

**Question:** Do Moravian's undergraduate students retain their knowledge of statistics?

### **Related Departmental Learning Objective**

**Critical Thinking.** Students will identify problems, gather the necessary evidence from multiple sources, and then organize, reflect, and evaluate it to develop reasoned conclusions.

### **Related Programs**

Majors in accounting, economics, and management

### **Introduction**

Faculty in the department expressed concern for the level of statistical knowledge students in the undergraduate program displayed in their work. Faculty wanted to know if students retained their knowledge of statistics after completing their undergraduate statistics course. An outbound assessment of statistics knowledge is not conducted for the undergraduate program. However, students entering the graduate program from Moravian College can be compared with those coming from elsewhere to determine the level of statistical knowledge they retain and if it differs from that retained by students from other programs.

Analytics is more and more a part of work in the business world. Students need to understand and be able to use statistics in their work after Moravian, as well as in graduate programs.

The Moravian Graduate Business Program uses Academic Leveling Courses (ALC) from Peregrine Academics for entering students to meet prerequisite requirements. The *Foundations of Quantitative Research Techniques and Statistics* ALC module is also used in the MGMT 555 Business Research Methods and MGMT 561 Measurement and Methods in HR Management courses as a required refresher in statistics on which students are graded. This provided the opportunity to collect comparative data to discern whether graduate students who studied at Moravian College for their baccalaureate degree retained more or less statistical knowledge than those students who studied elsewhere. Student learning objectives and a content outline of the module are in the appendix of this paper.

### **Data**

Students taking the quantitative ALC module take a pre-test then complete a series of "chapters" of study on methods and statistics than finish the module with a post-test. The pre-test consists of 20 questions. Students receive a grade for the pre-test based on the number of questions correctly answered. The grade is reported as a percentage of the total questions asked in the pre-test. The grade ranges from 0% to 100%.

Table 1 displays the results of the pre-tests for full academic years beginning with the 2015-16 academic year and for half of the 2018-19 academic year. The table shows the number of

students who earned their baccalaureate degree from a college other than Moravian and the average score of their pre-test in each year. The table similarly shows the same results for students who attended Moravian College to earn their baccalaureate degree. Figure 1 shows the results in a bar chart from year-to-year.

A total of 113 students have taken the statistics module since the beginning of the 2015-16 academic year. Only 27 of those students earned their bachelor’s degree at Moravian College. The annual number of students from Moravian taking the module appears to be growing slowly but increasing as a proportion of the total number of students taking the module.

Table 1

*Average Pre-Test Score (%) Earned by Student Taking the Quantitative Academic Leveling Course Module by Year and Source of Undergraduate Degree*

Undergraduate Program Number of Cases	2015	2016	2017	2018*	Total
Non-Moravian n	43.52 27	42.63 19	43.10 21	42.37 19	42.97 86
Moravian n	34.29 7	49.29 7	45.63 8	41.00 5	42.78 27
Total n	41.62 34	44.42 26	43.79 29	42.08 24	42.92 113

Note: Only students taking the module in the first half of the 2018-19 academic year are included in this table.

Figure 1 shows the variation from year-to-year in how well Moravian alumni do as opposed to those from other colleges. Initial data shows Moravian alumni doing less well but recent data shows they are about equal to those from other schools. In total, over the three and one-half years, Moravian alumni appear to score equally as well as those from other schools in the pre-test.

