PUSHKAR KUMAR VERMA — (2022AC05272)

1. To test the claim that the new plant food increases the masses of cucumber, we can perform a hypothesis test using Z-test for means.

Null hypothesis (H_0): The new plant has no effect on masses of cucumber, $\mu = \mu_0$

Alternative hypothesis (H_1): The new plant increases the masses of cucumber, $\mu > \mu_0$

Significance level - 5%, which corresponds to $\alpha = 0.05$

Test Statistic: The test statistic for a z-test is calculated as:

$$Z = \frac{\bar{X} - \mu_0}{\frac{\sigma}{\sqrt{n}}}$$

where: $\bar{x}$ = Sample mean → 316 gm.

μ_0 - claimed population mean - 310 gm.

σ - population standard dev = 22 gm

n - Sample size (40)

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$$Z = \frac{316-310}{22/\sqrt{40}}$$

$$= \frac{6}{22/\sqrt{40}} = 1.7248$$

Critical value for $\alpha = 0.05$ is 1.645

Since $Z = 1.7248 > 1.645$

Reject H_0 and Accept H_1

This means that there is a significant evidence to support the claim that the new plant food increases the masses of cucumbers.

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(2) We can use a paired t-test to evaluate whether accounting course improved performance.

Hypothesis.

→ Null hypothesis H_0: The mean difference between before and after scores is zero ($\mu_{diff} = 0$); meaning course has no effect.

→ Alternative hypothesis (H_1): The mean difference between the before and after scores is greater than zero ($\mu_{diff} > 0$).

Level of significance: Let's use a significance α of value 5% (0.05)

Calculation & Statistics

Before	After	Diff (After - Bef)	~~Diff²~~ (d-mean)²	(d-mean)²
44	53	9	81	16
40	38	-2	4	49
61	69	8	64	9
52	57	5	25	0
32	46	14	196	81
44	39	-5	25	100
70	73	3	9	4
41	48	7	49	4
67	73	6	36	1
72	74	2	4	9
53	60	7	49	4
72	78	6	36	1
Total		~~53~~ 60		278

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$$\bar{d} = \frac{\sum_{i=1}^{n} d_i}{n} = \frac{60}{12} = 5$$

$$S_d = \sqrt{\frac{\sum_{i=1}^{n} (d_i - \bar{d})^2}{n-1}} = \sqrt{\frac{278}{11}}$$

$$S_d = 5.0271$$

⇒ Let's find t value.

$$t = \frac{\bar{d}}{S_d/\sqrt{n}} = \frac{5}{5.0271/\sqrt{12}}$$

$$t = \cancel{3.2988}\ 3.445$$

→ For one tailed, $\alpha = 0.05$, $df = n-1 = 11$ degrees of freedom, t value is 1.796

Since calculated $t = \cancel{3.2988}\ 3.445$ is greater than the critical t-value of 1.796 we reject the null hypotheses

Conclusion: Based on this ~~conclusion~~ calculation, we can conclude that there is enough evidence at 5% level of significance to say that the accounting course did improve performance

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(3)

Shifts	Good	Bad	Total.
Day	900	130	1030
Evening	700	170	870
Night	400	200	600
Total	2,000	500	2500

Null Hypothesis (H_0): There is no association between the shifts and quality of parts produced (i.e. variables are independent)

Alternative Hypothesis (H_1): There is an association between shifts and the quality of parts produced. (i.e. variables are dependent).

Value of significance: α is set at 0.05

Calculation of expected frequency

$$\text{Expected frequency} = \frac{\text{Row Total} \times \text{Column Total}}{\text{Grand Total}}.$$

