Comparative Academic Performance in ELA 101: Assessing the Impact of In-Person Versus Online Learning Environments

Ariel Rosario, Jr.

Summary:

At NotReal University, we need to compare the educational outcomes of an introductory English class. The goal of this report is to investigate and contrast the academic performance of students enrolled in the Introduction to English (ELA 101) course, comparing those who attended in-person classes with those who participated online. According to our analysis, utilizing the Welch Two Sample t-test, a significant disparity was observed in the mean test scores between the two groups.

Remarkably, students who attended the course in-person tended to achieve higher scores than their counterparts who took the class online. These initial findings indicate a necessity for further research to comprehensively understand the diverging trends in online and in-person learning outcomes, potentially expanding the scope to encompass different majors offered at the institution. This will help in developing a deeper insight into the impact of the mode of learning on student performance and outcomes.

Introduction:

The advent of online education has revolutionized the academic landscape, offering unprecedented flexibility and access to a plethora of learning opportunities. However, this innovation also prompts critical questions about the efficacy of online courses in comparison to traditional in-person classes.

The present report seeks to address this debate by examining student performance in English Language Arts (ELA) 101 courses taught in the NotReal University system during the Spring 2022 semester. Utilizing data sourced from the NotReal University database, we employ a Welch's Two-Sample t-test to rigorously compare the final ELA scores between students who enrolled in online and in-person classes.

The primary purpose of this analysis is twofold: to offer insights that can enrich academic advisement practices and to enhance the overall college experience for students. By understanding the nuances in student performance across different instructional mediums, educators and administrators can better allocate resources, optimize class inventories, and implement strategies for improved student outcomes.

```
library(readxl)
library(tidyverse)
Online_VS_InPerson <- read_excel("/Users/ariel_rosario/Desktop/Projects/Online_VS_InPerson.xlsx")
head(Online_VS_InPerson)
```

```
## # A tibble: 6 x 2
##   Type   Final_ELA_Score
##   <chr>            <dbl>
## 1 online              68
## 2 online              62
## 3 online              72
## 4 online              78
```

```
## 5 online                65
## 6 online                73
```

Descriptive Statistics:

The analysis of the Final_ELA_Score reveals some interesting insights into the distribution and central tendencies of the English Language Arts test scores. The minimum score in the dataset is 55, which is the lowest boundary for the grades, while the maximum is 95, close to the upper limit of 100. This wide range of scores, spanning 40 points, suggests that there's considerable variability in the performance of the students. The first quartile (Q1) is 68.25 and the third quartile (Q3) is 84, indicating that 50% of the students scored within this interquartile range.

The median score is 78, which serves as a robust measure of the central tendency of the dataset and suggests that half of the students have scores above 78 while the other half fall below this value. However, it's noteworthy that the mean score is slightly below the median, at 76.33. This could imply that the lower scores might be pulling the mean down, although the data does not appear to be severely skewed. The mean and median being close to each other also indicates a fairly symmetrical distribution of scores. Overall, the summary statistics indicate a broad range of performance, with a concentration of students scoring between the mid-60s and mid-80s.

```
summary(Online_VS_InPerson)
```

```
##       Type           Final_ELA_Score
##   Length:94          Min.   :55.00
##   Class :character   1st Qu.:68.25
##   Mode  :character   Median :78.00
##                      Mean   :76.33
##                      3rd Qu.:84.00
##                      Max.   :95.00
```

Data Visualization:

The following graph presents a density plot illustrating the distribution of grades for ELA 101 courses conducted in-person and via virtual platforms during the Spring 2022 semester. A scrutiny of the visual data corroborates that students enrolled in in-person sections of ELA 101 consistently outperformed their counterparts in online courses.

```
p <- ggplot(Online_VS_InPerson, aes(x=Final_ELA_Score)) +
  geom_density(aes(group=Type, colour=Type), alpha=.5) +
  ggtitle("Density Plot of Final ELA Scores") +
  xlab("Final ELA Score") +
  ylab("Density") +
  theme_minimal()

# Print the plot (optional, just if you want to see it in the R console)
print(p)
```

