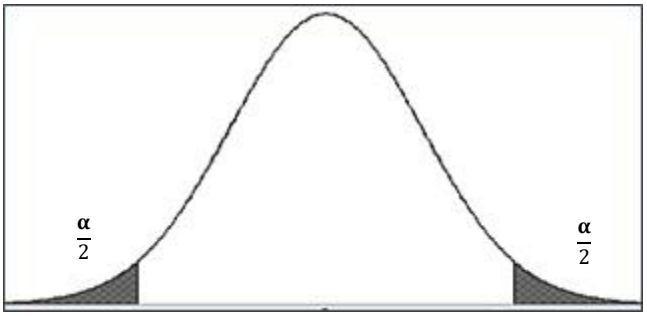
The school registrar believes that the average number of enrollees this school year is not the same as the previous school year.

In the above situation,

let μ_0 be the average number of enrollees last year.

H_o: $\mu = \mu_0$

H_a: $\mu \neq \mu_0$

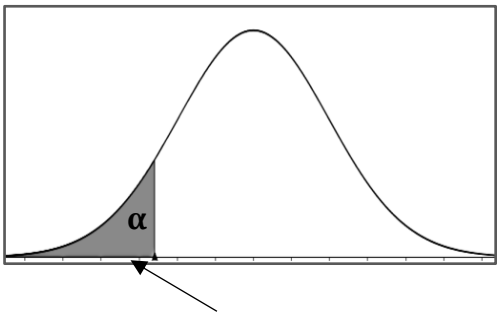


If H_a uses $\neq$, use a two-tailed test.

However, if the school registrar believes that the average number of enrollees this school year is less than the previous school year, then you will have:

H_o: $\mu = \mu_0$

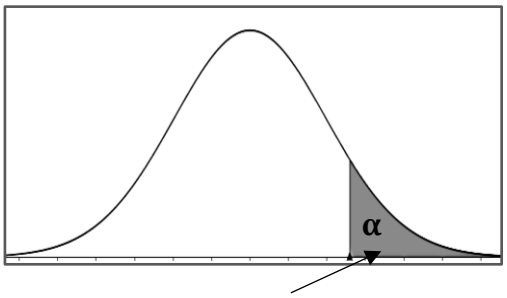
H_a: $\mu < \mu_0$



Use the left-tailed when H_a contains the symbol <.

On the other hand, if the school registrar believes that the average number of enrollees this school year is greater than the previous school year, then you will have:

H_o: $\mu = \mu_0$
H_a: $\mu > \mu_0$



Use the right-tailed test when H_a contains the symbol >.

Now back to the two claims of Sofia, what do you think should be the type of test in her following claims?

Claim A: The average daily usage of social media of her friends is the same as the global average usage.

Claim B: The average daily usage of social media of her friends is higher than the global average usage.

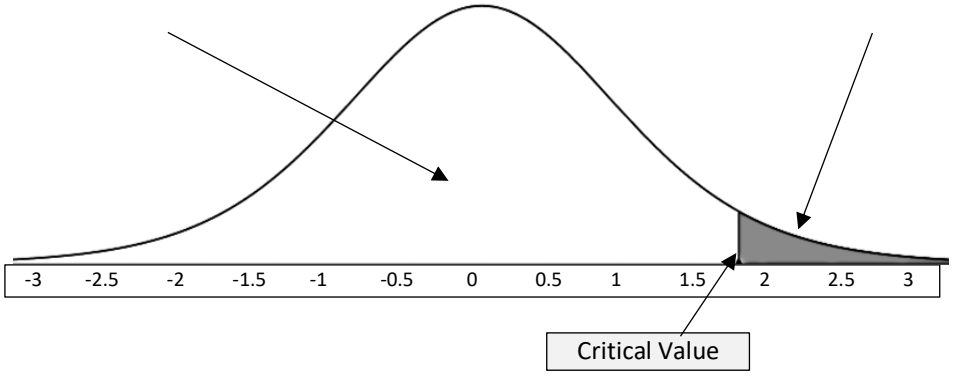
Here is the other concept!

Illustration of the Rejection Region

- ✓ The *rejection region* (or *critical region*) is the set of all values of the test statistic that causes us to reject the null hypothesis.
- ✓ The *non-rejection region* (or *acceptance region*) is the set of all values of the test statistic that causes us to fail to reject the null hypothesis.
- ✓ The *critical value* is a point (boundary) on the test distribution that is compared to the test statistic to determine if the null hypothesis would be rejected.

Non-Rejection Region

Rejection Region



Illustrative Example 1:

Now, let's take a look at Sofia's first claim. She assumed that the average online usage of her friends is the same as the global usage (H_o).

