This study aims to examine the impact that voluntary participation in online discussion activities has on students’ understanding of statistical concepts in an undergraduate statistics course. A study of 90 undergraduate students enrolled in an introductory statistics course was conducted. The Levels of Conceptual Understanding in Statistics (LOCUS) assessment was utilized to measure students’ conceptual understanding in statistics. Form 1 of the 23 question Intermediate/Advanced online version of LOCUS was administered as a pre-test at the start of the 16-week course. Form 2 of the 23 question Intermediate/Advanced online version of LOCUS was utilized as the post-test after completion of the course. A statistical analysis of the difference between pre- and post-test data was completed in SAS® using propensity score matching techniques.
Examining the Impact of Discussion Activities on Student Understanding in Introductory Statistics

Rachael N. Becker
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Abstract
Introduction
Methods
Results 1
Results 2
Conclusion

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Intro

Motivation:
• Engage students in a large lecture class
• Create an environment where questions are encouraged

Literature:
• Focus on discussion boards in online statistics courses
• Encouraging statistical writing and thinking through journals and discussions
• Scaffolded discussions

Example Discussion

Abstract

Introduction

Methods

Results 1

Results 2

Conclusion

Research Question

Does voluntary participation in discussion board activities increase learning gains for students in an introductory statistics course?

You are told that a significance test is significant at the 5% level. From this information, can you determine whether or not it is significant at the 1% level? Explain?

I'm confused on this homework question.

No, you can't. Think about a p-value of 0.002. At the 5% significance level you would reject the null, but at the 1% significance level you would fail to reject the null.

How can you figure out if it is a two tailed test or one tailed test. Are there specific words you look for in the question to find this out?

Two tailed is when the symbol used for H0 is ≠. Left is < Right is >

Which measures (mean, median, range, etc.) are robust, and why?

• Median
• IQR (Interquartile range)

Are robust measurements; meaning they are much more resistant to outliers.

• Mean
• Standard Deviation
• Range

Are not robust measurements; meaning they are much more easily affected by outliers.

What is the Interquartile range?

The Interquartile range, or IQR, is calculated by doing Q3-Q1, and it's typically where the majority of your data set lies within.
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Data Collection

- \( n = 90 \) undergraduate students in introductory stats
- Online LOCUS Assessments
- Class Activities
- Survey Results

Continuous Variables

- Pretest score on LOCUS Assessment
- Posttest score on LOCUS Assessment
- Grades for Exam 1 to Exam 4
- Grades for Homework 1 to Homework 10 (dropped from model)
- Grades for Lab 1 to Lab 14 (dropped from model)
- Grades for Quiz 1 to Quiz 10 (dropped from model)

Categorical Variables

- Academic Program (6 categories as defined by school)
- Gender (2 categories provided as free response to a survey)
- Double Major (3 categories: No, Yes, and Did not answer)
- Academic Level (4 categories: Freshman, Sophomore, Junior, and Senior)
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Using Propensity Scores to Match

- Creating a comparable “control” group
- Utilizes logistic regression
- Matched based on probability of being in the discussion group

Logistic Model

$$\logit = 6.1 - 0.05(\text{PreLOCUS}) + 0.03(\text{Exam1}) + 0.03(\text{Exam2}) + 0.02(\text{Exam3})$$
$$- 0.07(\text{Exam4}) - 3.7(\text{PreMajors}) - 17.4(\text{Education}) + 7.9(\text{Arts})$$
$$- 3.5(\text{Business}) + 7.9(\text{Engineering}) - 0.7(\text{Gender}) - 0.6(\text{SingleMajor})$$
$$- 0.1(\text{DoubleMajor}) + 1.0(\text{Freshman}) - 0.1(\text{Sophomore}) - 0.8(\text{Junior})$$

Source of Macro Code and Calling Macro

Used the macro found in Fraeman’s (2015) A General SAS® Macro to Implement Optimal N:1 Propensity Score Matching Within a Maximum Radius

```sas
%mismatch_multi(pat_dsn = prop_score_discussion, pat_idvar = ID, pat_pvar = PropensityScore, cntl_dsn = prop_score_no_discussion, cntl_idvar = ID, cntl_pvar = PropensityScore, match_dsn = matched_pairs1, match_ratio = 1, score_diff = 0.10);
```
Examining the Equivalency Between the Groups

Before Matching

- **Categorical Variables**
  - Percentages are unequal
  - Females, Pre-Majors, Students with a single major, and Sophomores are over represented

- **Continuous variables**
  - Means between the two groups appear roughly equivalent

After Matching

- **Categorical Variables**
  - Percentages are roughly equal
  - A lot of categories and a small matched sample

- **Continuous variables**
  - Means between the two groups appear roughly equivalent, smaller sample size might be an issue

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Frequencies and Means for Variables Before Matching</th>
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<tbody>
<tr>
<td>Variables</td>
<td>Discussion Group</td>
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<td>Gender</td>
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<td>Mean (SD)</td>
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<td>Exam 1</td>
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<tr>
<td>Exam 2</td>
<td>82.34</td>
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<td>Exam 3</td>
<td>77.38</td>
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<td>Exam 4</td>
<td>87.66</td>
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<td>78.20 (16.68)</td>
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<tr>
<td>Exam 4</td>
<td>87.00 (10.64)</td>
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Proc ttest

Hypotheses:

\[ H_0: \mu_{\text{control}} - \mu_{\text{discussion}} = 0 \]
\[ H_1: \mu_{\text{control}} - \mu_{\text{discussion}} \neq 0 \]

Equality of Variances:
- Fail to reject null that they are unequal
- Use Pooled method

T-value (p-value):
\[ t = -1.52 \ (0.1372) \]

Conclusion: Fail to reject the null, not a significant difference between groups.
Limitations

- Small study
- Lack of demographic information
- Hard to define participation threshold

Conclusions

- Voluntary participation in online discussion activities did not significantly increase student learning gains

References


The LOCUS assessments can be found at https://locus.statisticseducation.org/
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