

Learning Biochemistry the Write Way: Applying Writing to Learn in STEM Education

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Introduction

- Several studies¹⁻⁵ pertaining to STEM disciplines have demonstrated enhanced conceptual understanding by students when the learning involved writing about the concept.
- This effective method of pedagogy is known as **writing-to-learn (WTL)**¹.
- Further analyses of the studies that demonstrated enhanced student learning from the use of WTL indicate that the writing is most effective when the writing assignments contain four important constructs.
 - (1) A meaning-making writing task
 - (2) Clear writing expectations
 - (3) Interactive writing practices
 - (4) A chance for students to partake in metacognition⁶.
- This study aimed to address the following question that have yet to be answered thoroughly with research:
 1. Can WTL assignments that explicitly include all four of the aforementioned constructs **enhance student conceptual understanding in general biochemistry**?

Method

Course: A first semester General Biochemistry Course for Junior/Senior year students at a small university.

Experimental Design:

- For two of the three concepts students either received just the lecture or received the lecture and completed a writing draft, gave/received peer feedback, and completed a second writing draft. This was done until all three concepts were taught by both methods.

- Students were given specific peer review guidelines to follow.

Measures:

- Pre/Post student scores** on selected written response exam questions mirroring the concept in question were compared to assess the relationship between teaching method of concept and student conceptual understanding.
- Student interviews** were conducted to assess mechanisms by which writing assignments might contribute to student learning.
- Holistic rubric scores**—first and second drafts of writing, in addition to comments made, and comments received during the peer review process were scored with the use of a holistic scoring rubric
- Constraints for performance groups** were set based on student scores on a scale of 0 to 5
 - **Low Performance:** score ≤ 3.0
 - **High Performance:** score > 3.0