1. Day and Good = $\frac{1030 \times 2000}{2500} = 824$

2. Day and Bad = $\frac{1030 \times 500}{2500} = 206$

Evening and Good $= \dfrac{2000 \times 870}{2500} = 696$

Evening and Bad $= \dfrac{500 \times 870}{2500} = 174$

Night and Good $= \dfrac{2000 \times 600}{2500} = 480$

Night and Bad $= \dfrac{600 \times 500}{2500} = 120$

<u>Calculation of Chi-Square</u>

Chi-square statistics X^2 is calculated as

$$X^2 = \sum \frac{(O-E)^2}{E}$$

→ Day and Good $= \dfrac{(900-824)^2}{824} = 7.0097$

Day and Bad $= \dfrac{(130-206)^2}{206} = 28.03$

Evening and Good $= \dfrac{(700-696)^2}{696} = 0.022$

Evening & Bad $= \dfrac{(170-174)^2}{174} = 0.0919$

Night and Good $= \dfrac{(400-480)^2}{480} = 13.33$

Night and Bad $= \dfrac{(200-120)^2}{120} = \cancel{530}\ 53.33$

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Summing these all together =

$7.0097 + 28.03 + 0.022 + 0.919 + 12.33 + [illegible]$

$= 101.81$

For, $\alpha = 5$ and $df = 2$ (no of rows − 1) critical value of χ^2 is approximately 5.991

Since, $\chi^2 = 101.81$ is much greater than 5.991 we reject the null hypothesis.

Conclusion: Since χ^2 is much larger than critical value, we have evidence at the 5% level of significance to reject the null hypothesis.

Therefore, the shift timing does appear to impact the quality of parts produced

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(4)

	Hank	Joseph	Susan
	8	8	10
	10	9	9
	9	9	10
	11	8	11
	10	10	9
Total	48	44	49
Mean	9.6	8.8	9.8

Overall mean $= \cancel{\frac{9.6+8.8+9.8}{3}}\ \frac{48+44+49}{15}$

$= 9.4$

Variance within group

Hank $= \frac{(8-9.6)^2+(10-9.6)^2+(9-9.6)^2+(11-9.6)^2+(10-9.6)^2}{5}$

$= \frac{5.2}{5}$

$= 1.04$

Joseph $= \frac{(8-8.8)^2+(9-8.8)^2+(9-8.8)^2+(8-8.8)^2+(10-8.8)^2}{5}$

$= \frac{2.8}{5} = 0.56$

Susan $= \frac{(10-9.8)^2+(9-9.8)^2+(10-9.8)^2+(11-9.8)^2+(9-9.8)^2}{5}$

$= 2.8/5 = 0.56$

Sum of squares for treatment (S.ST)

$$SST = \left[(9.6-9.4)^2 + (8.8-9.4)^2 + (9.8-9.4)^2\right] \times 5$$
$$= 2.8$$

Sum of square for error. (SSE)

$$SSE\_hank = (8-9.6)^2 + (10-9.6)^2 + (9-9.6)^2 + (11-9.6)^2 + (10-9.6)^2$$
$$= 5.2$$

$$SSE\_joseph = (8-8.8)^2 + (9-8.8)^2 + (9-8.8)^2 + (8-8.8)^2 + (10-8.8)^2$$
$$= 2.8.$$

$$SSE\_susan = (10-9.8)^2 + (9-9.8)^2 + (10-9.8)^2 + (11-9.8)^2 + (9-9.8)^2$$
$$= 2.8$$

$$\Sigma SSE = SSE\_hank + SSE\_joseph + SSE\_susan$$
$$= 5.2 + 2.8 + 2.8$$
$$= 10.8$$

Degrees of freedom (DF) for treatment and Error.

DF for treatment (DF 1) $= 3-1 = 2$

DF for Error (DF2) $= 15-3$
$= 12$

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$$MST_r = \frac{SST_r}{K-1} = \frac{2.8}{3-1} = 1.4$$

$$MSE = \frac{SSE}{N-K\,(DF_2)}$$

$$= \frac{10.8}{15-3} = \frac{10.8}{12}$$

$$MSE = 0.9$$

$$F = \frac{MST_r}{MSE}$$

$$F_{Static} = \frac{1.4}{0.9} = 1.5556.$$

Critical F value = 3.8885

$\alpha = 0.05$

ANOVA					
Source of Variation	Sum of Squares	Degrees of freedom	Mean Square	F-value	P-value
Between groups	2.8	2	1.4	1.5556	0.250789
Within Groups	10.8	12	0.9	0.900	
Total	13.6	14			