Senior High School

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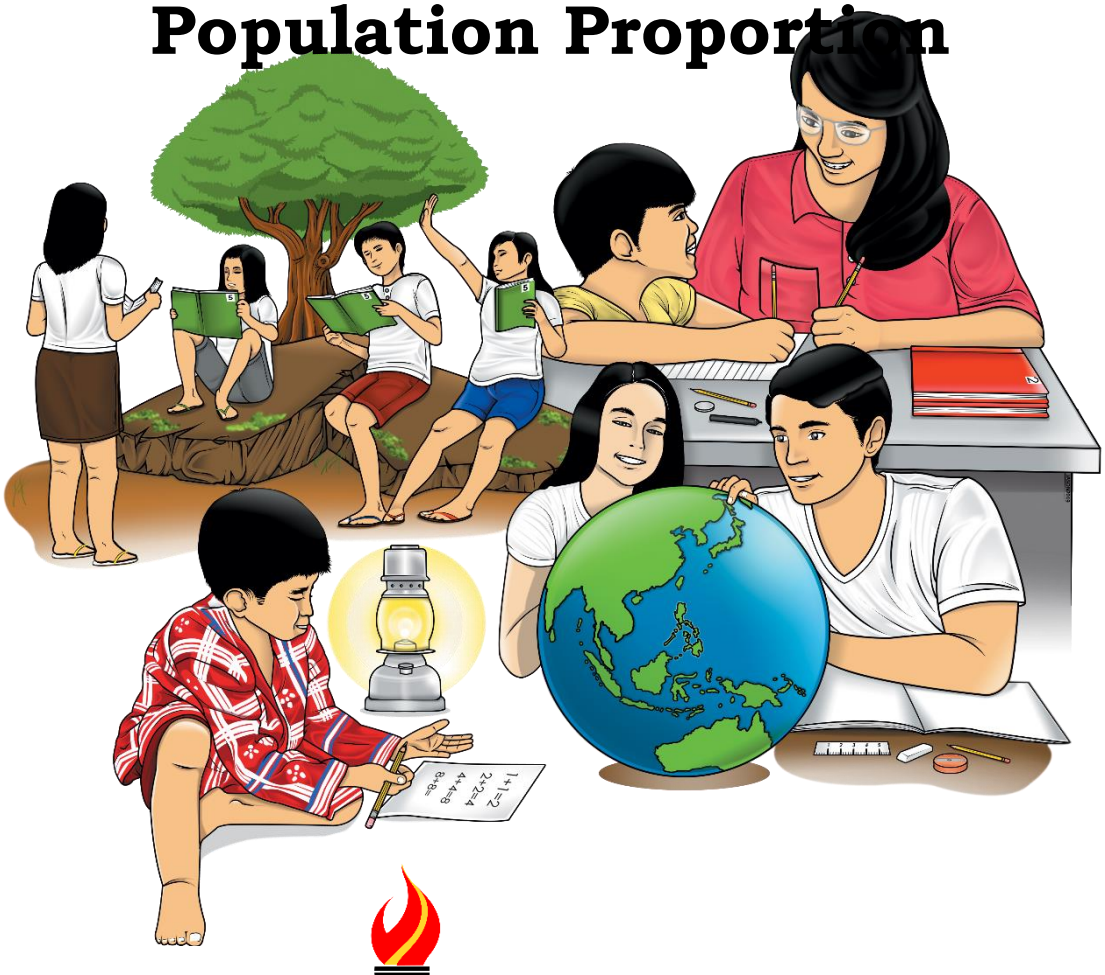
Statistics and Probability

Quarter 4 – Module 11: Identifying Appropriate Rejection Region Involving Population Proportion



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ADM

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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.

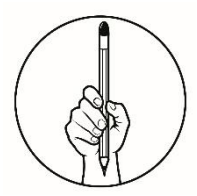
What I Need to Know

Recall that the normal curve evolves from the probability distribution. With the area under the curve being 1, it serves as a mathematical model in hypothesis testing. The areas are the probability value that we will need in decision-making on whether to accept or reject the hypothesis.

This module will help you identify the appropriate rejection region for a given level of significance when the Central Limit Theorem is to be used.

After going through this module, you are expected to:

1. determine the critical value using the given level of significance;
2. transform the alternative hypothesis from statement into symbols; and
3. illustrate and identify the rejection region under the normal curve.



What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following is a mathematical model used in decision-making?
   a. z-statistic
   b. proportion
   c. normal curve
   d. graphical representation

2. What is the alternative hypothesis in the statement below?
   "Less than 35% of the students are fluent Filipino language speakers."
   a. $p > 35$
   b. $p < 35$
   c. $p > 0.35$
   d. $p < 0.35$

3. Which of the following situations is non-directional?
   a. More than 45% of the barangay population is male residents.
   b. The proportion of ADHD students in the school decreased by 10%.
   c. The principal claims that 30% of Grade 4 students are in favor of staying in the playground after classes.
   d. There is enough evidence to conclude that the percentage of students who are in favor of the new uniform is different from 85%.

