

# Chapter 21: More Hypothesis Tests

1. A statistics professor has observed that for several years about 13% of the students who initially enroll in her Math 140 course withdraw before the end of the semester. A salesman suggests that she try a statistics software package that gets students more involved with computers, predicting that it will cut the dropout rate. The software is expensive, and the salesman offers to let the professor use it for a semester to see if the dropout rate goes down significantly. The professor will have to pay for the software only if she chooses to continue using it.

a) Is this a one-tailed or two-tailed hypothesis test? Explain.

**One-tailed. Software is supposed to decrease the dropout rate.**

b) Write the null and alternative hypotheses.

$H_0: p = .13$        $H_A: p < .13$

c) In this context, explain what would happen if the professor makes a Type I error.

**She buys the software, but the software doesn't help the students. (Reject  $H_0$ , but  $H_0$  was true).**

d) In this context, explain what would happen if the professor makes a Type II error.

**She doesn't buy the software, but the software would have helped the students. (Fail to reject  $H_0$ , but  $H_0$  was false).**

e) What would the power of the test represent in this context?

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**The power is the probability of correctly deciding the software is helpful. (Reject  $H_0$  when  $H_0$  is false)**

f) Initially 203 students signed up for the Stats course. They used the software suggested by the salesman, and only 11 dropped out of the course. Should the professor spend the money for this software? Support your recommendation with an appropriate test.

**Using the null and alternative given above, we enter the sample data into Minitab.**

Test of  $p = 0.13$  vs  $p < 0.13$

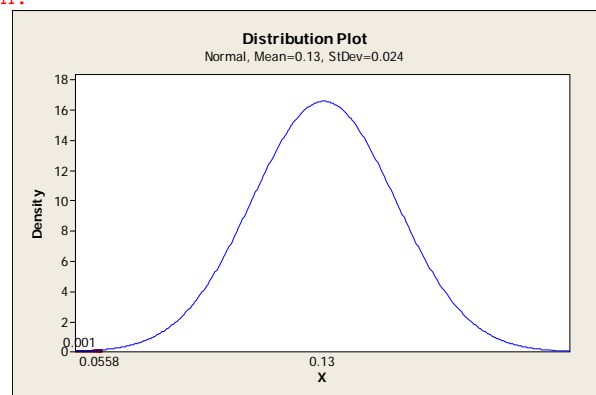
| Sample | X  | N   | Sample p | 95% Upper Bound | Z-Value | P-Value |
|--------|----|-----|----------|-----------------|---------|---------|
| 1      | 11 | 203 | 0.054187 | 0.080323        | -3.21   | 0.001   |

Using the normal approximation.

**Model:      Mean = .13  
SD = 0.024  
Left-Tail Shaded**

**Test statistic: -3.21. P-value: 0.001.**

**Since the p-value is low, we reject  $H_0$ . Therefore, there is significant evidence to suggest that the professor should spend the money for the software.**



g) How much lower than 13% was the proportion who dropped out? (Hint: This means confidence interval...)

**Note: If you tested the above at 5%, the corresponding confidence level is 90%.**

| Sample | X  | N   | Sample p | 90% CI               | Z-Value | P-Value |
|--------|----|-----|----------|----------------------|---------|---------|
| 1      | 11 | 203 | 0.054187 | (0.028052, 0.080323) | -3.21   | 0.001   |

Using the normal approximation.

**The 90% confidence interval is (2.8%, 8.0%). Therefore, we are 90% confident that the percent who drop out is between 2.8% and 8.0 %.**

h) Explain what your p-value means in this context.

**The probability of observing 11 or fewer dropouts in a class of 203 is only 0.1% if the dropout rate really is 13%.**

2. A company manufacturing computer chips finds that 8% of all chips manufactured are defective. Management is concerned that employee inattention is partially responsible for the high defect rate. In an effort to decrease the percentage of defective chips, management decides to offer incentives to employees who have lower defect rates on their shifts. The incentive program is instituted for one month—if successful, the company will continue with the incentive program.
- Write the company's null and alternative hypotheses.  
 $H_0: p = 0.08$        $H_A: p < 0.08$
  - In this context, describe a Type I error and the impact such an error would have on the company.  
*A Type I error would be deciding the percentage of defective chips has decreased, when it has not. The company would waste money on a new incentive program that does not decrease the defect rate of the chips.*
  - In this context, describe a Type II error and the impact such an error would have on the company.  
*A Type II error would be deciding the percentage of defective chips has not decreased, when it has. The company would miss an opportunity to decrease the defect rate of the chips.*
  - Based on the data they collected during the trial program, management found that a 95% confidence interval for the percentage of defective chips was (5%, 7%). What conclusion should management reach about the new incentive program? Explain.  
*The confidence interval contains values that are below the hypothesized value of 8%, so the data provide convincing evidence that the incentive program lowers the defect rate of the computer chips.*
  - What level of significance did management use?  
*Because they are conducting a 1-sided test, the level of significance is 2.5%*
  - Describe to management an advantage and disadvantage of using a 2% alpha level of significance instead.  
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*Note: If you're having a hard time with the balancing act of power and alpha levels, use the applet in class... For this problem you will want to make the red region smaller to indicate a decrease in alpha level.*  
  
*Advantage: Management would be more likely to think the incentive program were not effective, even if it were. Therefore, they could stop spending money on it.*  
  
*Disadvantage: Power would decrease... The test would have less power to detect a positive effect of the new incentive program.*
  - Management decided to extend the incentive program so that the decision can be made on three months of data instead. Will the power increase, decrease, or remain the same?  
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*Power would increase because of the larger sample size.*
  - Over the trial month, 6% of the computer chips manufactured were defective. Management decided that this decrease was significant. Why might management choose not to permanently institute the employee incentive program?  
*Although statistically significant, the practical significance (cost of the incentive program compared to the savings due to the decrease in defect rate of chips) might not be great enough to institute the program permanently.*