**Quantitative Methods**

**List of Exercises N. 9**

**Selected Exercises from McClave (2014) – Chapter 9**

**9.1 Elements of a Designed Experiment**

1. (5). ***Identifying the type of experiment***. Brief descriptions of a number of experiments are given next. Determine whether each is designed or observational and explain your reasoning.

a) An economist obtains the unemployment rate and gross state product for a sample of states over the past 10 years, with the objective of examining the relationship between the unemployment rate and the gross state product by census region.

b) A manager in a paper production facility installs one of three incentive programs in each of nine plants to determine the effect of each program on productivity.

c) A marketer of personal computers runs ads in each of four national publications for one quarter and keeps track of the number of sales that are attributable to each publication’s ad.

d) An electric utility engages a consultant to monitor the discharge from its smokestack on a monthly basis over a 1- year period to relate the level of sulfur dioxide in the discharge to the load on the facility’s generators.

e) Intrastate trucking rates are compared before and after governmental deregulation of prices changed, with the comparison also taking into account distance of haul, goods hauled, and the price of diesel fuel.

**9.2 The Completely Randomized Design: Single Factor**

2. (28, ADREC). ***Study of recall of TV commercials***. Do TV shows with violence and sex impair memory for commercials? To answer this question, IOWA State researchers conducted a designed experiment in which 324 adults were randomly assigned to one of three viewer groups of 108 participants each (*Journal of Applied Psychology*, June 2002). One group watched a TV program with a violent content code (V) rating, the second group viewed a show with a sex content code (S) rating, and the last group watched a neutral TV program with neither a V nor a S rating. Nine commercials were embedded into each TV show. After viewing the program, each participant was scored on his or her recall of the brand names in the commercial messages, with scores ranging from 0 (no brands recalled) to 9 (all brands recalled). The data (simulated from information provided in the article) are saved in the ADREC file. The researchers compared the mean recall scores of the three viewing groups with an analysis of variance for a completely randomized design. Summary for their results are given in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| One-way ANOVA: VIOLENT, SEX, NEUTRAL | | | | | |
| Source | DF | SS | MS | F | P |
| Factor | 2 | 123.27 | 61.63 | 20.45 | 0.000 |
| Error | 321 | 967.35 | 3.01 |  |  |
| Total | 323 | 1090.62 |  |  |  |
| S = 1.736 | | R-Sq = 11.3% | | R-Sq (adj)=10.75% | |

1. Identify the experimental units in the study.
2. Identify the dependent (response) variable in the study.
3. Identify the factor and treatments in the study.
4. The sample mean recall scores for the three groups were  and . Explain why one should not draw an inference about differences in the population mean recall scores on the basis of only these summary statistics.
5. An ANOVA on the data yielded the results shown in the table above. Locate the test statistic and p-value on the table.
6. Interpret the results from part e, using α = 0.01. What can the researchers conclude about the 3 groups of TV ad viewers?
7. Check that the ANOVA assumptions are reasonably satisfied.

3. (30, ACCHW). ***Homework assistance for accounting students***. The Journal of Accounting Education (Vol. 25, 2007) did a study of assisting accounting students with their homework. A total of 75 junior-level accounting majors who were enrolled in Intermediate Financial Accounting participated in the experiment. Students took a pretest on a topic not covered in class and then each was given a homework problem to solve on the same topic. A completely randomized design was employed, with students randomly assigned to receive one of the three different levels of assistance on the homework: (1) the completed solution, (2) check figures at various steps of the solution, and (3) no help at all. After finishing the homework, each student was given a posttest on the subject. The response variable of interest to the researchers was the knowledge gain (or, test score improvement), measured as the difference between the posttest and the pretest scores. The data (simulated from the descriptive statistics published in the article) are saved in the accompanying file.

1. Give the null and alternative hypotheses tested in an analysis of variance of the data.
2. Summarize the results of the analysis in an ANOVA table.
3. Interpret the results, practically.