4. Which of the following is the critical value if the level of significance is 5% and tailed to the right?
   a. 0.125
   b. 0.165
   c. 1.645
   d. 1.960

5. It is the range of the values of the test value indicating that there is a significant difference and that the null hypothesis (H_o) should be rejected.
   a. critical value
   b. rejection region
   c. level of significance
   d. non-rejection region

6. It is the basis for the critical or rejection region dictated by the alternative hypothesis.
   a. critical value
   b. rejection region
   c. acceptance region
   d. level of significance

7. Which of the following terms does NOT describe a right-tailed test?
   a. more
   b. improve
   c. changed
   d. increased

8. The z-score value in the critical region means that you should _____.
   a. reject the null hypothesis
   b. not reject the null hypothesis
   c. reject the alternative hypothesis
   d. not reject the alternative hypothesis

9. Which is the alternative hypothesis (in notation) of the following statement? "Less than 4% of senior high school students take Statistics."
   a. H_a: $p > 0.4$
   b. H_a: $p < 0.4$
   c. H_a: $p > 0.04$
   d. H_a: $p < 0.04$

10. Which of the following is not an option for an alternative hypothesis?
   a. $H_a > k$
   b. $H_a = k$
   c. $H_a < k$
   d. $H_a \neq k$

11. Which of the following shows a non-directional test?
   a. $p = k$
   b. $p > k$
   c. $p \neq 0.4$
   d. $p < 0.4$

12. What is the critical value(s) for a two-tailed test with $\alpha = 0.05$?
   a. $z = -1.64$
   b. $z = \pm 0.06$
   c. $z = 1.64$
   d. $z = \pm 1.96$

For nos. 13-15, refer to the situation below.

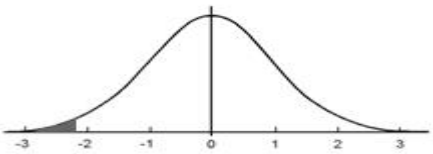
During the previous year, 55% of the people believed that there was an improvement in the country's economy. This year, only 280 out of 500 randomly selected people believe that there is an improvement in the country's economy. Using 0.05 level of significance, answer the following questions to determine if this indicates a decrease in the number of people who believe that there is an improvement in the country's economy.

13. Which of the following represents the alternative hypothesis?
   a. $H_a : p > 0.55$
   b. $H_a : p \neq 0.55$
   c. $H_a : p < 0.55$
   d. $H_a : p = 0.55$

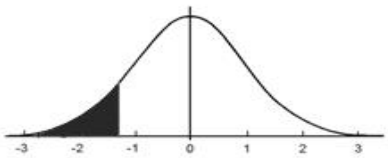
14. Which of the following is the critical value?
   a. –2.325
   b. –1.960
   c. –1.645
   d. –1.285

15. Which of the following shows the appropriate rejection region?

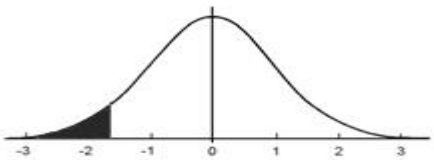
a. -2.325



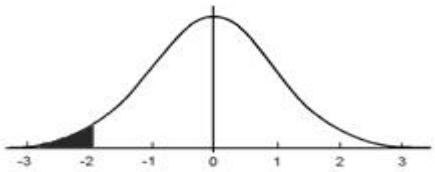
c. -1.285



b -1.645



d. -1.960



How did you find this pre-test? Did you encounter both familiar and unfamiliar terms? Kindly compare your answers in the Answer Key on the last part of this module.

If you got a perfect score or 100%, skip this module and proceed to the next one. But if you missed even a single point, please continue with this module as it will enrich your knowledge in hypothesis testing involving population proportion.

Lesson 1 Identifying Appropriate Rejection Region Involving Population Proportion

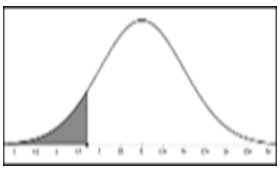
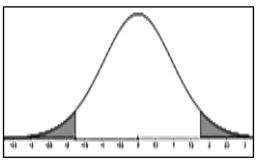
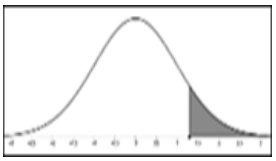
One part in testing hypothesis is determining if the results of a theory or the hypothesis from the experiment is probably true or statistically significant. To be able to do this, the rejection region or critical region will be employed. Every rejection region can be drawn on a probability distribution. Its image can be done using the normal curve. It can either be one-tailed or two-tailed rejection region. More specifically, one-tailed rejection region can be left-tailed or right-tailed. Now, how can we determine the rejection regions? Let us find

What's In

Activity 1: Where Do I Belong?