### Findings

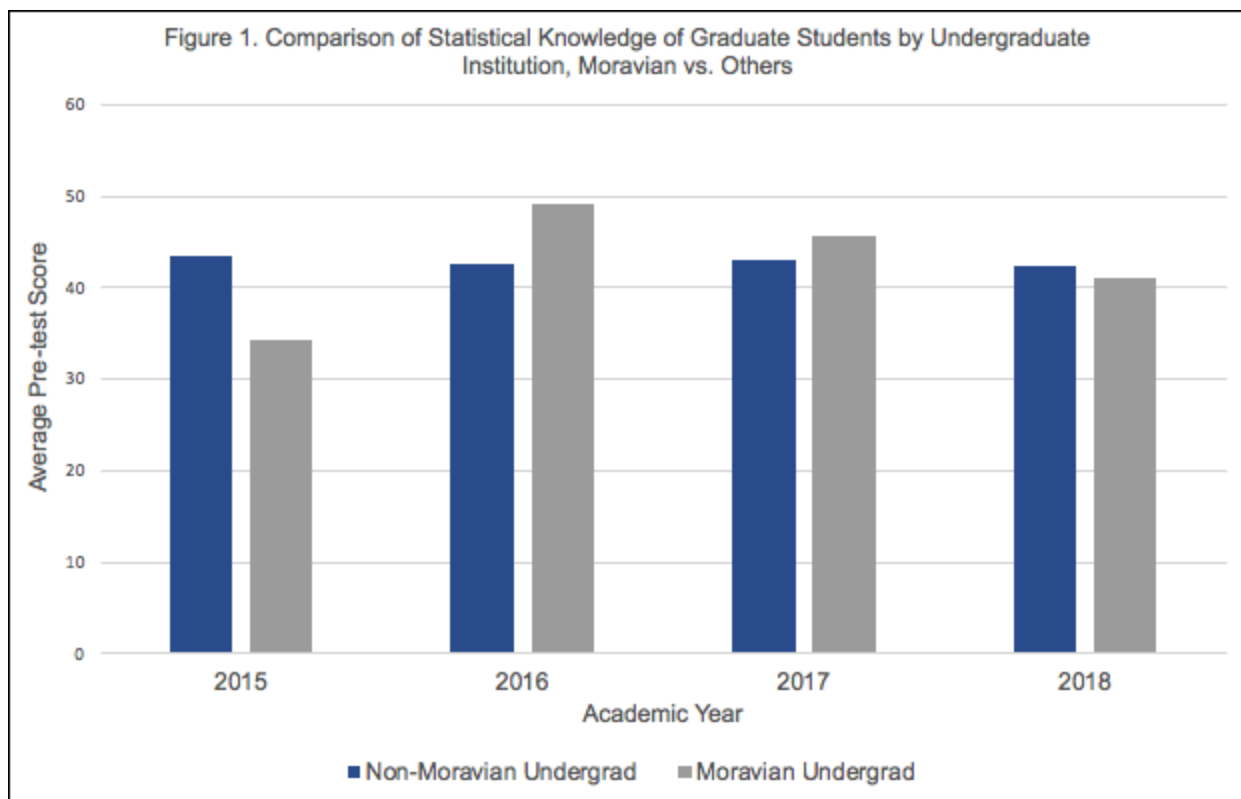
To determine if there was no difference between the groups, a t-test assuming equal variances was run to test the difference between the non-Moravian and Moravian overall average scores. The total number of cases rather than the yearly cases were used because of the small number of Moravian alumni in each year. The variances of each group were calculated, compared, and found not to be unequal using an F-test ( $F = 1.01$ ;  $p = 0.51$ ).

The mean score for Moravian alumni on the pre-test was 42.78%; for non-Moravian students the mean score was 42.97%. A two-tailed, equal variances t-test found no difference between

the scores of the two groups ( $t = 0.043$ ;  $p = 0.95$ ). Moravian alumni appear to be as equally knowledgeable of statistics as their peers from others undergraduate programs.

## Discussion

The ALC module in statistics used by the Graduate Business Program allows for a comparison between Moravian alumni entering that program and those entering from colleges other than Moravian. The comparison provides a benchmark to judge how well Moravian alumni are retaining what they learn in their undergraduate statistics courses.



These results suggest that Moravian alumni are doing as well as other students entering the graduate program from other programs. There is no statistically significant difference in the scores on the pre-test of the statistical module between the two groups. This is good news for the department.

The good news, however, needs to be tempered with the realization that alumni appear to be retaining less than half of their basic statistical knowledge based on the pre-test results. The module pre-test results answer only part of the question of how well Moravian alumni are prepared to use their statistical knowledge as they enter the work world.

