Case-Based Statistics Assignment: ANOVA and Hypothesis Testing

Case 1: Analyzing the Effect of Different Teaching Methods on Student Performance

A university wants to analyze the effectiveness of three different teaching methods on student performance. They conducted an experiment where students were divided into three groups. Each group was taught using a different method over a semester, and their final exam scores were recorded. The data is as follows:

Group 1 (Traditional Classroom Method):
65, 70, 75, 80, 85, 78, 82, 79, 74, 68, 72, 77, 71, 84, 73

Group 2 (Online Learning Method):
58, 62, 67, 65, 69, 70, 64, 60, 66, 68, 71, 59, 63, 67, 61

Group 3 (Blended Learning Method):
75, 78, 80, 85, 87, 82, 79, 88, 83, 81, 85, 84, 89, 86, 80

Questions:

1. Descriptive Statistics: Calculate the mean, median, and standard deviation of exam scores for each group.

2. ANOVA Test: Perform a one-way ANOVA to test if there is a significant difference in the mean exam scores between the three teaching methods. Use a 5% significance level.

3. Post-Hoc Analysis: If the ANOVA results show a significant difference, conduct a post-hoc analysis (Tukey's HSD test) to identify which groups differ significantly.

4. Assumptions of ANOVA: Check the assumptions of normality and homogeneity of variance for the groups. Use appropriate tests like the Shapiro-Wilk test for normality and Levene's test for equality of variances.

5. Conclusion: Based on the ANOVA and post-hoc results, discuss which teaching method appears to be the most effective for improving student performance.

Case 2: Examining the Impact of Marketing Campaigns on Sales

A retail company launched three different marketing campaigns in three regions (North, South, and West) to evaluate their effectiveness on increasing sales. After one month, the following sales data (in thousands of dollars) was collected from 20 stores in each region:

Region 1 (North Region):
102, 110, 108, 104, 112, 109, 115, 114, 120, 118, 107, 113, 117, 121, 116, 111, 119, 122, 125, 126

Region 2 (South Region):
95, 100, 98, 102, 97, 101, 104, 105, 108, 106, 99, 103, 107, 109, 110, 98, 102, 108, 105, 107

Region 3 (West Region):
110, 115, 120, 125, 123, 119, 121, 124, 127, 130, 118, 126, 129, 128, 131, 117, 122, 128, 132, 134

Questions:

1. Descriptive Statistics: Calculate the mean, median, and standard deviation of sales for each region.

2. ANOVA Test: Perform a one-way ANOVA to determine if there are significant differences in sales between the three regions. Use a 5% significance level.

3. Post-Hoc Analysis: If the ANOVA shows significant differences, conduct a Tukey's HSD test to find out which regions differ significantly in terms of sales.

4. Assumptions of ANOVA: Check for normality and homogeneity of variances. Use the Shapiro-Wilk test for normality and Levene's test for equality of variances.

5. Hypothesis Testing: Assume that the company expects the mean sales to be at least $110,000 in all regions. Perform a one-sample t-test for each region to check if the mean sales significantly differ from $110,000.

6. Conclusion: Based on the ANOVA and t-test results, provide recommendations on which marketing campaign is the most effective for increasing sales and whether the company's expectations of mean sales are being met.