The following are the common terms or phrases used to describe whether the alternative hypothesis (*Ha*) is directional or non-directional such as *right-tailed, left-tailed,* or *two-tailed.* Copy the table and write each under the group where it should belong.

higher	lower	changed	different
better	worsened	more	increased
varied	less	affects	improve
effective	greater than	less than	influences
favored	not equal to	smaller	decreased
not the same as			

	Left –Tailed	**Two – Tailed**	**Right – Tailed**
			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Notes to the Teacher

This lesson is simply about finding the critical value and illustrating the rejection region. Making conclusions whether to accept or reject is included in the scope of Module 13. If the learner did not pass the assessment, please give them more practice activities on how to determine the critical value and illustrate the rejection region. Otherwise, the learner may not be able to make a conclusion.

What's New

Activity 2: Tail Me Now

In each of the following statements, formulate *the alternative hypothesis (H_a).* Then, determine if it describes *two-tailed, right-tailed, or left-tailed.* The first one is done for you as an example.

1. The hypothesis that less than 20% of the population is right-handed
   H_a: $p < 0.20$; left – tailed

2. The hypothesis that the proportion of ADHD students in the school is not 0.40
   _____ ; _____

3. The hypothesis that more than 45% of the barangay population is male residents
   _____ ; _____

4. The claim that less than 35% of the students are fluent Filipino language speakers
   _____ ; _____

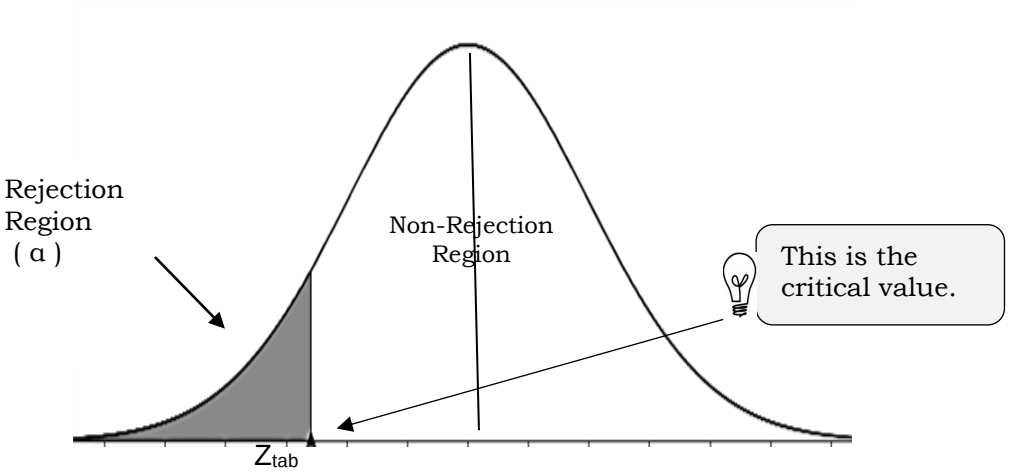
5. The principal's claim that 30% of Grade 4 students stay in the playground after classes
   _____ ; _____

6. The hypothesis that there is enough evidence to conclude that the percentage of students who are in favor of the new uniform is different from 85%
   _____ ; _____

What is It

There are two ways to test the hypothesis: with a p-value approach and with a critical value approach. Here, we will consider the rejection region with the critical value approach. The critical value enables us to reject or not the null hypothesis. Also, it is calculated through alpha (α) levels and symbolized by Z or Z_{tab}.

This is the first statement in Activity 2: "*The hypothesis that less than 20% of the population is right-handed"* wherein H_a: $p < 0.20$ and it indicates a left-tailed rejection region. Illustrating it in the normal curve, we will come up with the picture below:



The illustration above is for you to visualize how the statement would look like when put into the normal curve. Notice that the line represented by z_{tab} separates the curve into two regions. The shaded part is the rejection region while the non-shaded part is the non-rejection region or the acceptance region/area. Therefore, it is important that we determine the value of z_{tab} or the critical value. Now, let us proceed!

Let us now describe the following important terms that we will be using in our discussion.

Critical Value, z_{tab}

- separates the rejection region from the acceptance region
- derived from the level of significance and expressed as the standard z-values
- symbolized as $\mathbf{z_{tab}}$

We can use the table of critical values for the commonly used levels of significance presented in the previous modules.