This study is a limited view of alumni's statistical knowledge. Not all Moravian alumni chose to attend our graduate program, of course. Those who may have superior knowledge of statistics may be more likely to opt to attend other graduate programs. On the other hand, we do get an indication of the statistical knowledge of those alumni who choose our graduate program over others when compared to the Graduate Business Program students who come to us from other undergraduate experiences. The choice to attend our program is something both groups have in common. That gives us a reasonable basis for making a comparison of statistical knowledge between the groups and using the results to improve our programs.

### Using These Results

1. Continue the comparison as a measure of improvement in the development of undergraduate students' statistical knowledge. Specifically, this data will be updated at the end of this academic year and in following years.  
**Goal.** Achieve higher statistics knowledge scores for Moravian alumni compared to students from other colleges taking the ALC module by Fall 2020.
2. Identify the courses offered in each undergraduate major in addition to ECON 156 Economics and Business Statistics in which statistics are taught as part of the class material and assess students' knowledge of statistics entering that course.  
**Goal.** Assess students' knowledge in the Spring 2019 semester.
3. Use the feedback from the assessment of the courses identified in item 2 to address knowledge deficits by adjusting what is taught in ECON 156.  
**Goal.** Implement changes to ECON 156 in Fall 2019 semester.
4. Use the feedback from the assessment of the courses identified in item 2 to determine if students taking MATH 107 Statistics in place of ECON 156 do equally as well or better with respect to the applicable knowledge of statistics. Faculty should consider requiring ECON 156 of students in all department majors if it is found that students from ECON 156 do better in upper-level courses than students who take MATH 107.  
**Goal.** Assess difference and make curriculum decision in the Fall 2019 semester.

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## Appendix: Module SLOs and Topics

### Module: Foundations of Quantitative Research Techniques and Statistics

#### Expected Student Learning Outcomes

At the conclusion of the course, students will be able to:

1. Explain key statistical concepts: the population, the sample, and the statistical inference.
2. Define descriptive and inferential statistics.
3. Describe methods of collecting data.
4. Discuss sampling plans and sampling and non-sampling errors.
5. Describe how to assign probability to events.
6. Explain three rules that are used to calculate the probability of more complex events from the probability of simpler events.
7. Apply Bayes's Law to calculate conditional probability.
8. Recognize the significance of the sampling distribution.
9. Review the concepts of hypothesis testing.
10. Discuss the results of a test of hypothesis.
11. Describe how to make inferences about the population mean when the population standard deviation is unknown.
12. Explain how to draw inferences about a population variance.
13. Discuss the factors that identify one-way analysis of variance.
14. Recognize the effect on the response variable of two or more factors.
15. Describe the process of selecting one alternative from a list of several possible decisions.
16. Recognize the importance of acquiring, using, and evaluating additional information in decision analysis.

#### Course Sections and Sub-sections

##### What Is Statistics?

- o Key Statistical Concepts
- o Statistical Applications In Business

##### Data Collection And Sampling

- o Methods Of Collecting Data
- o Sampling
- o Sampling Plans
- o Sampling And Non-sampling Errors

##### Probability

- o Assigning Probability To Events
- o Joint, Marginal, And Conditional Probability

## Summative Assessment: Statistics

- o Probability Rules And Trees
- o Bayes's Law
- o Identifying The Correct Method

### Sampling Distributions

- o Sampling Distribution Of The Mean
- o Sampling Distribution Of A Proportion
- o Sampling Distribution Of The Difference Between Two Means
- o From Here To Inference

### Introduction To Hypothesis Testing

- o Concepts Of Hypothesis Testing
- o Testing The Population Mean When The Population Standard Deviation Is Known
- o Calculating The Probability Of A Type II Error
- o The Road Ahead

### Inference About A Population

- o Inference About A Population Mean When The Standard Deviation Is Unknown
- o Inference About A Population Variance
- o Inference About A Population Proportion

### Analysis Of Variance

- o One-Way Analysis Of Variance
- o Multiple Comparisons
- o Analysis Of Variance Experimental Designs
- o Randomized Block (Two-Way) Analysis Of Variance
- o Two-Factor Analysis Of Variance

### Decision Analysis

- o Decision Problem
- o Acquiring, Using, And Evaluating Additional Information