Density Plot of Final ELA Scores
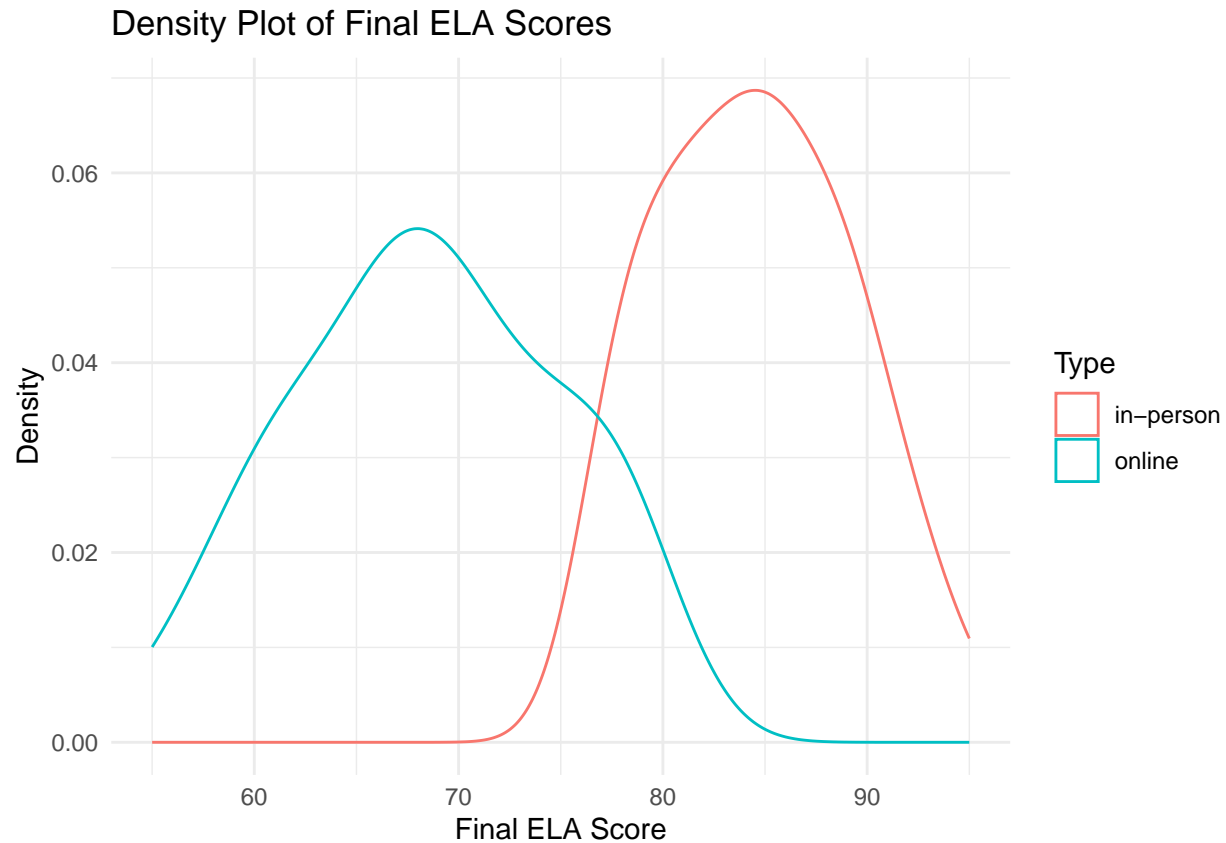
Results:

In a Welch Two-Sample t-test comparing final ELA scores between in-person and online courses, a remarkably large t-value of 13.72 and degrees of freedom of 86.126 were observed, yielding a p-value that is essentially zero ($< 2.2e\text{-}16$). These results resoundingly reject the null hypothesis, affirming that there is a statistically significant difference in mean scores between the two types of classes. The 95% confidence interval for the difference in means ranges from approximately 13.68 to 18.32. Further, the sample estimates reveal that the mean score for the in-person group stands at 84.5, substantially higher than the online group's mean score of 68.5. This provides compelling evidence for the superiority of in-person instruction in the context of ELA 101 courses for the semester and dataset under consideration.

```
t_result <- t.test(Final_ELA_Score ~ Type, data = Online_VS_InPerson)
print(t_result)
```

```
##
##  Welch Two Sample t-test
##
## data:  Final_ELA_Score by Type
## t = 13.72, df = 86.126, p-value < 2.2e-16
## alternative hypothesis: true difference in means between group in-person and group online is not equa
## 95 percent confidence interval:
##  13.68172 18.31828
## sample estimates:
## mean in group in-person    mean in group online
##                    84.5                    68.5
```

Conclusion:

In the domain of inferential statistics, the computed t-value serves as an essential indicator, quantifying the distance between the mean scores of two groups in units of standard error. Conceptually, this t-value articulates the extent to which the means of the two distinct groups diverge, normalized by the inherent variability within each group. The magnitude of the t-value is directly proportional to the statistical significance of the difference between the group means: a larger absolute t-value generally implies a more pronounced difference between the groups.

The p-value is a critical metric offering probabilistic evidence against the null hypothesis, essentially quantifying the likelihood of observing the data at hand if the null hypothesis were indeed true. Traditionally, a p-value less than 0.05 is deemed sufficient to reject the null hypothesis, indicating a statistically significant divergence between the groups under examination. In our case, the p-value is denoted as 2.2e-16, which, in scientific notation, translates to a value practically indistinguishable from zero. This minuscule p-value furnishes robust evidence to invalidate the null hypothesis.

Given the exceedingly large t-value of 13.72 coupled with a virtually zero p-value, the data present compelling statistical evidence to reject the null hypothesis. Consequently, one can confidently infer that there exists a statistically significant difference in the performance—measured via Final ELA Scores—between the groups delineated by the In-person vs online variable. In other words, there is a significant difference between the mean test scores for the ELA 101 class. On average, students in the in-person model outperform students taking the same class in person.

In the study comparing in-person and online learning, it was found that using post-hoc tests typically meant for multiple group comparisons, such as Tukey's HSD or Bonferroni, is not necessary or applicable when there are only two groups. These tests are intended to address the risk of Type I error associated with multiple comparisons, but this concern is not relevant in cases with just two groups. Since the two-sample t-test already indicated a significant difference between the in-person and online groups, further post-hoc testing is not required. However, for a deeper analysis or exploration of the data, methods like effect size calculation, subgroup analysis, sensitivity analysis, or regression analysis could be considered, depending on the specifics and objectives of the research.