

## Mock FRQ #6

93% of students in Mr. Adkins AP statistics class turn in their assignments on time, 85% of Mr. Adkins AP statistics students turn in their assignments with every problem completed, and 80% of Mr. Adkins AP statistics students turn in their assignments on time and with every question completed. Assume that assignment submissions are independent.

- (a) Given that a randomly selected assignment is turned in late, what is the probability that every problem was completed?

L = Late, C = Completed

$$P(C|L) = \frac{P(C \cap L)}{P(L)} = \frac{0.05}{0.07} = \frac{5}{7}$$

- (b) If Mr. Adkins randomly selects student assignments one at a time, what is the probability that the first assignment he finds that is not turned in on time with every question completed is one of the first 5 selected?

X = Number of assignments checked before a late or incomplete is found

X is geometric with  $p = 0.2$

$$\begin{aligned} P(X \leq 5) &= \text{geomcdf}(p = 0.2, X = 5) \\ &= (0.2) + (0.8)(0.2) + (0.8)^2(0.2) + (0.8)^3(0.2) + (0.8)^4(0.2) \\ &= 1 - (0.8)^5 = 0.67232 \end{aligned}$$

OR

X is binomial with  $n = 5$  and  $p = 0.2$

$$P(X \geq 1) = 1 - P(X = 0) = 1 - (.8)^5 = 0.67232$$

- (c) Mr. Adkins has 70 total AP statistics students. Describe the distribution of the proportion of papers that are turned in complete and on time for a randomly chosen assignment.

Sampling Distribution of the sample proportion with  $p = 0.8$  and  $n = 70$

Center:  $\mu_{\hat{p}} = p = 0.8$  since the assignment was randomly chosen

Spread:  $\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{0.8(0.2)}{70}} = 0.0478$  since one assignment <10% of all assignments

Shape: approximately normal since  $np = (70)(0.8) = 56 > 10$  and  $n(1-p) = (70)(0.2) = 14 > 10$

- (d) Explain how you would conduct a simulation to estimate the probability that at least 68 of Mr. Adkins 70 AP statistics students would turn an assignment in on time.

$P(\text{on time}) = .93$

Using random digits 1-100, assign 1-93 to indicate an assignment was turned in on time and 94-100 to a late assignment. Use a computer to select 70 random numbers from 1-100 and look to see if more than 2 of them are between 94-100. If no, then the result is a success. Repeat this process many times and record the proportion of successes that are observed. This proportion is the estimate of the probability.

Because of the coronavirus crisis, Mr. Adkins AP statistics classes are now involved in remote learning, and Mr. Adkins is worried that the proportion of assignments that are completed and on time has decreased. To see if this is true, Mr. Adkins randomly selects 50 student assignments from before the remote learning began and randomly selects 50 student assignments from after remote

learning started. He finds that 37 of the assignments from the traditional school group were completed and on time, while only 30 of the assignments from the remote learning group were completed and on time. Use this information to answer the following questions.

(e) Identify the explanatory and response variables in Mr. Adkins' study.

Explanatory: **learning method (traditional or remote)**

Response: **assignment completed and on time (yes or no)**

(f) Was Mr. Adkins' study an observational study or an experiment? Explain.

**This is an observational study. Mr. Adkins did not break the class into treatment and control groups. He simply recorded results from before and after the remote learning began. No manipulation of treatments took place.**

(g) Describe a method by which Mr. Adkins could use a matched pairs design to improve his study.

**Mr. Adkins could choose individual students at random and compare each student's assignment completion percentage before the switch to remote learning with their percentage after the switch. Each student would then be paired with themselves.**

(h) Mr. Adkins wants to use the results of his study to construct a 95% confidence interval for the difference in the proportion of assignments completed and on time for the traditional school group and the remote learning group. Confirm that all appropriate conditions have been satisfied.

**Random – problem stated separate random samples from before and after change in learning method.**

**Independence – Need to assume that there were at least 500 assignment submissions before and after the switch so that  $50 < 10\%$  of all assignments is satisfied.**

**Normality – There were 37 successes and 13 failures in the traditional group, and 30 success and 20 failures in the remote group. All are greater than 10.**

The confidence interval from part (h) is calculated to be  $(-0.0423, 0.3223)$ . Interpret the results of this confidence interval in the context. Based on the results of this confidence interval do you believe there is convincing evidence that the proportion of students turning in assignments complete and on time has decreased since remote learning began.

**We can be 95% confident that the proportion of assignments completed and on time for the traditional school is between 4.23% less and 32.23% more than that of the remote school group. Because this confidence interval includes zero, we do not have convincing evidence of a difference in proportions of complete and on time assignments between the 2 groups.**