She computed for the t-value using the formula $t = \frac{\bar{x}-\mu}{\frac{s}{\sqrt{n}}}$ where μ = 142, $\bar{x}$ = 152, s = 19.855, and n = 10.

This t-test formula was discussed in the last chapter.

$$t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

$$t = \frac{152 - 142}{\frac{19.855}{\sqrt{10}}}$$

$$t = \frac{10}{6.2787}$$

$$t = 1.593$$

Use a scientific calculator to verify the computed t-value.

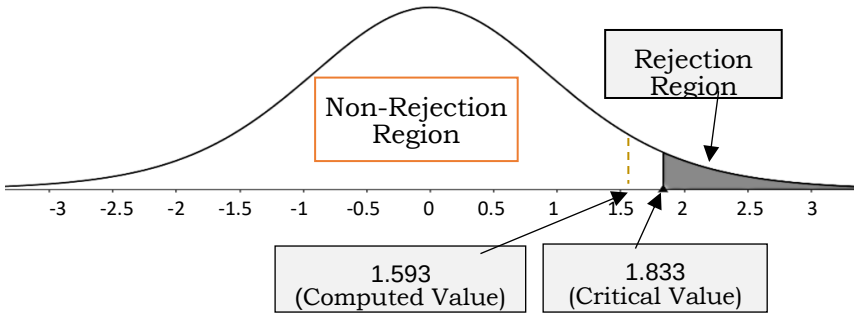
From the table of t-values, determine the critical value. Use *df* = n-1 = 9, one-tailed test at 5% level of significance.

The critical t-value is 1.833. How did we get that value? Look at this illustration!

The table of t-values can be found at the last part of this module.

	Area in One Tail				
	0.005	0.01	0.025	0.05	0.10
Degrees of Freedom	Area in Two Tails				
	0.01	0.02	0.05	0.10	0.20
1	63.657	31.821	12.706	6.314	3.078
2	9.925	6.965	4.303	2.920	1.886
3	5.841	4.541	3.182	2.353	1.638
4	4.604	3.747	2.776	2.132	1.533
5	4.032	3.365	2.571	2.015	1.476
6	3.707	3.143	2.447	1.943	1.440
7	3.499	2.998	2.365	1.895	1.415
8	3.355	2.896	2.306	1.860	1.397
9	3.250	2.821	2.262	1.833	1.383
10	3.169	2.764	2.228	1.812	1.372

Now, you can sketch a t distribution curve and label showing the rejection area (shaded part), the non-rejection region, the critical value, and the computed t-value. This is how your t distribution curve should look like!



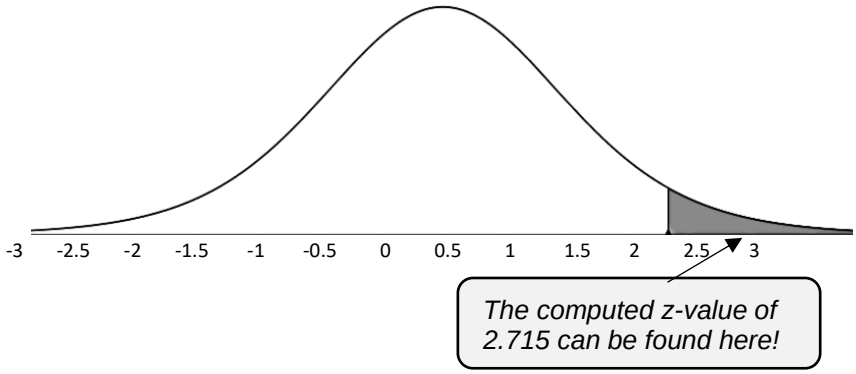
As you can see from your previous illustration, the computed t-value of 1.593 is at the left of the critical value 1.833. So, in which region do you think the computed value falls?

The computed value is less than the critical value.

H_o: The average online usage of her friends is the same as the global usage.	The computed t-value is at the non-rejection region.	We fail to reject the null hypothesis, H_o.
H_a: The average online usage of her friends is higher than the global usage.		

Illustrative Example 2:

A medical trial is conducted to test whether a certain drug reduces cholesterol level or not. Upon trial, the computed z-value of 2.715 lies in the rejection area.



The computed value is greater than the critical value.

