Analysis of Student Exam Preferences Under Various Conditions

STA4211 Final Project

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December 6, 2023

Project Objective

- Observe student preference for a course based on its exam format.
- Whether this preference changes once exam averages are revealed.
- Test main and interaction effects for educational status, primary field of study.
- Analysis conducted using methods learned in STA4211.

Survey Format

Created a 6 Question Qualtrics survey with 51 respondents.

Question 1: Educational Status

- 1st Year Undergraduate **(5)**
- 2nd Year Undergraduate **(4)**
- 3rd Year Undergraduate **(15)**
- 4th Year Undergraduate **(16)**
- 5th Year Undergraduate **(8)**
- Graduate Student **(3)**

Question 2: Primary Study

- CS, CPE, or DAS **(35)**
- Statistics or Data Science **(2)**
- Mathematics **(0)**
- Other **(14)**

Survey Format

Question 3: For a typical course in your primary field of study, which of the following exam formats would you most prefer?

- **Format A:** A 1 week long take-home (open-book) midterm worth 40% of your grade. No final exam.
- **Format B:** Three timed in-person and closed-book exams worth a combined 75% of your grade. No final exam.
- No Preference

Question 4: How much do you prefer the option selected in Q3 over the alternative?

- 1 (Slight Preference) to 5 (Extreme Preference) in 0.5 intervals.
- "No Preference" in Q3 $=$ 0

Survey Format

Question 5: In a previous semester, both formats were tested and the following exam averages were reported

- **Format A:** 61% Midterm Average
- **Format B:** 73%, 76%, and 75% Average for Each Exam

Assuming you would receive an exam(s) of similar difficulty, does this new information change which exam format you would most prefer?

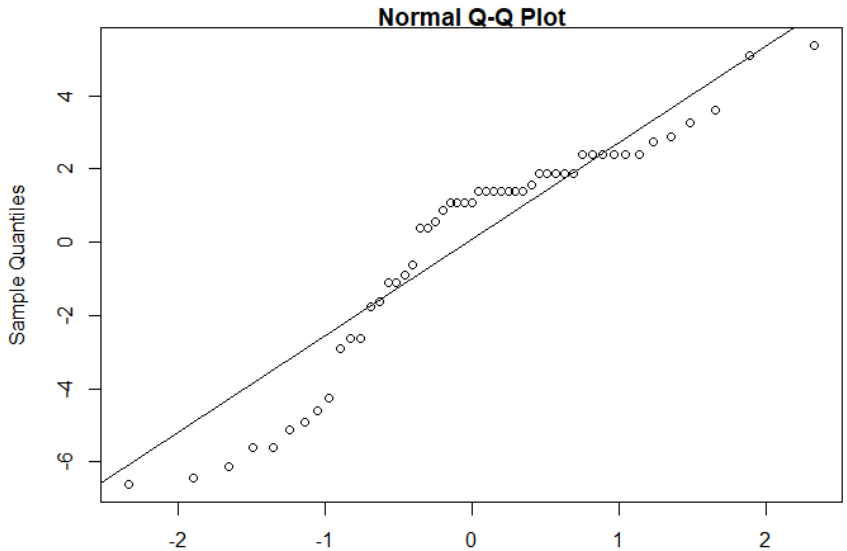
Question 6: Preference rating of selection with new information over alternative. No preference in Q5 $= 0$.

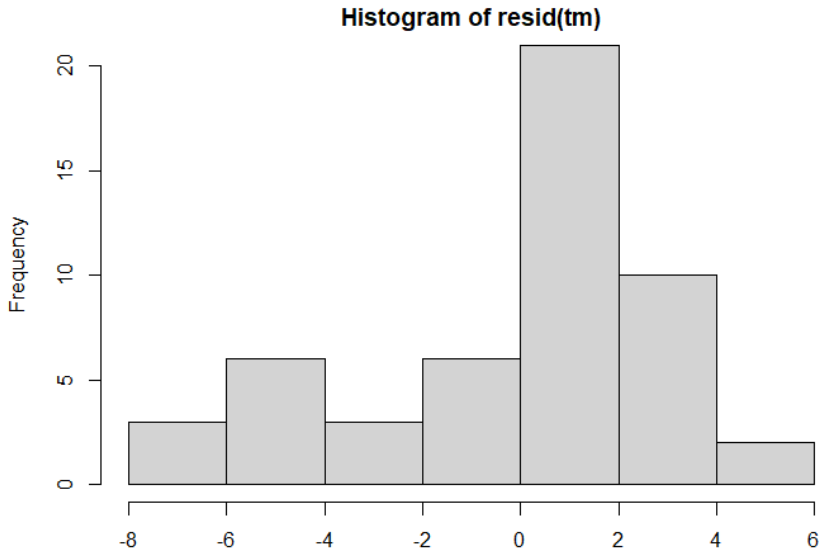
Data Processing and Notation

- Educational status: low **(24)** and high **(27)**
- Primary Field of Study: CS **(35)**, SCI **(7)**, LI **(5)**, O **(4)**
- Denote initial rating and new rating as IR and NR respectively.
  - $IR, NR > 0$ when **Format A** is selected.
  - $IR, NR < 0$ when **Format B** is selected.
- Define new variable `cip` (change in preference) as $NR - IR$
  - `cip` > 0 when **A** becomes preferred format or **B** is less preferred when exam averages are given
  - `cip` < 0 when **B** becomes preferred format or **A** is less preferred when exam averages are given