Test Type	Level of Significance			
	$\alpha = 0.01$	$\alpha = 0.025$	$\alpha = 0.05$	$\alpha = 0.10$
left-tailed test	-2.33	-1.96	-1.645	-1.28
right-tailed test	2.33	1.96	1.645	1.28
two-tailed test	± 2.575	± 2.33	± 1.96	± 1.645

Level of Significance, α (Greek letter, alpha)

- the degree of significance in which we reject or do not reject the null hypothesis
- the basis for the critical or the rejection region dictated by the alternative hypothesis

The following are the common values of statistical significance:

- 0.01 highly significant
- 0.05 statistically significant
- 0.10 significant

For instance, if we use 0.05 level of significance, then the size of the rejection region is 0.05 or 5%.
For α = .01, then the size of the rejection region is 1%, and 10% for 0.10.

Rejection Region

- the range of the values of the test value which indicates that there is a significant difference and that the null hypothesis (H_o) should be rejected

Non-Rejection Region

- the range of the values of the test value which indicates that the difference was statistically insignificant and that we failed to reject the null hypothesis (H_o)

Illustrative Example1:

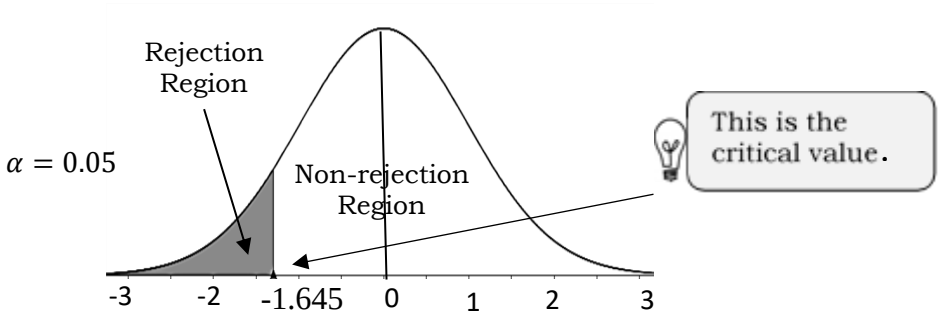
A sample of 100 students is randomly selected from Pinagpala High School and 18 of them said they are left-handed. Test the hypothesis that less than 20% of the students are left-handed by using $\alpha = 0.05$ as the level of significance.

What to do:

a. Identify the level of significance.
b. Formulate the alternative hypothesis, H_a.
c. Determine the critical value, z_{tab}.
d. Illustrate the rejection region in the normal curve.

Solution:

a. The level of significance is $\alpha = 0.05$.
b. The alternative hypothesis is H_a: $p < 0.20$.
   It is one directional or left-tailed as determined by the term "*less than*".
c. To determine the critical value using the table, we consider the intersection of the row for the left-tailed test and the column for = 0.05. Hence, the table tells us that the critical value is ***– 1.645***.
d. Illustrating it under the normal curve makes:



From here, you will decide whether the null hypothesis will be rejected or not, although that part will be discussed in the next module.

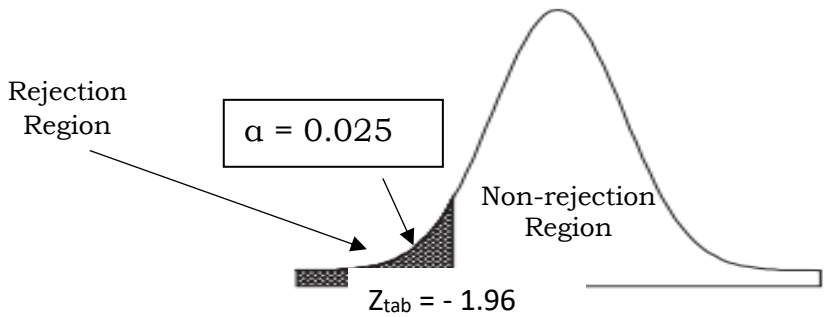
Illustrative Example 2:

The claim is made that 40% of tax filers use computer software to file their taxes. In a sample of 50 tax filers, 14 used computer software to file their taxes. If Ha: $p < 0.40$ at $\alpha = 0.025$ where p is the population proportion who use computer software to file their taxes. Determine the critical value, $\boldsymbol{Z_{tab}}$ and illustrate the rejection region in the normal curve.

Solution:

At $\alpha = 0.025$ level of significance, with $p < 0.40$, by referring to the table of the Level of Significance, it shows that the critical value or $\boldsymbol{Z_{tab} = -1.96}$

Illustrating the rejection region, we have



Illustrative Example 3:

In Kalinga Special Education School, a sample of 144 students was chosen and among them, 48 were diagnosed with Attention Deficit Hyperactivity Disorder (ADHD). At $\alpha = 0.01$, test the hypothesis that the proportion of ADHD students in the school is not 0.40.