**9.3. Multiple comparisons of means**

4. (46, ADREC). *Study of recall of TV commercials*. Refer to the Journal of applied psychology (June 2002) completely randomized design study to compare the mean commercial recall scores of viewers of three TV programs, presented in List 9, Exercise 2. Recall that one program had a violent content code (V) rating, one had a sex content code (S) rating, and one was a neutral TV program.

Take the information from List 9, Exercise 2 and conduct multiple comparison of the three mean recall scores using Tukey’s method. Use an error rate of .05.

a) How many pairwise comparisons were made?

b) The multiple comparison procedure was applied to the data and you now have the results. Locate the confidence interval for the comparison of the V and S groups. Interpret this result practically.

c) Repeat part **b** for the remaining comparisons. Which of the groups has the largest mean recall score?

d) In the journal article, the researchers concluded that “memory for (television) commercials is impaired after watching violent or sexual programming”. Do you agree?

**9.4 The randomized block design**

(60, PLANTS). ***Reducing on-the-job stress***. Plant therapist believe that plants can reduce on-the-job stress. A Kansas State University study was conducted to investigate this phenomenon. Two weeks prior final exams, 10 undergraduate students took part in an experiment to determine what effect the presence of a live plant, a photo of a plant, or absence of a plant has on a student’s ability to relax while isolated in a dimly lit room. Each student participated in three sessions - one with a live plant, one with a plant photo, and one with no plant (control). During each session, finger temperature was measured at 1-minute intervals for 20 minutes. Because increasing finger temperature indicates an increased level of relaxation, the minimum temperature (in degrees) was used as the response variable. For example, one student’s finger measured 95.6 in the “live plant” condition, 92.6 in the “plant photo” condition, and 96.6 in the “no plant” condition (those are information for Student 1). The temperatures under the three conditions for the other nine students follow:

|  |  |
| --- | --- |
| Student 2 | 95.6 94.8 96.0 |
| Student 3 | 96.0 97.2 96.2 |
| Student 4 | 95.2 94.6 95.7 |
| Student 5 | 96.7 95.5 94.8 |
| Student 6 | 96.0 96.6 93.5 |
| Student 7 | 93.7 96.2 96.7 |
| Student 8 | 97.0 95.8 95.4 |
| Student 9 | 94.9 96.6 90.5 |
| Student 10 | 91.4 93.5 96.6 |

These data are saved in the accompanying file. Conduct an ANOVA and make the proper inferences at α = .10.

**9.5 Factorial experiments: Two factors**

(76, EGGS). ***Commercial eggs produced from different housing systems***. Refer to the Food Chemistry (Vol. 106, 2008) study of four different types of egg housing systems, Exercise 33. Recall that the four housing systems were cage, barn, free range, and organic. In addition to housing system, the researchers also determined the weight class (medium or large) for each sampled egg. The data on whipping capacity (percent overrun) for the 28 sampled eggs are shown in the accompanying table. The researchers want to investigate the effect of both housing system and weight class on the mean whipping capacity of the eggs. In particular, they want to know whether the difference between the mean whipping capacity of medium and large eggs depends on the housing system.

|  |  |  |
| --- | --- | --- |
| Housing | Wtclass | Overrun (%) |
| Cage | M  L | 495, 462, 488, 471, 471  502, 472, 474, 492, 479 |
| Free | M  L | 513, 510, 510  520, 531, 521 |
| Barn | M  L | 515, 516, 514  526, 501, 508 |
| Organic | M  L | 532, 511, 527  530, 544, 531 |

a) Identify the factors and treatments for this experiment.

b) Use statistical software to conduct an ANOVA on the data. Report the results in an ANOVA table.

c) Is there evidence of interaction between housing system and weight class? Test using α = .05 (Hint: Due to an unbalanced design, you will need to analyse the data using the general linear model procedure of your statistical software). What does this imply, practically?

d) Interpret the main effect test for housing system (using α = .05). What does this imply, practically?

e) Interpret the main effect test for weight class (using α = .05). What does this imply, practically?