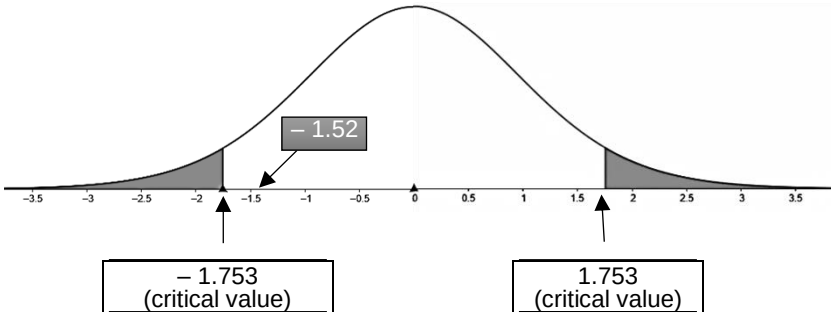
H_o: The certain drug is not effective in reducing cholesterol level.	The computed z-value is at the rejection region.	We reject the null hypothesis, H_o in favour of H_a.
H_a: The certain drug is effective in reducing cholesterol level.		

Illustrative Example 3:
Sketch the rejection region of the test hypothesis with critical values of ± 1.753 and determine if the computed t-value of –1.52 lies in that region.

Solution:

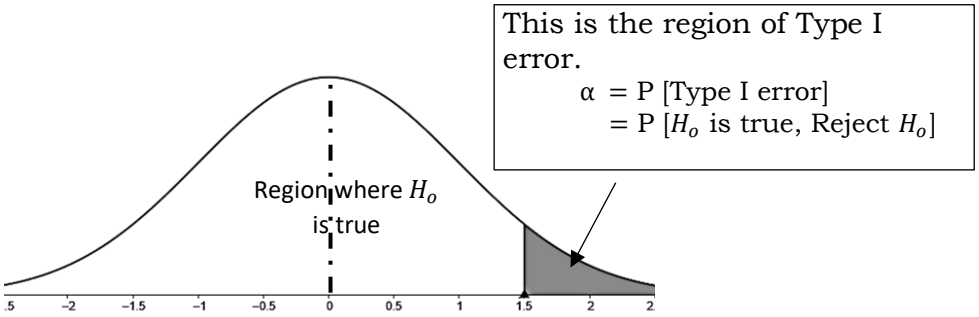
Draw a t-distribution curve. Since there are two critical values, it is a two tailed test. Locate the critical values and shade the rejection regions.

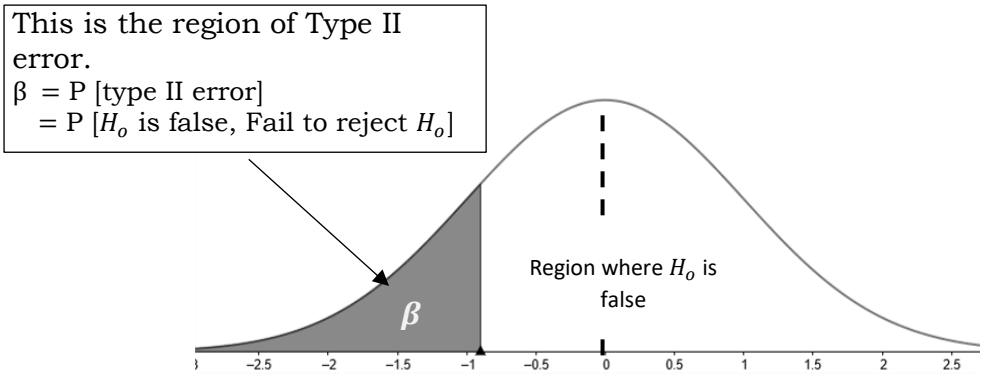
Now, locate the computed t-value of –1.52. You can clearly see that it is *not at the rejection region* as shown in the following figure. The computed t-value is at the non-rejection region. Therefore, we fail to reject the null hypothesis, H_o.



Type I and Type II Errors

- ✓ Rejecting the null hypothesis when it is true is called a **Type I error** with probability denoted by **alpha (α)**. In hypothesis testing, the normal curve that shows the critical region is called the alpha region.
- ✓ Accepting the null hypothesis when it is false is called a **Type II error** with probability denoted by **beta (β).** In hypothesis testing, the normal curve that shows the acceptance region is called the beta region.
- ✓ The larger the value of alpha, the smaller is the value of beta.





To summarize the difference between the Type I and Type II errors, take a look at the table below.

Null Hypothesis H_o	**Fail to Reject H_o**	**Reject H_o**
True	Correct Decision *- Failed to reject H_o when it is true*	**Type I Error** *- Rejected H_o when it is true*
False	**Type II Error** *- Failed to reject H_o when it is false*	Correct Decision *- Rejected H_o when it is false*

Now, complete the statements that follow.