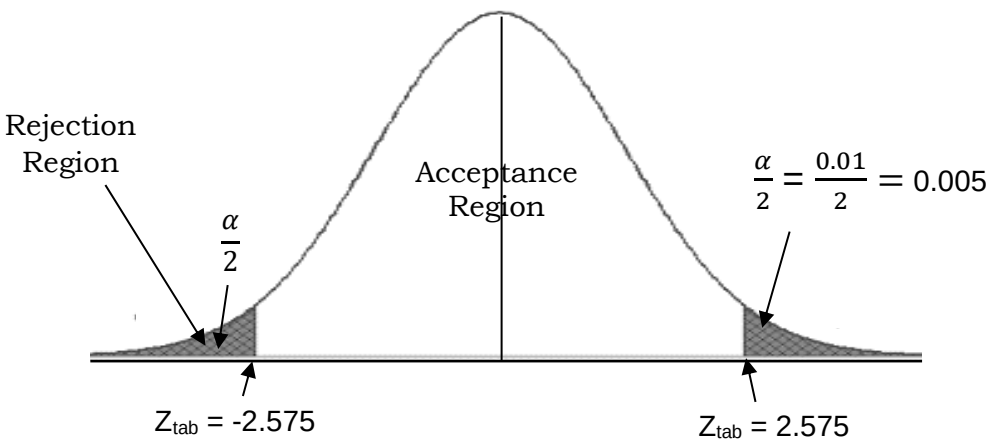
What to do:

a. Identify the level of significance.
b. Formulate the alternative hypothesis, $\boldsymbol{H_a: p \neq p_o}$.
c. Determine the critical value.
d. Illustrate the rejection region in the normal curve.

When a statement did not specify any cue word that describes direction, then it is non-directional or two-tailed.

Solution:

a. The level of significance is $\alpha = 0.01$.
b. The alternative hypothesis is $p \neq 0.40$ due to the expression "*is not 0.40*". This explains why it is non-directional or two-tailed.
c. To determine the critical value using the table, we consider the intersection of the row for the two-tailed test and the column for $\alpha = 0.01$. Hence, the table tells us that the critical value is $\boldsymbol{\pm 2.575}$.
d. Illustrating the rejection region in the normal curve gives:



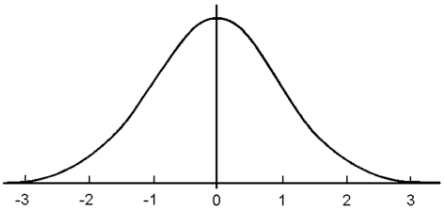
What's More

Activity 3.1: Be Critical!

Determine the critical value and illustrate the rejection region under the normal curve by using the given information.

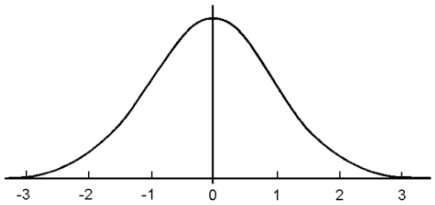
1. H_a: $p \neq 0.52$
   $\alpha = 0.05$

   Critical Value: _____



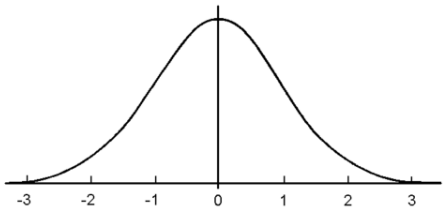
2. Ha: $p > 0.35$
   $\alpha = 0.01$

   Critical Value: _____



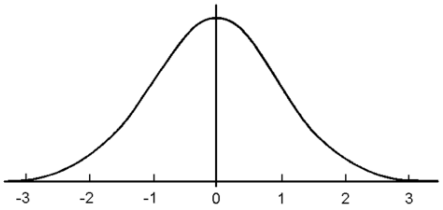
3. Ha: $p < 0.70$
   $\alpha = 0.10$

   Critical Value: _____



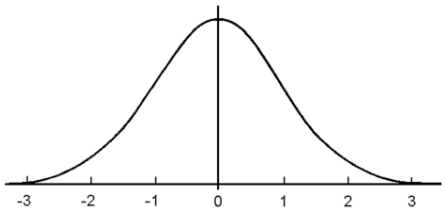
4. Ha: $p > 0.65$
   $\alpha = 0.10$

   Critical Value: _____



5. Ha: $p \neq 0.46$
   $\alpha = 0.05$

   Critical Value: _____



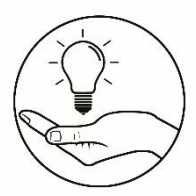
Activity 3.2. Be Quick!