Residual Analysis for ANOVA Models

Check if residuals are normal and group variances are equal





Bartlett Test for high/low ($H_0 : \sigma_1^2 = \sigma_2^2$)
$X_B^2 = 0.48342$, $df = 1$, p-value $= 0.4869$
Bartlett Test for FieldOfStudy ($H_0 : \sigma_1^2 = \ldots = \sigma_4^2$)
$X_B^2 = 1.1032$, $df = 3$, p-value $= 0.7763$

- Can perform non-parametric equivalent to ANOVA: Kruskal-Wallis Test

Kruskal-Wallis Test

Rank all observations across treatments from 1 to n_T, assign average rank for ties. $\overline{R}_{i\bullet}$ is the average rank of the observations in each group.

$$X^2_{KW} = \left[\frac{12}{n_T(n_T+1)\sum_{i=1}^{R}\frac{R^2_{i\bullet}}{n_i}}\right] - 3(n_T+1) = \frac{SSTR_R}{\left[\frac{SSTO_R}{n_T-1}\right]}$$

$$RR : X^2_{KW} \geq \chi^2(1-\alpha, r-1)$$

`cip` by high/low $\rightarrow X^2_{KW} = 0.28418$, $df = 1$, p-value $= 0.594$
`cip` by FieldOfStudy $\rightarrow X^2_{KW} = 2.8703$, $df = 3$, p-value $= 0.4121$

- We can conclude that the `cip` medians for high/low are approximately equal and the `cip` medians for FieldOfStudy groups are approximately equal.

Unbalanced 2-Factor Studies

$$\begin{aligned} Y_{ijk} =& \mu_{\bullet\bullet} + \alpha_1 X_{ijk1} + \beta_1 X_{ijk2} + \beta_2 X_{ijk3} + \beta_3 X_{ijk,4} \\ &+ (\alpha\beta)_{11} X_{ijk1} X_{ijk2} + (\alpha\beta)_{12} X_{ijk1} X_{ijk3} + (\alpha\beta)_{13} X_{ijk1} X_{ijk4} + \epsilon_{ijk} \end{aligned}$$

Where:

$$X_1 = \begin{cases} 1 & \text{low in high/low} \\ -1 & \text{high in high/low} \end{cases} \qquad X_2 = \begin{cases} 1 & \text{LI in FoS} \\ -1 & \text{CS in FoS} \\ 0 & \text{otherwise} \end{cases}$$

$$X_3 = \begin{cases} 1 & \text{O in FoS} \\ -1 & \text{CS in FoS} \\ 0 & \text{otherwise} \end{cases} \qquad X_4 = \begin{cases} 1 & \text{SCI in FoS} \\ -1 & \text{CS in FoS} \\ 0 & \text{otherwise} \end{cases}$$

and $\sum \alpha_i = \sum \beta_j = \sum_i (\alpha\beta)_{ij} = \sum_j (\alpha\beta)_{ij} = 0$

Unbalanced 2-Factor Studies (cont.)

- Model 1: All high/low, FoS, and Interaction Effects
- Model 2: All high/low, FoS Effects (Remove Interaction)
- Model 3: All FoS, Interaction Effects (Remove high/low)
- Model 4: All high/low, Interaction Effects (Remove FoS)
- Test H_0 : All Interaction Effects $= 0$.
  - Model 1 $\rightarrow$ Full, Model 2 $\rightarrow$ Reduced
- Test $H_0 : \alpha_1 = \alpha_2 = 0$.
  - Model 1 $\rightarrow$ Full, Model 3 $\rightarrow$ Reduced
- Test $H_0 : \beta_1 = \ldots = \beta_4 = 0$.
  - Model 1 $\rightarrow$ Full, Model 4 $\rightarrow$ Reduced

$$F^* = \frac{\left[\frac{SSE(R)-SSE(F)}{df_E(R)-df_E(F)}\right]}{SSE(F)/df_E(F)} \quad RR : F^* \geq F(1-\alpha, df_E(R) - df_E(F), df_E(F))$$

Unbalanced 2-Factor Studies (cont.)

Test H_0 : All Interaction Effects $= 0$.

- $F^* = 3.7013$, $F(0.95, 3, 46) = 2.807$, Reject Null

Test $H_0 : \alpha_1 = \alpha_2 = 0$.

- $F^* = 0.0735$, $F(0.95, 1, 46) = 4.052$, Confirm Null

Test $H_0 : \beta_1 = \ldots = \beta_4 = 0$.

- $F^* = 1.9020$, $F(0.95, 3, 46) = 2.807$, Confirm Null

Conclusion and Limitations

- We can conclude that interaction effects between educational status and primary field of study exist, whereas both main effects do not.

- The midterm averages shown in the survey were fixed.
  - Different reported averages may result in different responses
  - Not enough samples to test this
- Not collecting if student has experienced either exam format.
- Volunteer Bias