Analyze the possibilities of Sofia's conclusion. Identify if it is a Type I Error, Type II Error, or a Correct Decision.
If Sofia finds out that her null hypothesis is …

1. true and she fails to reject it, then she commits a _____.
2. true and she rejects it, then she commits a _____.
3. false and she fails to reject it, then she commits a _____.
4. false and she rejects it, then she commits a _____.

Your answers should be: 1) Correct Decision, 2) Type I Error, 3) Type II Error, and 4) Correct Decision.

Illustrative Example:

Bryan is starting his own food cart business and he is choosing cities where he will run his business. He wants to survey residents and test at 5% level of significance whether the demand is high enough to support his business or not before he applies for the necessary permits to operate in his selected city. He will only choose a city if there is strong evidence that the demand there is high enough. We can state the null hypothesis for his test as:

H_o: The demand is high enough.

What would be the consequence of a Type I error in this setting?

_____ He doesn't choose a city where demand is actually high enough.
_____ He chooses a city where demand is actually high enough.
_____ He chooses a city where demand isn't actually high enough.

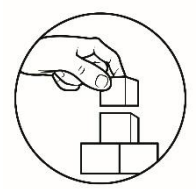
The Type I error is the first statement because he rejected the true null hypothesis.

What would be the consequence of a Type II error in this setting?
_____ He doesn't choose a city where demand is actually high enough.
_____ He chooses a city where demand is actually high enough.
_____ He chooses a city where demand isn't actually high enough.

The Type II error is the third statement because he failed to reject the false null hypothesis.

What is the probability of Type I error?
_____ 0.10 _____ 0.25 _____ 0.05 _____ 0.01

The probability of Type I error is 0.05 because it is the level of significance used.



What's More

Activity 1.1 Null Vs Alternative

State the null and the alternative hypotheses of the following statements.

1. A medical trial is conducted to test whether a new medicine reduces uric acid by 50% or not.
   H_o: _____
   H_a: _____
2. We want to test whether the general average of students in Math is different from 80%.
   H_o: _____
   H_a: _____
3. We want to test whether the mean height of Grade 8 students is 58 inches.
   H_o: _____
   H_a: _____
4. We want to test if LPIHS students take more than four years to graduate from high school, on the average.
   H_o: _____
   H_a: _____
5. We want to test if it takes less than 60 minutes to answer the quarterly test in Calculus.
   H_o: _____
   H_a: _____
6. A medical test is conducted to determine whether a new vaccine reduces or not the complications of dengue fever.
   H_o: _____
   H_a: _____
7. The enrolment in high school this school year increases by 10%..
   H_o: _____
   H_a: _____
8. The intelligence quotient of male grade 11 students is the same as the female students.
   H_o: _____
   H_a: _____

9. The school want to test if the students in Grade 7 prefer online distance learning as the method of instruction.
   H_o: _____
   H_a: _____
10. The school librarian wants to find out if there was an increase in the number of students accessing the school library.
   H_o: _____
   H_a: _____

Activity 1.2 The Tale of Tails

Determine if one-tailed test or two-tailed test fits the given alternative hypothesis.

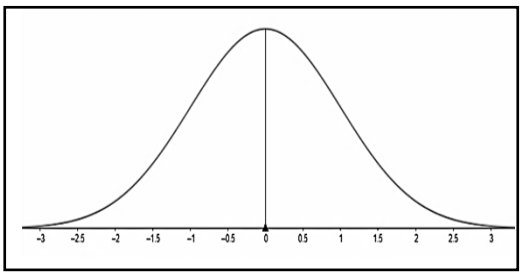
1. The mean height of Grade 12 students is less than 66 inches.
2. The standard deviation of their height is not equal to 5 inches.
3. Male Grade 7 and Grade 12 students differ in height on average.
4. The proportion of senior male students' height is significantly higher than that of senior female students
5. The average grade of Grade 11 students in Statistics is lower than their average grade in Calculus.
6. The newly found vaccine reduces the risks of viral infections of the patients.
7. The enrolment in elementary schools is not the same as the enrolment in the secondary schools.
8. Male adolescents have higher intelligence quotient level than the female adolescents.
9. The average number of internet users this year is significantly higher as compared last year.
10. Paracetamol and Ibuprofen have the same rate of time to reduce the headache of the patients.

Activity 1.3 Are You In or Out?

Illustrate the rejection region given the critical value and identify if the t-values lie in the non-rejection region or rejection region.