The following are the different critical values under the various level of significance and tails. By using their respective codes, tell the direction of their tail and the corresponding level of significance. Your answer will be a combination of codes, tail and α. Set time limit.

L: Left – tailed
R: Right – tailed
T: Two - tailed

1: α = 0.01
25: α = 0.025
5: α = 0.05
10: α = 0.10

	Z_{tab}	Answer		Z_{tab}	Answer
Ex.	±2.33	T25			
1	1.96		6	1.645	
2	1.28		7	−2.33	
3	−1.645		8	±1.96	
4	2.33		9	±2.575	
5	±1.645		10	−1.96	



What I Have Learned

A. Fill in each blank with the correct word or phrase to complete the statement.

1. The range of the values of the test value which indicates that there is a significant difference and that the null hypothesis (H_o) should be rejected is called _____.
2. The basis for the critical or the rejection region dictated by the alternative hypothesis is called _____.
3. The _____ separates the rejection region from the non-rejection region.
4. The _____ is the range of the values of the test value which indicates that the difference was statistically insignificant and that we failed to reject the null hypothesis (H_o).
5. The _____ is the symbol used to represent the critical value.

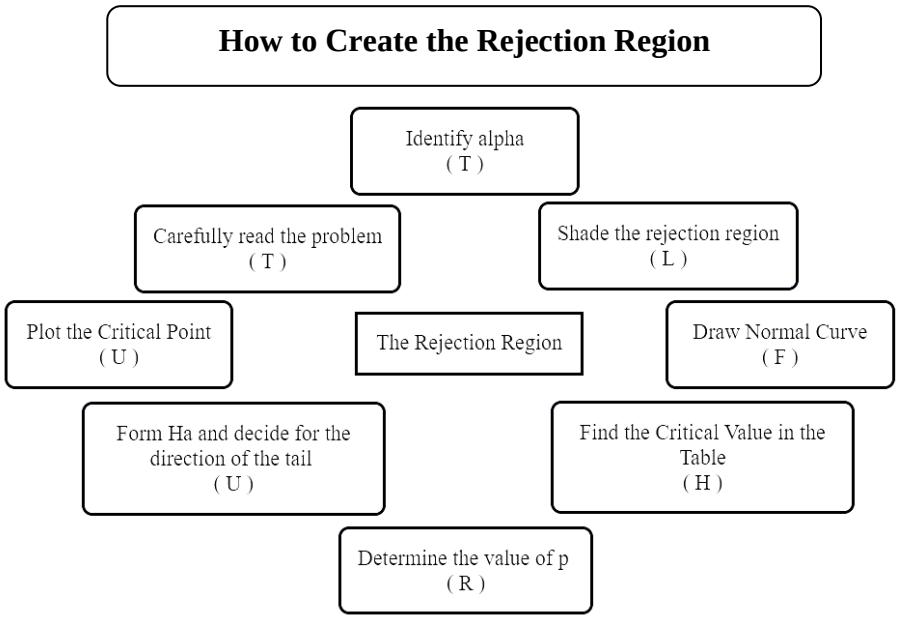
B. Carefully read and answer the following questions

1. Is it true that if the rejection region is two-tailed, α needs to be divided by 2 to be able to identify the rejection region?
2. The computed value should be negative if the rejection region is right-tailed. Is it true? Explain.
3. A 0.01 level of significance means that the size of the rejection region is 10%. Is this correct? Why?
4. If a problem does not indicate any term of direction, it is non-directional or two-tailed. Is it true or false?
5. In a right-tailed test, what is the critical value at $\alpha = 0.10$?

What I Can Do

Activity 4.1: The Mystery Word

The following are the steps in creating the rejection region in testing hypothesis for population proportion. Arrange them in their best order by writing the codes indicated in each. What is the mystery word?



Steps	1	2	3	4	5	6	7	8
Answer								

Activity 4.2: Borderline

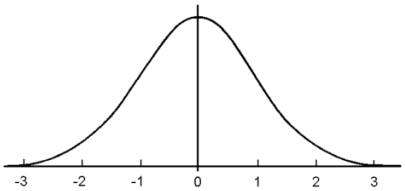
Carefully read and analyze the following situations. Identify the information being asked. Then, determine the critical value and shade the area of the rejection region under the normal curve.

1. Suppose that in the past, 40% of all adults favored capital punishment. Do we have reason to believe that this proportion has increased if in a random sample of 150 adults, 80 favored capital punishmen nce.

