**STATISTICS**
**SECTION II**
**Part B**
**Question 6**
**Spend about 25 minutes on this part of the exam.**
**Percent of Section II score—25**

**Directions:** Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

6. Administrators in a large school district wanted to determine whether students who attended a new magnet school for one year achieved greater improvement in science test performance than students who did not attend the magnet school. Knowing that more parents would want to enroll their children in the magnet school than there was space available for those children, the district administrators decided to conduct a lottery of all families who expressed interest in participating. In their data analysis, the administrators would then compare the change in test scores of those children who were selected to attend the magnet school with the change in test scores of those who applied to attend the magnet school but who were not selected.



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The tables below show the scores on the same science pretest and the same science posttest for 20 students. Of the 20 students, 8 were randomly selected from the magnet school and 12 were randomly selected from those who applied to attend the magnet school but who were not selected and then attended their original school.

| Magnet School | | |
|---|---|---|
| Pretest Score | Posttest Score | Posttest − Pretest |
| 80 | 97 | 17 |
| 78 | 98 | 20 |
| 86 | 84 | −2 |
| 78 | 79 | 1 |
| 64 | 89 | 25 |
| 71 | 77 | 6 |
| 71 | 83 | 12 |
| 73 | 88 | 15 |
| $\bar{x}$ = 75.125 | $\bar{x}$ = 86.875 | $\bar{x}$ = 11.750 |
| $s$ = 6.770 | $s$ = 7.699 | $s$ = 9.407 |

| Original School | | |
|---|---|---|
| Pretest Score | Posttest Score | Posttest − Pretest |
| 83 | 80 | −3 |
| 80 | 89 | 9 |
| 63 | 65 | 2 |
| 79 | 78 | −1 |
| 83 | 93 | 10 |
| 77 | 79 | 2 |
| 66 | 70 | 4 |
| 80 | 84 | 4 |
| 73 | 80 | 7 |
| 90 | 90 | 0 |
| 77 | 78 | 1 |
| 90 | 91 | 1 |
| $\bar{x}$ = 78.417 | $\bar{x}$ = 81.417 | $\bar{x}$ = 3.000 |
| $s$ = 8.207 | $s$ = 8.512 | $s$ = 3.977 |

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## Question 6 (continued)

Component 3: Performs correct mechanics, which include the value of the test statistic and *p*-value (or rejection region): $t = \dfrac{\bar{x}_M - \bar{x}_O}{\sqrt{\dfrac{s_M^2}{n_M} + \dfrac{s_O^2}{n_O}}} = \dfrac{11.75 - 3}{\sqrt{\dfrac{88.55}{8} + \dfrac{15.84}{12}}} \approx 2.487$

with a (one-sided) *p*-value ≈ 0.0177, df ≈ 8.69.

Component 4: Draws an appropriate conclusion in context and with linkage to the *p*-value (or rejection region):

Using $\alpha = 0.05$, we reject $H_0$ because 0.0177 < 0.05. We conclude that the sample data provide convincing evidence that students who attend the magnet school have a higher mean difference in test scores than students who attend the original school.

**Part (b):**

Let *y* = posttest score and *x* = pretest score.

(i). The predicted regression equation for the magnet school is $\hat{y} = 73.27 + 0.1811x$. For students at the magnet school, a 1-point increase in the pretest score is associated with a predicted increase of 0.1181 points on the posttest (i.e., the slope is positive but close to zero).

(ii). The predicted regression equation for the original school is $\hat{y} = 9.24 + 0.9204x$. For students at the original school, a 1-point increase in the pretest score is associated with a predicted increase of 0.9204 points on the posttest (i.e., the slope is positive and close to 1).

**Part (c):**

(i). The test statistic is *t* = 0.40 with a ***p*-value of 0.706**. Because the *p*-value is greater than any reasonable significance level, say 0.05, we fail to reject $H_0$. We conclude that there is insufficient evidence to state that pretest score is a significant predictor of posttest score at the magnet school. The data do not support a conclusion that a correlation exists between pretest and posttest scores at the magnet school.

(ii). The test statistic is *t* = 6.09 with a ***p*-value of 0.000**. Because the *p*-value is less than any reasonable significance level, say 0.05, we reject $H_0$ and conclude that there is sufficient evidence to state that pretest score is a significant predictor of posttest score at the original school. The data support a conclusion that a correlation exists between pretest and posttest scores at the original school.

**Part (d):**

Unlike the two-sample analysis of differences in part (a), the regression analyses allow us to explore the relationship between pretest and posttest scores at each school. From the regression output and graph, we see that students with low pretest scores benefit more from attending magnet schools, as compared with students with low pretest scores at the original school. Also at the magnet school, students with low pretest scores benefit more than students with high pretest scores. In other words, students at the magnet school all score high on the posttest, regardless of how they scored on the pretest. But at the original school, only students who scored high on the pretest scored high on the posttest.

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## Question 6 (continued)

**Scoring**

Parts (a), (b), (c), and (d) are scored as essentially correct (E), partially correct (P), or incorrect (I).

**Part (a)** is scored as follows:

Essentially correct (E) if all four components are correct.

Partially correct (P) if two or three components are correct.

Incorrect (I) if at most one component is correct.

**Part (b)** is scored as follows:

Essentially correct (E) if all four components—both equations and both interpretations in (i) and (ii)—are correct.

Partially correct (P) if two or three components are correct.

Incorrect (I) if at most one component is correct.

**Part (c)** is scored as follows:

Essentially correct (E) if all four components—both *p*-values and both conclusions in (i) and (ii)—are correct.

Partially correct (P) if two or three components are correct.

Incorrect (I) if at most one component is correct.

**Part (d)** is scored as follows:

Essentially correct (E) if the response clearly explains how the regression analyses provide additional information in this context **by addressing the impact of the magnet school on students with low pretest scores.**

Partially correct (P) if the response clearly describes how the regression analyses provide additional information in context but does not explain the impact of the magnet school on students with low pretest scores.

Incorrect (I) if the response does not meet the criteria for an E or P.