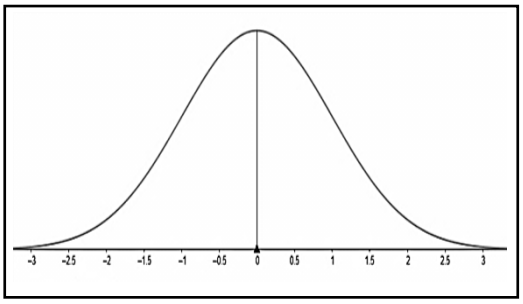
1. critical t-value of 1.318
   computed t-value of 1.1

   The computed t-value is at the _____ region.



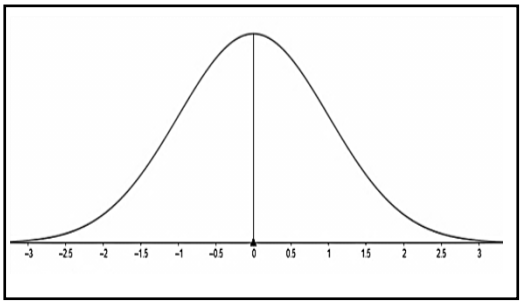
2. critical t-value of −1.671
   computed t-value of −2.45

   The computed t-value is at the _____ region.



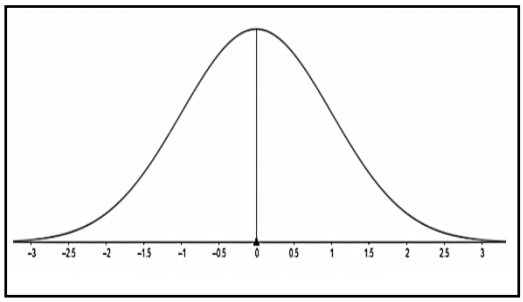
3. critical t-value of 1.725
   computed t-value of 2.14

   The computed t-value is at the _____ region.



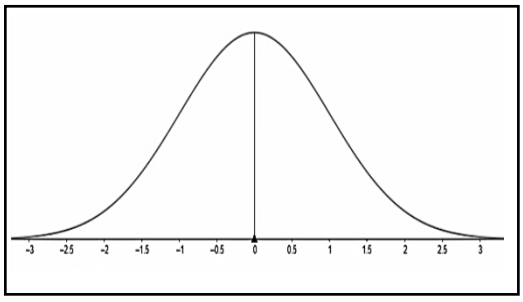
4. critical t-value of ±1.311
   computed t-value of −1.134

   The computed t-value is at the _____ region.



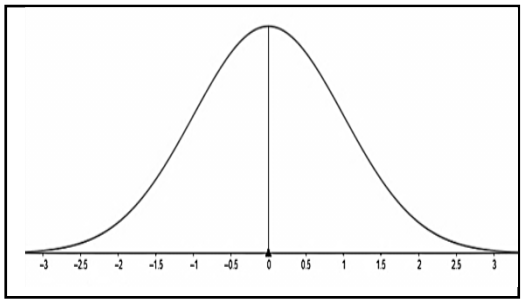
5. critical t-value of −1.701
   computed t-value of −2.48

   The computed t-value is at the _____ region.



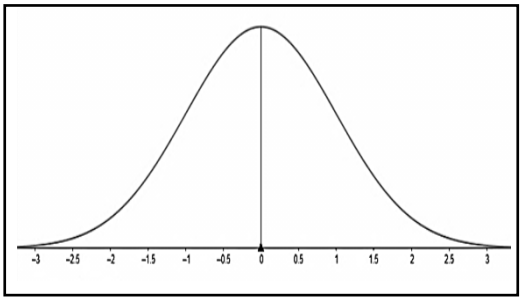
6. critical t-value of 2.12
   computed t-value of 2.15

   The computed t-value is at the _____ region.



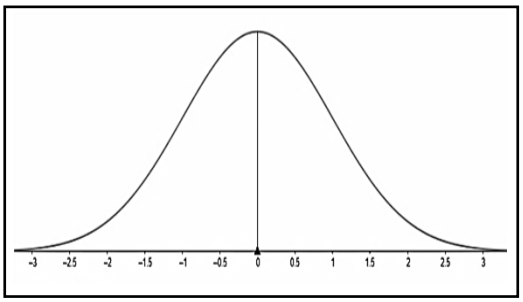
7. critical t-value of −2.306
   computed t-value of −2.110

   The computed t-value is at the _____ region.



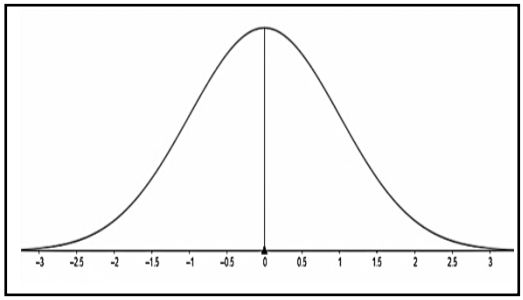
8. critical t-value of 2.228
   computed t-value of 1.987

   The computed t-value is at the _____ region.