   Ha: _____

   α = _____

   Critical Value: _____

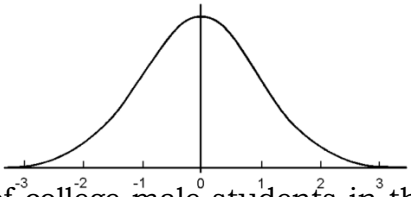


2. Professors from a professional organization for private colleges and universities reported that more than 16% of professors attended a national convention in the past year. To test this claim, a researcher surveyed 200 professors and found that 50 attended a national convention in the past year. At $\alpha = 0.10$, test if the figure in the claim is correct.

   Ha: _____

   α = _____

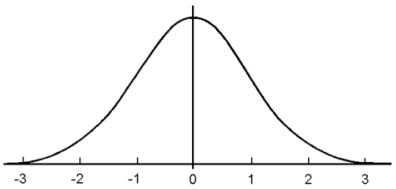
   Critical Value: _____



3. Malakas made a claim that at least 5% of college male students in their school join triathlon. His friend, Mayumi, finds this hard to believe and decided to check the validity of such claim, so she took a random sample.
   At 0.01, does Mayumi provide enough indication to reject the claim of Malakas if there were 60 racers in her sample of 300 evidences?

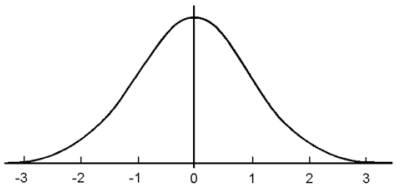
   Ha: _____
   α = _____

   Critical Value: _____



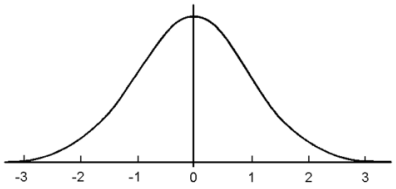
4. A pharmaceutical company is on the first phase of testing a vaccine for a new virus. They form a group consists of 100 people each who have a disease and given a vaccine. It is found out that, 65 recovered from the disease. At significance level of 0.01, determine the critical value and illustrate the rejection region.

   Ha: _____
   α = _____
   Critical Value: _____



5. A sample poll of 300 voters from Town A showed that 56% were in favor of a given candidate. At a significance level of 0.10, determine the critical value and illustrate the rejection region.

   Ha: _____
   α = _____
   Critical Value: _____



Assessment

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. When the confidence level is 99%, α is ___.
   a. 0.01 b. 0.05 c. 0.10 d. 0.50

2. Which is the alternative hypothesis for the following statement?
   "More than 65% of the students are fluent Filipino language speakers."
   a. $p > 65$ b. $p < 65$ c. $p > 0.65$ d. $p < 0.65$

3. Which of the following situations is directional?
   a. A teacher wants to know if listening to popular music affects the performance of the pupils.
   b. The principal claims that more than 30% of Grade 4 students are in favor of staying in the playground after classes.
   c. The owner of a factory that sells a particular bottled juice drink claims that the content of his product is 250ml.
   d. There is enough evidence to conclude that the percentage of students who are in favor of the new uniform is different from 85%.

4. Which of the following is the critical value if the level of significance is 0.01 tailed to the right?
   a. 2.330 b. 2.325 c. 2.320 d. 2.315

5. It is the range of the values of the test value which indicates that there is significant difference and that the null hypothesis (H_o) should be rejected.
   a. critical value
   b. rejection region
   c. level of significance
   d. non-rejection or acceptance region

6. What graphical model is appropriate for decision-making?
   a. bell shape c. normal curve
   b. test statistic d. graphical representation

7. It separates the rejection region from the acceptance region.
   a. critical value c. acceptance region
   b. rejection region d. level of significance

8. Which of the following terms does NOT describe a left-tailed rejection region?
   a. lower
   b. worsened
   c. decreased
   d. influences

9. Which of the following terms does NOT describe a non-directional rejection region?
   a. at most
   b. effective
   c. different
   d. not the same as
   c.

10. A farmer believes that using organic fertilizer on his plants will yield a greater income. His income increased by 20% from last year. State the alternative hypothesis in symbols.
   a. H_a: $p < 0.02$
   b. H_a: $p > 0.02$
   c. H_a: $p > 0.20$
   d. H_a: $p < 0.20$

11. Which of the following represents the critical value?
   a. C_V b. C_{com} c. Z_{tab} d. Z_{com}

12. What is the critical value(s) for a left-tailed test with $\alpha = 0.01$ level of significance?
   a. –2.325 b. –1.960 c. –1.645 d. –1.285

For nos. 13-15, refer to the situation below.

