Does categorizing laboratory exercise questions before class using Bloom's Taxonomy improve the student's learning process and outcomes?

Wairimu Magua, PhD, MS[1] and Mari Palta, PhD[1]

[1] *Department of Population Health Sciences, University of Wisconsin-Madison*

Overview

Course Goals

Introduction to Biostatistics for Population Health is a course designed to help students develop skills in identifying and applying suitable statistical methods to analyze population health data.

Using Bloom's Taxonomy

A Bloom's taxonomy tool has been used in classroom activities as a way to enhance higher order cognitive skills and to develop metacognition knowledge, the ability to choose a study strategy suitable for the cognitive task.[1]

Learning Challenges

Students in our biostatistics course usually have advanced graduate or medical degrees and bring highly varied backgrounds. Since they encountered mathematical courses earlier in their academic careers, many students find this course challenging. To overcome this challenge, we used Bloom's taxonomy that is contextualized to our course to organize laboratory and quiz material. We invited students to classify laboratory questions into Bloom's taxonomy levels before attending each laboratory session.

Hypothesis

We hypothesize that categorizing questions based on their cognitive learning outcomes before working on the solutions will help students reflect on the questions, and hence deepen student understanding of how to better answer laboratory exercise and quiz questions, and deepen overall understanding of the material.

Approach

We used a Likert scale to probe student self-perception of the extent to which the question classification influenced how students prepared for laboratory. Heat maps were used to explore how accurately students classified questions. We used crossed random effects and least squares linear regression models to investigate whether the classification exercise influenced learning outcomes measured with respect to quizzes and exams.

Lessons Learned

1. The classification exercise helped students reflect on questions before lab sessions, influenced how students prepared for lab, and helped students link knowledge levels to research.
2. Classification exercise participation dose was associated with higher overall performance.

Table 1. Bloom's Taxonomy[2] Levels that are Contextualized for the Course

Learning Level	Learning Goals
Knowing	Know and recognize terminology, symbols, definitions and formulas
Calculating	Execute probability and statistical calculations from information provided
Understanding	Explain the meaning, assumptions, and interrelationships of concepts and formulas
Interpreting	State the assumptions, conclusions and interpretation in subject matter terms of statistical and probability computations

Calculating and interpreting questions more accurately classified than those in other levels

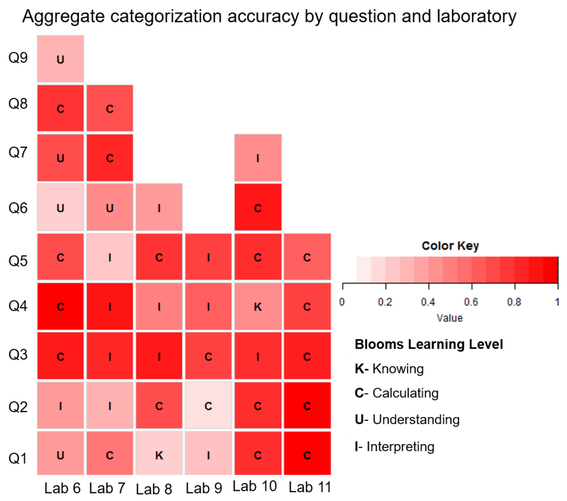

Fig 1. ***Degree to which the Bloom's level assigned to questions by the students aligned with those assigned by the investigators.***

How accurate was the categorization by question and lab?

1. Explicit instruction classification might have improved the accuracy of question classification.
2. Lower classification accuracy in knowing and understanding levels impeded review of correlation between categorization accuracy by question and quiz and exam performance in questions assigned to same levels.

Students reported that the classification exercise helped them to better prepare for labs

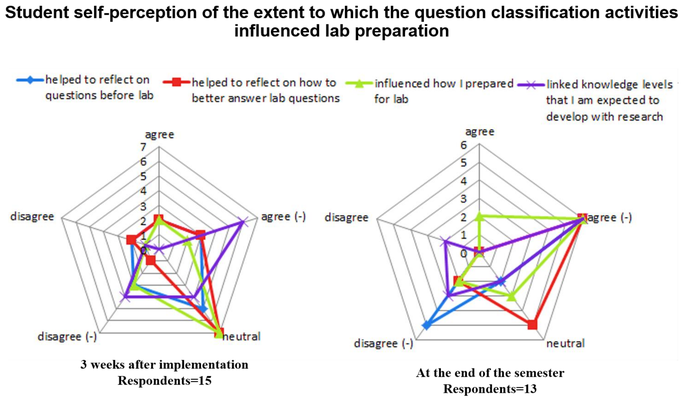

Fig 2. ***Change of student self-reported answers over time to four questions on a five item Likert scale (disagree, somewhat disagree, neutral, somewhat agree, agree). The scale measured whether the classification exercise helped students (a) reflect on questions before the lab, (b) reflect on how to better answer questions, (c) prepare for lab, and (d) link the knowledge levels with statistical analysis in research.***

How did the perception of the classification exercise value change over time?

1. Since the students shifted from neutral to somewhat agree, a free text follow up question might have provided information on the perceived shortfalls of the exercises.
2. Labs progressively got more difficult and may have influenced the results.

Participation dose correlated to overall class performance

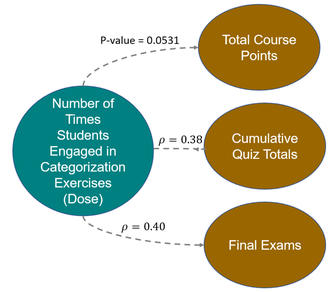

Fig 3. ***Correlation between the level of engagement in the categorization exercise and cumulative learning outcomes.***

Impact of the intervention on learning outcomes

1. There were no statistically significant association at α=0.05 between categorization accuracy and quizzes and exams.
2. Dose and total cumulative course points had a weak positive association with **p-value=0.053**.
3. Dose may be a proxy measure of student engagement that might result in better cumulative performance regardless of intervention.

Limitations

1. Explicit categorization instructions may have improved the quality of the data.
2. Materials and exams got harder over time; hence, comparison data collected in the first third of the course may have been inadequate.
3. Sample size was small.

References:

1. Crowe, Alison, Clarissa Dirks, and Mary Pat Wenderoth. "Biology in bloom: implementing Bloom's taxonomy to enhance student learning in biology." *CBE-Life Sciences Education* 7, no. 4 (2008): 368-381.
2. Krathwohl, David R. "A revision of Bloom's taxonomy: An overview." *Theory into practice* 41, no. 4 (2002): 212-218.

Acknowledgment

I am grateful to Dr. Devin Wixon for her guidance and for generously sharing her insights and advice as I worked towards the completion of the Delta Certificate Program in Research, Teaching and Learning. I would also like to express gratitude to Dr. Jessica Maher for all her support and to Janaina Peabody for seamless and successful management of events. Lastly and importantly, I am truly privileged to partner with a great scholar and mentor, Dr. Mari Palta. I remain deeply thankful for the privilege to work with her.