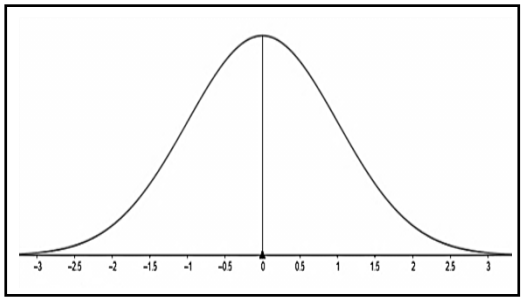
9. critical t-value of ±1.812
   computed t-value of −1.915

   The computed t-value is at the _____ region.



10. critical t-value of −1.860
    computed t-value of −2.3

    The computed t-value is at the _____ region.

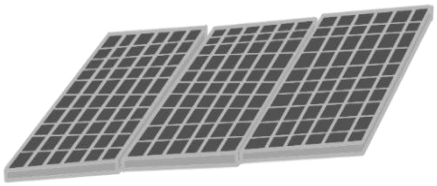


Activity 1.4 Type I or Type II

Check the box that corresponds to your answer.

Situation 1:

A quality control expert wants to test the null hypothesis that an imported solar panel is an effective source of energy.



1. What would be the consequence of a Type I error in this context?

They do not conclude that the solar panel is effective when it is not actually effective.	They do not conclude that the solar panel is effective when it is actually effective.
They conclude that the solar panel is effective when it is actually effective.	They conclude that the solar panel is effective when it is not actually effective.

2. What would be the consequence of a Type II error?

They do not conclude that the solar panel is effective when it is not actually effective.	They do not conclude that the solar panel is effective when it is actually effective.
They conclude that the solar panel is effective when it is actually effective.	They conclude that the solar panel is effective when it is not actually effective.

Situation 2:

A resort owner does a daily water quality test in their swimming pool. If the level of contaminants is too high, then he temporarily closes the pool to perform a water treatment.

We can state the hypotheses for his test as:
H_o: The water quality is acceptable.
H_a: The water quality is not acceptable.

1. What would be the consequence of a Type I error in this setting?

The owner closes the pool when it needs to be closed.	The owner does not close the pool when it needs to be closed.
The owner closes the pool when it does not need to be closed.	The owner does not close the pool when it does not need to be closed.

2. What would be the consequence of a Type II error in this setting?

The owner closes the pool when it needs to be closed.	The owner closes the pool when it does not need to be closed.
The owner does not close the pool when it does not need to be closed.	The owner does not close the pool when it needs to be closed.

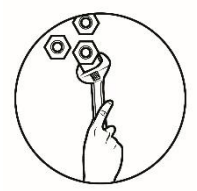
3. In terms of safety, which error has more dangerous consequences in this setting?

Type I Error	Type II Error

What I Have Learned

Complete the following statements. Write the answers in your notebook.

1. _____is a statistical method applied in making decisions using experimental data.
2. A _____ is a proposed explanation, assertion, or assumption about a population parameter or about the distribution of a random variable.
3. The null hypothesis is an initial claim which the researcher tries to _____.
4. The alternative hypothesis is contrary to the _____.
5. The level of significance is denoted by_____.
6. The significance level α is also the probability of making the wrong decision when _____.
7. When the alternative hypothesis is two-sided, it is called _____.
8. When the given statistics hypothesis assumes a less than or greater than value, it is called _____.
9. The rejection region (or critical region) is the set of all values of the test statistic that causes us to _____
10. Rejecting the null hypothesis when it is true results to what type of error?



What I Can Do

Cite five (5) situations in your community where you can apply hypothesis testing. Then, just choose one situation and:

1. create a problem statement;
2. formulate the null and alternative hypothesis;
3. select the level of significance and sketch the rejection region; and
4. state the possible Type I and Type II errors.

Assessment

Choose the best answer to the given questions or statements. Write the letter of your answer on a separate sheet of paper.

1. It is the statistical method used in making decisions using experimental data.
   a. observation
   b. simple analysis
   c. analytical testing
   d. hypothesis testing

2. What term is being used to describe a proposed explanation, assertion, or assumption about a population parameter or about the distribution of a random variable?
   a. statistic b. decision c. hypothesis d. probability

3. What term is being used to describe a proposed explanation, assertion, or assumption about a population parameter or about the distribution of a random variable?
   a. level of error
   b. level of hypothesis
   c. level of acceptance
   d. level of significance

4. Which of the following would be an appropriate null hypothesis?
   a. The mean of a sample is equal to 80.
   b. The mean of a population is equal to 80.
   c. The mean of a population is not equal to 80.
   d. The mean of a population is greater than 80.