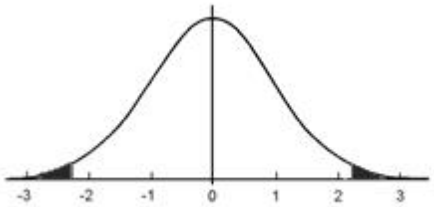
A researcher claims that 75% of college students would rather spend their extra money for internet access loads than food. Another researcher would like to verify this claim. She randomly selected 400 students. Among them, 296 said that they would rather use their extra money for internet access loads than food. Answer the following questions to determine if there is enough evidence to conclude that the percentage of students who would want to spend their extra money in internet access loads than food is different from 75% at 0.05 level of significance.

13. Which of the following represents the alternative hypothesis?
   a. $H_a : p > 0.75$
   b. $H_a : p < 0.75$
   c. $H_a : p \neq 0.75$
   d.. $H_a : p = 0.75$

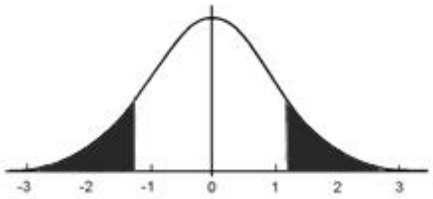
14. Which of the following is the critical value?
   a. ± 2.325 b. ± 1.960 c. ± 1.645 d. ± 1.245

15. Which of the following shows the appropriate rejection region?

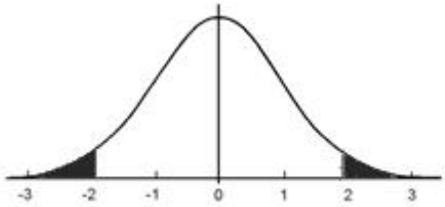
a. -2.325



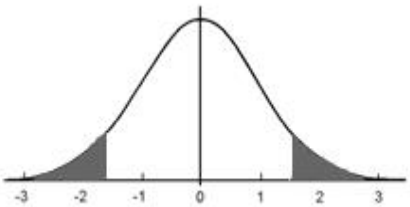
c. -1.285



b. - 1.960



d. -1.645



Additional Activities

Activity 4. Think and Reflect

1. In your own words, describe the following:
   a) critical value
   b) rejection region

2. What do you think will your conclusion be if the computed test statistic (Z_{com}) is found outside the rejection region?

3. Explain: A rejection is a chance to consider if there are things we can possibly work on.

"Rejection is merely a redirection; a course correction to your destiny."

~Bryant H. Mc.Gil

Answer Key

What I Know

1. A
2. D
3. D
4. C
5. B
6. D
7. C
8. A
9. D
10. B
11. C
12. D
13. C
14. C
15. B

Tail Me Now

1	set as example	set as example
2	H_a: $p \neq 0.40$	two-tailed
3	H_a: $p > 0.45$	right-tailed
4	H_a: $p < 0.35$	left-tailed
5	H_a: $p \neq 0.30$	two-tailed
6	H_a: $p \neq 0.85$	two-tailed

What I Have Learned

A.

1. rejection region
2. level of significance
3. critical value
4. non-rejection region
5. Z_{tab}

B.

1. Yes
2. No, it should be positive.
3. No, 1%
4. True
5. 1.28

ASSESSMENT

1. A
2. C
3. B
4. B
5. B
6. C
7. A
8. D
9. A
10. C
11. C
12. A
13. C
14. B
15. B

The Mystery Word

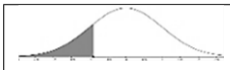
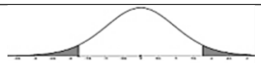
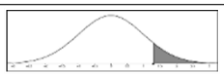
TRUTHFUL

Be Quick

1. R25
2. R10
3. L5
4. R1
5. T10
6. R5
7. L1
8. T5
9. T1
10. L25

Be Critical	BORDERLINE
1. $z_{tab} = \pm 1.96$ 	1. H_a: $p>0.40$ $\alpha = 0.05$ $z_{tab} = 1.645$ 
2. $z_{tab} = 2.325$ 	2. H_a: $p>0.16$ $\alpha = 0.10$ $z_{tab} = 1.285$ 
3. $z_{tab} = -1.285$ 	3. H_a: $p<0.05$ $\alpha = 0.01$ $z_{tab} = -2.325$ 
4. $z_{tab} = 1.28$ 	4. H_a: $p\neq 0.50$ $\alpha = 0.01$ $z_{tab} = \pm 2.576$ 
5. $z_{tab} = \pm 1.96$ 	5. H_a: $p\neq 0.56$ $\alpha = 0.10$ $z_{tab} = \pm 1.645$ 

Where Do I Belong?

		
worsened less lower less than decreased smaller	not equal to affect changed influence not the same as different varied	higher greater than more increased improve favored effective better

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