

# Meta-Analysis of Student Achievement on Natural Science FLO SCI1 in a 200-Level Biology Course

Dr. Clifton Franklund<sup>1</sup>

## Abstract

This report is a proof-of-concept for the proposed General Education assessment strategy at Ferris State University. Course-level student assessment data was gathered using TracDat and de-identified. The clean and tidy dataset was used to generate this report using the R statistical programming language. Thirteen semesters of student performance on a lecture exam were used to evaluate student competency on Ferris Learning Outcome (FLO) 1. A meta-analysis of these data demonstrated that performance was very near the criterion of success. There was substantial variation in enrollment and course performance over the timespan examined. The utility of reports like these to analyze, distribute, and act up General Education assessment data will be investigated using faculty focus groups in the fall of 2016.

## Keywords

Meta-Analysis — Forest plot — Natural Sciences — Scientific concepts

<sup>1</sup> General Education Coordinator, Ferris State University

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*Assessment is not a spreadsheet;  
it's a conversation. — Irmeli Halinen*

## Introduction

This report is a real analysis of course-level assessment data. However, its primary purpose is to serve as a proof-of-concept for the new General Education assessment process at Ferris State University. Assessment is perhaps best viewed as a scholarly activity that is focused upon programmatic improvement. Such scholarly work should be built upon, and contribute to, the relevant professional literature (Weimer,

2015). To emphasize that reality, this report is formatted in the form of a journal article and will be registered online with a digital objects identifier (doi).

## Methods

### Collection of assessment data

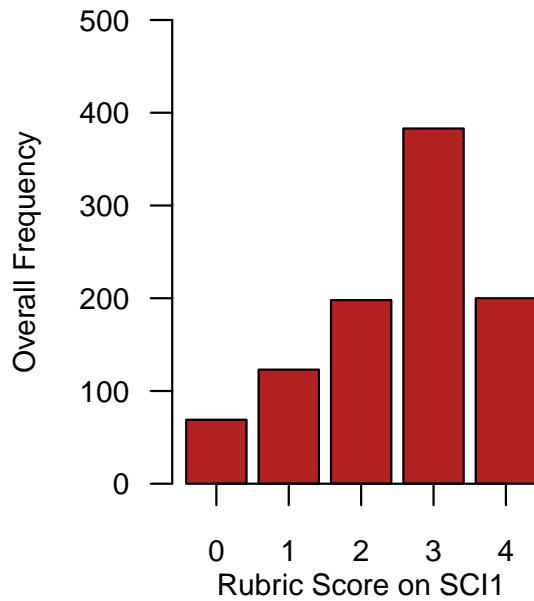
Student performance on the first lecture exam in a 200-level Biology course was analyzed. The content assessed in all exams was biological diversity. However, the number and format of the questions used varied by semester. Individual student scores were collected using the new General Education Natural Sciences "scores" data workbook for 13 semesters. Student scores were automatically converted to a rubric score by the workbook using the equivalencies shown in Table 1.

**Table 1.** Conversion of percentages to rubric scores

Percent correct	Rubric	Interpretation
0.0 to 49.9%	0	Unsatisfactory
50.0 to 59.9%	1	Beginning
60.0 to 69.9%	2	Developing
70.0 to 84.9%	3	Proficient
85.0 to 100.0%	4	Advanced

These workbook files contain personally identifiable information (PII) and are, therefore, subject to FERPA regulations. For this reason, they are not directly shared. Instead, they are permanently housed within a data folder in TracDat: Core Competency: Natural Sciences ⇒ Assessment ⇒ Proof\_of\_Concept.

[illegible]



**Figure 1.** A histogram of the distribution of individual rubric score frequencies over all twelve semesters.

The overall overall average rubric score for all 13 semesters was 2.54. The distribution of the rubrics scores is shown below.

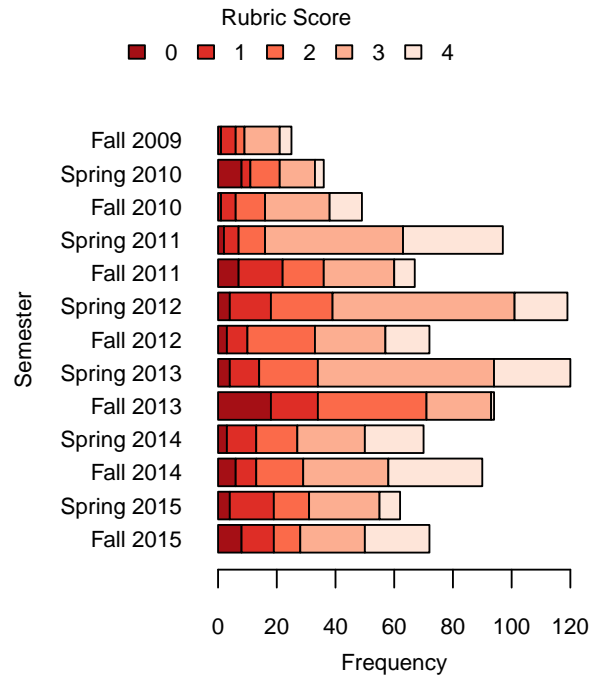
**Table 2.** One-way ANOVA analysis of scores by semester

