

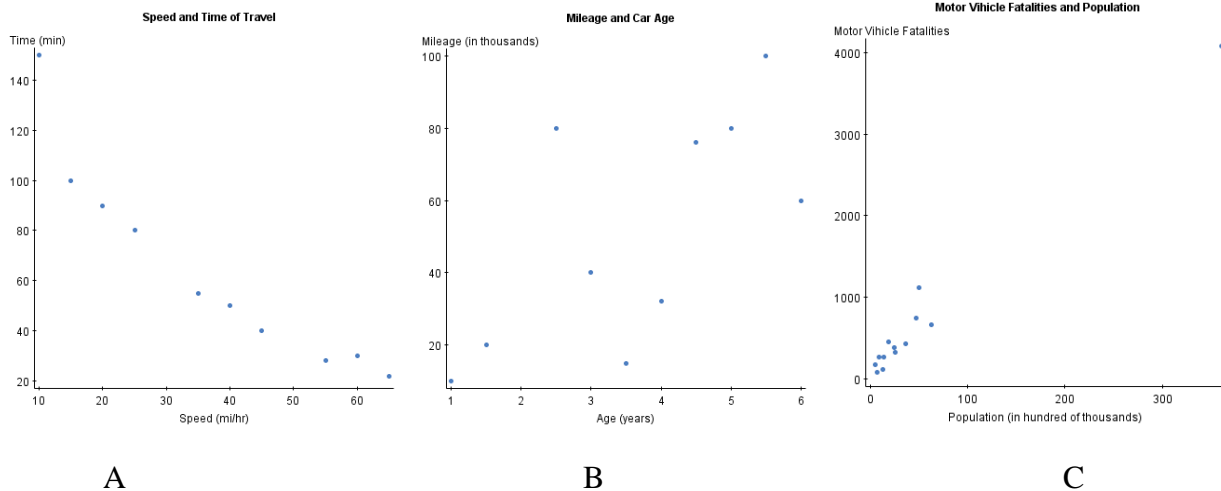
Assessment of Advanced Mathematical Reasoning /Statistics Classes

K200, S262, PSY-K300, and SPEA-K300

Four statistics teachers in four different statistics courses got together in Spring 2013, exchanged syllabi, and suggested questions for common assessment tool of students' learning. The common assessment tool, that we all approved, consisted of four questions that address student learning outcomes of the Advanced Mathematical reasoning domain of IU Northwest General Education Principle 1. We imbedded the four questions to exams or quizzes that we gave to 214 students during the same semester. Note that this group includes all students that took the assessment tools, without regard if students passed the course. These assessment tools were part of students' grades. Individual instructors graded their own students based on the common key and point system that we developed. Our students were able to use formulae, calculators/computer software, and/or statistical tables to solve the problems.

Outcome 1 (ask students to make inferences from charts or graphs)

1. Three scatterplots are shown below. The calculating correlations are 0.9889 , 0.6667, and -0.9351 . Determine which correlation goes with which graph. (9 points)



Graph A has a correlation $r = \underline{\hspace{2cm}}$. $r = -0.9351$.

Graph B has a correlation $r = \underline{\hspace{2cm}}$. $r = 0.6667$.

Graph C has a correlation $r = \underline{\hspace{2cm}}$. $r = 0.9889$.

This was a question that 97-98% of our students answered correctly.

Outcome 2 (represent mathematical information)

2. Given the following raw scores on a standard 10-point scale measuring political dissatisfaction:

10, 8, 4, 4, 6, 2, 3, 2, 2, 5, 3, 8, 5, 7, 9, 9, 6, 9, 5, 4, 1, 5, 4, 2, 8 it was calculated that $n = 25$, $\bar{x} = 5.24$, and $s = 2.6$. (9 points)

A) Based on the information above, estimate the standard error of the mean (standard error $SE = \frac{s}{\sqrt{n}}$).

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B) Estimate the population mean by calculating both the 95% and 99% confidence intervals. (Confidence interval for means: $\bar{x} \pm t \cdot SE$)

95% Confidence = 4.15 - 6.33

99% Confidence = 3.76 - 6.72

C) What can you conclude about the population from which this sample was drawn?

Based on this sample data I can be 95% sure that the population has a mean political dissatisfaction score somewhere between 4.15 and 6.33 on a 10-point scale. I can be 99% sure that the population mean is between 3.76 and 6.72.

The question was answered correctly by 71% of students. The most common error was calculating the margin of error but not providing the confidence interval in the interpretation of the data.

3. For the following numerical summaries of data, determine what the distribution looks like (i.e. shape). Explain your reason for each conclusion. (9 points)

a. $M = 50$; median = 40, mode = 30

Positive (i.e. right) skew, unimodal: the mean is being pulled towards the larger side and the most numbers are on the smaller side

b. $M = 50$, median = 50, mode = 50

Approximately Normal curve: in unimodal symmetrical distribution the $M = \text{median} = \text{mode}$.

c. $M = 50$, median = 60, mode = 70

Negative (i.e. left) skew, unimodal: the mean is being pulled towards the smaller side and the most numbers are on the larger side

The questions a, b, and c were answered correctly by 68%, 77% and 69% of students, respectively. The most common error was confusing a positively skewed distribution with a negatively skewed distribution.

Outcome 3 (use methods to solve problems)

4. Twenty GPAs from a randomly selected sample of statistics students at a college are given below. 2.85, 3.36, 3.13, 2.57, 3.48, 2.77, 3.08, 3.51, 2.61, 3.98, 2.82, 2.65, 3.55, 3.01, 2.76, 3.42, 2.48, 3.13, 3.45, 3.16

Summary statistics:

Column	n	Mean	Variance	Std. Dev.	Std. Err.	Median	Range	Min	Max	Q1	Q3
GPA	20	3.0885	0.161392	0.401737	0.089831	3.105	1.5	2.48	3.98	2.765	3.435

Assume that the population distribution is approximately normal. The population mean GPA for the whole college is 2.85.

a) What is the sample mean? _____ (3 pts) Is it higher or lower than the population mean of 2.85? _____ (3 pts)

a) *Sample mean is 3.0885 ; sample mean is higher than the population mean.*

b) The chair of the statistics department claims that statistics students typically have higher GPAs than a typical college student. Use the four-step procedure (12 pts), (state correctly H_0 and H_a , find the test statistic, find the p -value, reject or do not reject the null hypothesis) to test his claim at significance level of 0.05. (Hypothesis testing for means: $t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$)

H_0 : Test statistic: _____

H_a : p -value: _____

$H_0: \mu = 2.85$ Test statistic: $t = \frac{3.0885 - 2.85}{0.4017/\sqrt{20}} \approx 2.655$, $d.f. = 19$

$H_a: \mu > 2.85$ p -value: 0.01

Conclusion: _____
There is statistically sufficient evidence at level $\alpha = 0.05$ ($p = 0.01 < 0.05 = \alpha$) to reject the null hypothesis and conclude that statistics students typically have higher GPAs than a typical college student.

The parts a and b were answered correctly by 71% and 54% of students, respectively. Most common errors were choosing the wrong test statistic or retaining the null hypothesis when it should have been rejected.

Our conclusion is that our students have most difficulty in applying correct methods to solve problems. This is the area where we plan to put more emphasis in the future. We plan to revise this assessment tool for future use. There was some difficulty in summarizing data, so we plan to develop more detailed key and report results uniformly in the future. One of the four stats courses has been revised based on the results of our common assessment and the syllabi we all provided. Thus, there were major changes made in one of the courses based on the common assessment process.

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