5. Which of the following describes a null hypothesis using two-tailed test?
   a. $H_0: \mu = \mu_0$
   b. $H_0: \mu \neq \mu_0$
   c. $H_0: \mu \geq \mu_0$
   d. $H_0: \mu \leq \mu_0$

6. Which of the following describes an alternative hypothesis using two-tailed test?
   a. $H_a: \mu < 50\ years\ old$
   b. $H_a: \mu > 50\ years\ old$
   c. $H_a: \mu \neq 50\ years\ old$
   d. $H_a: \mu = 50\ years\ old$

7. Which of the following must be used as the significance level if we want a lower possibility of correct decision?
   a. 1% b. 2% c. 5% d. 10%

8. Which of the following would be an appropriate alternative hypothesis for one-tailed test?
   a. $H_a: \mu = 85$ b. $H_a: \mu \geq 85$ c. $H_a: \mu \geq 85$ d. $H_a: \mu < 85$

9. In a one-tailed test, in which critical values below will the computed z of 2.312 falls in the non-rejection region?
   a. 1.383 b. 1.533 c. 2.228 d. 2.354

10. When is a Type I error committed?
    a. We reject a null hypothesis that is true.
    b. We reject a null hypothesis that is false.
    c. We fail to reject a null hypothesis that is true.
    d. We fail to reject a null hypothesis that is false.

11. When is a Type II error committed?
    a. We reject a null hypothesis that is true.
    b. We reject a null hypothesis that is false.
    c. We fail to reject a null hypothesis that is true.
    d. We fail to reject a null hypothesis that is false.

12. Which of the following is a Type I error?
    a. H_0 is true; reject H_0.
    b. H_0 is false; reject H_0.
    c. H_0 is true; fail to reject H_0.
    d. H_0 is false; fail to reject H_0.

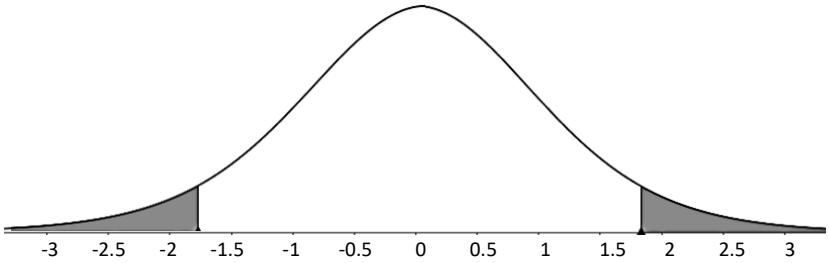
13. If the computed z-value is 1.286 and the critical value is 1.383, which of the following statements could be true?
    a. It lies in the rejection region, H_o must be rejected.
    b. It lies in the rejection region, hence we fail to rejectH_o.
    c. We fail to reject a null hypothesis that is true.
    d. We fail to reject a null hypothesis that is false.

14. Using a left-tailed test, which of the following value of z will *not* fall in the rejection region where the critical value is – 1.638?
    a. – 1.637 b. – 1.639 c. – 1.641 d. – 1.706

15. If the computed z-value is 1.915 and the critical value is 1.812, which of the following statements could be true?
    a. It lies in the rejection region, H_o must be rejected.
    b. It lies in the rejection region, hence we fail to rejectH_o.
    c. It lies in the non-rejection region, H_o must be rejected.
    d. It lies in the non-rejection region, hence we fail to rejectH_o

Additional Activities

A medical trial is conducted to test to test whether a certain drug can treat a certain allergy or not. Upon trial, the t-value is computed as 1.311. The critical value is shown in the figure. Locate the t-value and complete the table below to discuss the findings of the medical trial.



H_o:	The computed t-value is at the _____ region.	Decision:
H_a:		

Justify your decision by writing an explanation in 5-10 sentences.

Check your output!
Ho: A certain drug is effective in treating a certain allergy.
Ha: A certain drug is not effective in treating a certain allergy.
The computed t-value is at the acceptance region.
Decision: Accept the null hypothesis.