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Semester	12	142.74	11.89	9.85	0.0000
Residuals	960	1159.22	1.21		

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### Meta-analysis

A meta-analysis of the student learning results was performed by examining the weighted average of rubric scores. The fweighted average for semester performance was calculated



**Figure 2.** A barplot showing the distribution of rubric scores broken down by semester.

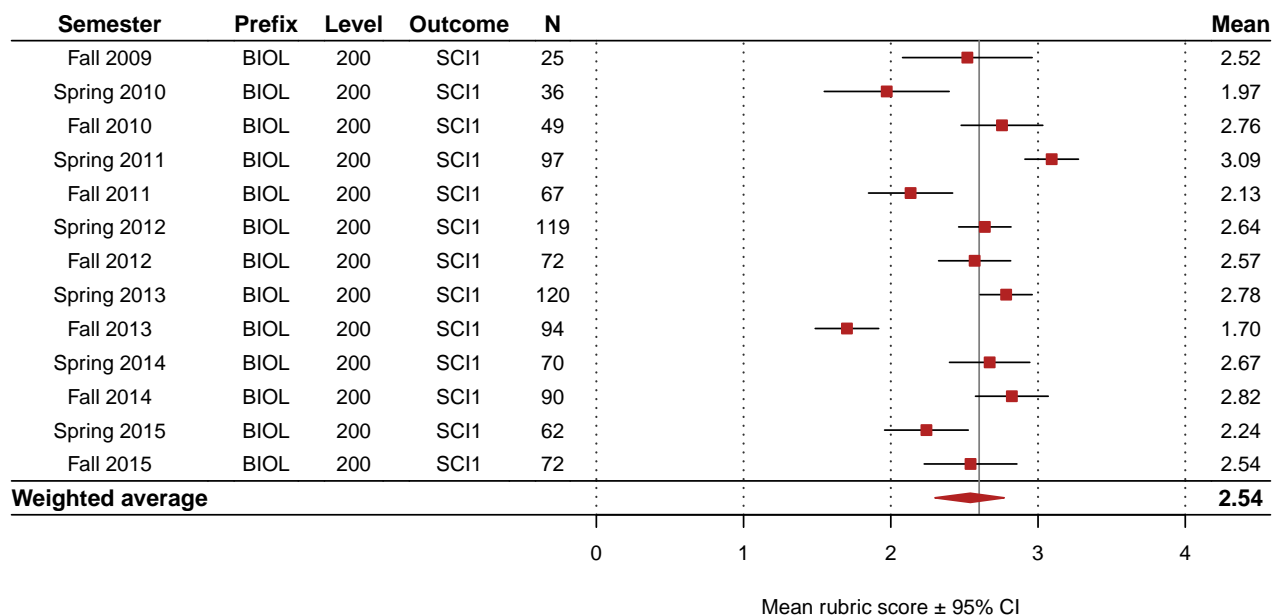
using formula 1. The confidence interval for the weighted mean was calculated using the calculated variance as described by Cochran (Cochran, 1977). The calculation for weighted variance is shown in formula 2.

$$\bar{X}_w = \frac{\sum X_i W_i}{\sum W_i} \quad (1)$$

$$(SEM_w)^2 = \frac{n}{(n-1)(\sum P_i)^2} \left[ \sum (P_i X_i - \bar{P} \bar{X}_w)^2 - 2 \bar{X}_w \sum (P_i - \bar{P})(P_i X_i - \bar{P} \bar{X}_w) + \bar{X}_w^2 \sum (P_i - \bar{P})^2 \right] \quad (2)$$

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**Figure 3.** A forest plot of the average scores for each semester with a weighted mean estimate for the entire period investigated. Error bars indicate the 95% confidence intervals.

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## Discussion

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**Table 3.** Table of Grades

Name		
First name	Last Name	Grade
John	Doe	7.5
Richard	Miles	2

## Faculty feedback

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**Word** Definition

**Concept** Explanation

**Idea** Text

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### Plan of action

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## References

- Buneman, Peter, Sanjeev Khanna, and Tan Wang-Chiew (2001). "Why and Where: A Characterization of Data Provenance". *Database Theory — ICDT 2001 8th Int. Conf. London, UK, January 4–6, 2001 Proc.* Ed. by Jan den Bussche and Victor Vianu. Berlin, Heidelberg: Springer Berlin Heidelberg, pp. 316–330. DOI: [10.1007/3-540-44503-X\\_20](https://doi.org/10.1007/3-540-44503-X_20).
- Cochran, William Gemmell (1977). *Sampling techniques*. 3rd Editio. New York: Wiley, p. 428.
- Knuth, D. E. (1984). "Literate Programming". *Comput. J.* 27.2, pp. 97–111. DOI: [10.1093/comjnl/27.2.97](https://doi.org/10.1093/comjnl/27.2.97).
- Weimer, Maryellen. (2015). *Enhancing scholarly work on teaching and learning*. John Wiley & Sons.

## Acknowledgments

So long and thanks for all the fish (Knuth, 1984).