

Analysis of Student Exam Preferences Under Various Conditions

STA4211 Final Project

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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?

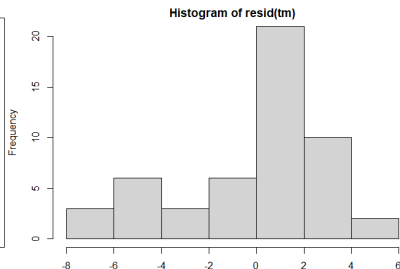
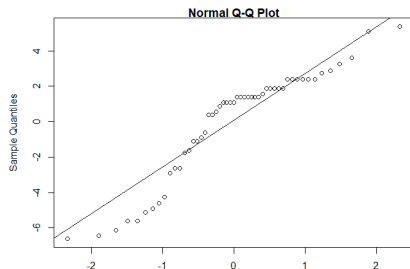
Question 6: Preference rating of selection with new information over alternative. No preference in Q5 = 0.

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 ($H_0 : \sigma_1^2 = \dots = \sigma_4^2$)

$X_B^2 = 1.1032$, $df = 3$, 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. $\bar{R}_{i\bullet}$ is the average rank of the observations in each group.

$$X_{KW}^2 = \left[\frac{12}{n_T(n_T + 1) \sum_{i=1}^R \frac{R_{i\bullet}^2}{n_i}} \right] - 3(n_T + 1) = \frac{SSTR_R}{\left[\frac{SSTO_R}{n_T - 1} \right]}$$
$$RR : X_{KW}^2 \geq \chi^2(1 - \alpha, r - 1)$$

cip by high/low $\rightarrow X_{KW}^2 = 0.28418$, $df = 1$, $p\text{-value} = 0.594$

cip by FieldOfStudy $\rightarrow X_{KW}^2 = 2.8703$, $df = 3$, $p\text{-value} = 0.4121$

- 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

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

Where:

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

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

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

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 : $\beta_1 = \dots = \beta_4 = 0$.
 - ▶ 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 : $\beta_1 = \dots = \beta_4 = 0$.

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

References

Predictors of students' preferences for assessment methods:

<https://doi.org/10.1080/02602938.2022.2087860>

Survey Results and Analysis:

<https://github.com/ZackAllen1/exam-preference>