Answer Key

What I Know

1. D
2. C
3. D
4. B
5. D
6. B
7. B
8. D
9. A
10. B

What's In

1. C
2. B
3. B

^ ^

Activity 1.1

1. H_o: The new medicine cannot reduce uric acid.
   H_a: The new medicine can reduce uric acid.
2. H_o: The general average of students in Math is equal to 80%.
   H_a: The general average of students in Math is different from 80%.
3. H_o: The mean height of students is 58 inches.
   H_a: The mean height of students is not (*or less than or higher than*) 58 inches.
4. H_o: LPIHS students take an average of four years or less to graduate from high school.
   H_a: LPIHS students take an average of more than four years to graduate from high school
5. H_o: It takes 60 minutes or more to answer the quarterly test in Calculus.
   H_a: It takes less than 60 minutes to answer the quarterly test in Calculus.

Activity 1.1 (Cont...)

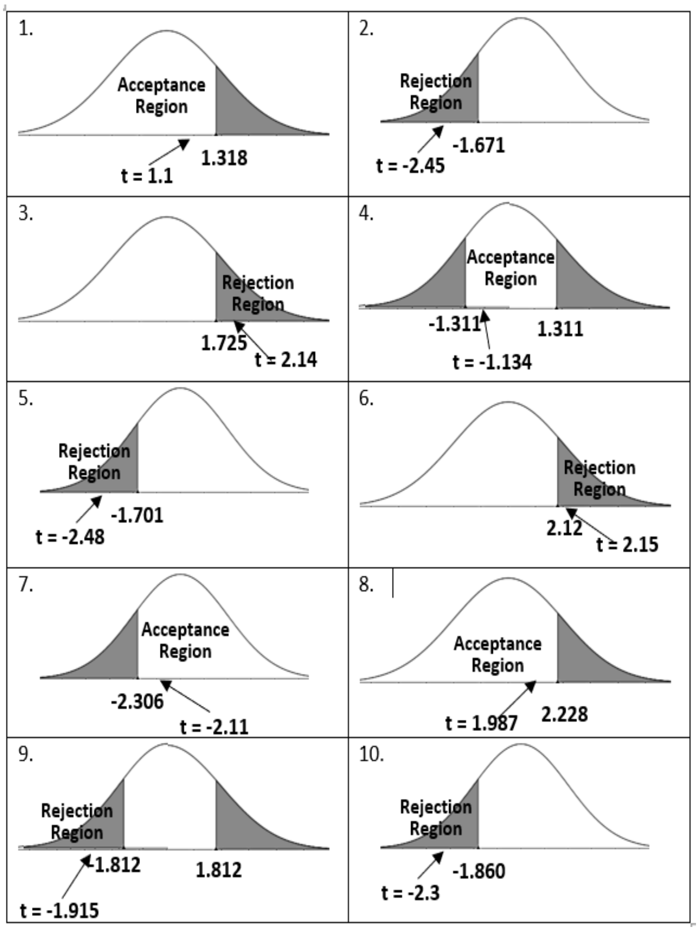
6. H_o: The new vaccine cannot reduce the complications of dengue fever.
   H_a: The new vaccine reduces the complications of dengue fever.
7. H_o: The enrolment in high school this school year did not increase by 10%.
   H_a: The enrolment in high school this school year increases by 10%.
8. H_o: The intelligence quotient of male grade 11 students is the same as the female students.
   H_a: The intelligence quotient of male grade 11 students is higher (or lower) than the female students.
9. H_o: Grade 7 students prefer online distance learning as the method of instructions.
   H_a: Grade 7 students did not prefer online distance learning as the method of instructions.
10. H_o: There was no increase in the number of students accessing the school library.
    H_a: There was an increase in the number of students accessing the school library.

Activity 1.2

1. one-tailed test
2. two-tailed test
3. two-tailed test
4. one-tailed test
5. one-tailed test
6. one-tailed test
7. two-tailed test
8. one-tailed test
9. one-tailed test
10. two-tailed test

Activity 1.3

1. acceptance
2. rejection
3. rejection
4. acceptance
5. rejection
6. rejection
7. acceptance
8. acceptance
9. rejection
10. rejection



Activity 1.4

1. They do not conclude that the solar panel is effective when it is actually effective.
2. They conclude that the solar panel is effective when it is not actually effective.
3. The owner closes the pool when it does not need to be closed.
4. The owner does not close the pool when it needs to be closed.
5. Type II Error

What I Have Learned

1. Hypothesis testing
2. hypothesis
3. disprove, reject, or nullify
4. null hypothesis
5. alpha (α)
6. the null hypothesis is true
7. two-tailed test
8. one-tailed test
9. reject the null hypothesis
10. Type I error

Assessment

16. D
17. C
18. D
19. B
20. A
21. C
22. D
23. D
24. D
25. A
26. D
27. A
28. D
29. A
30. A

The t-distribution Table

one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
Z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

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