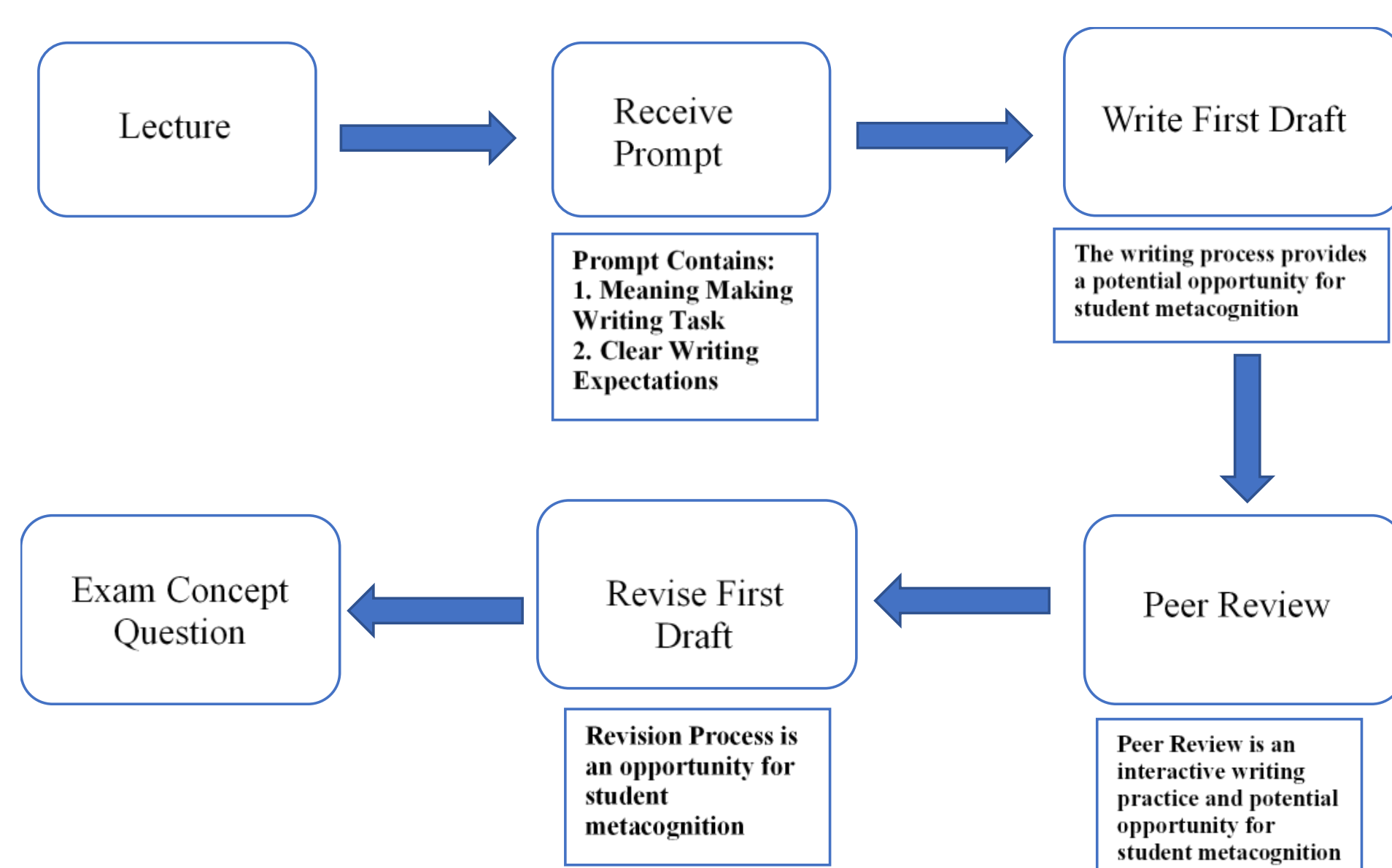


Figure 1. Flow chart depicting the order of events for the WTL assignment. The areas in which the constructs were applied are noted.

Results

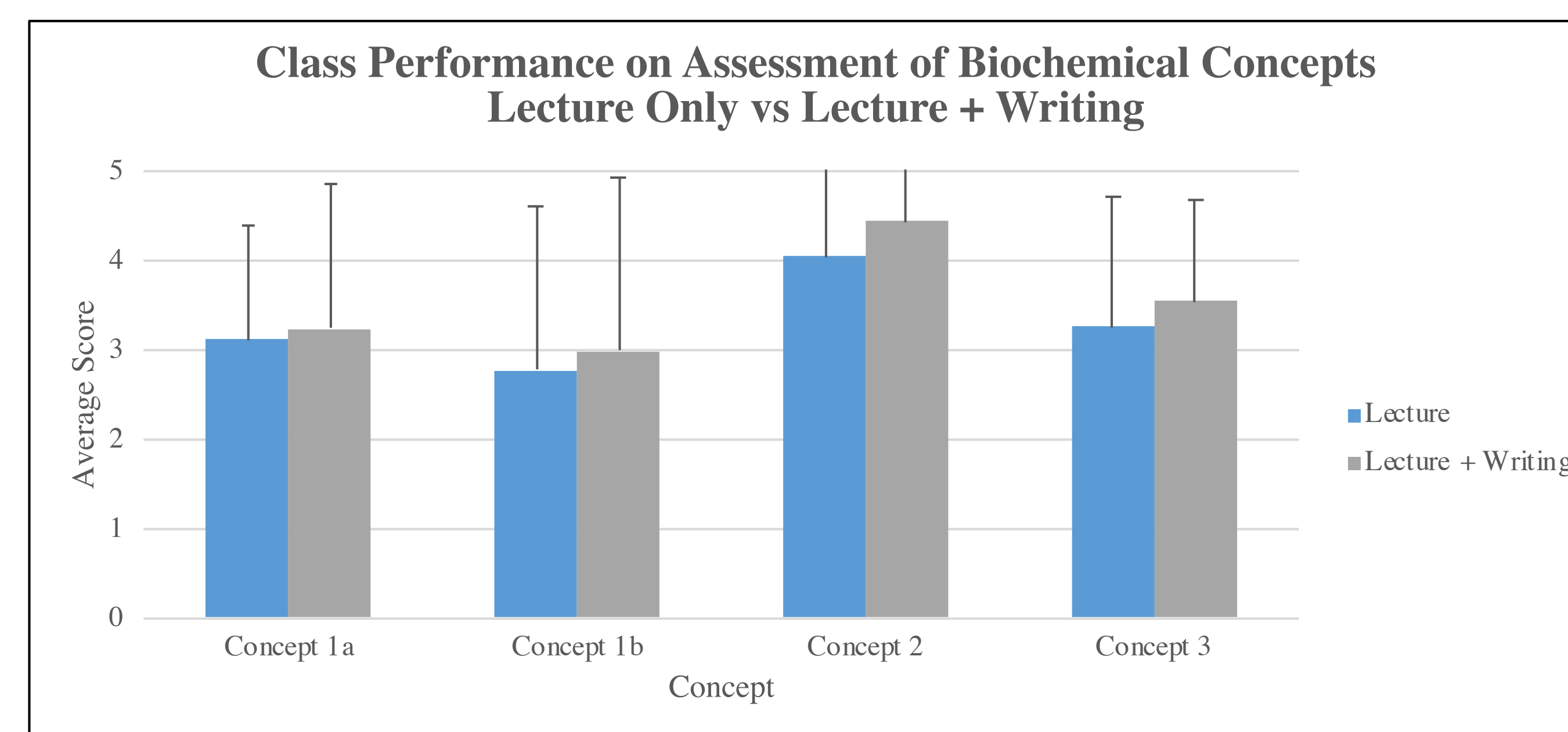


Figure 2. Comparison of average student scores for lecture alone and for the combination of lecture and the writing assignments. Improvement to students overall scores were observed when the writing assignment was utilized in combination with the lecture.

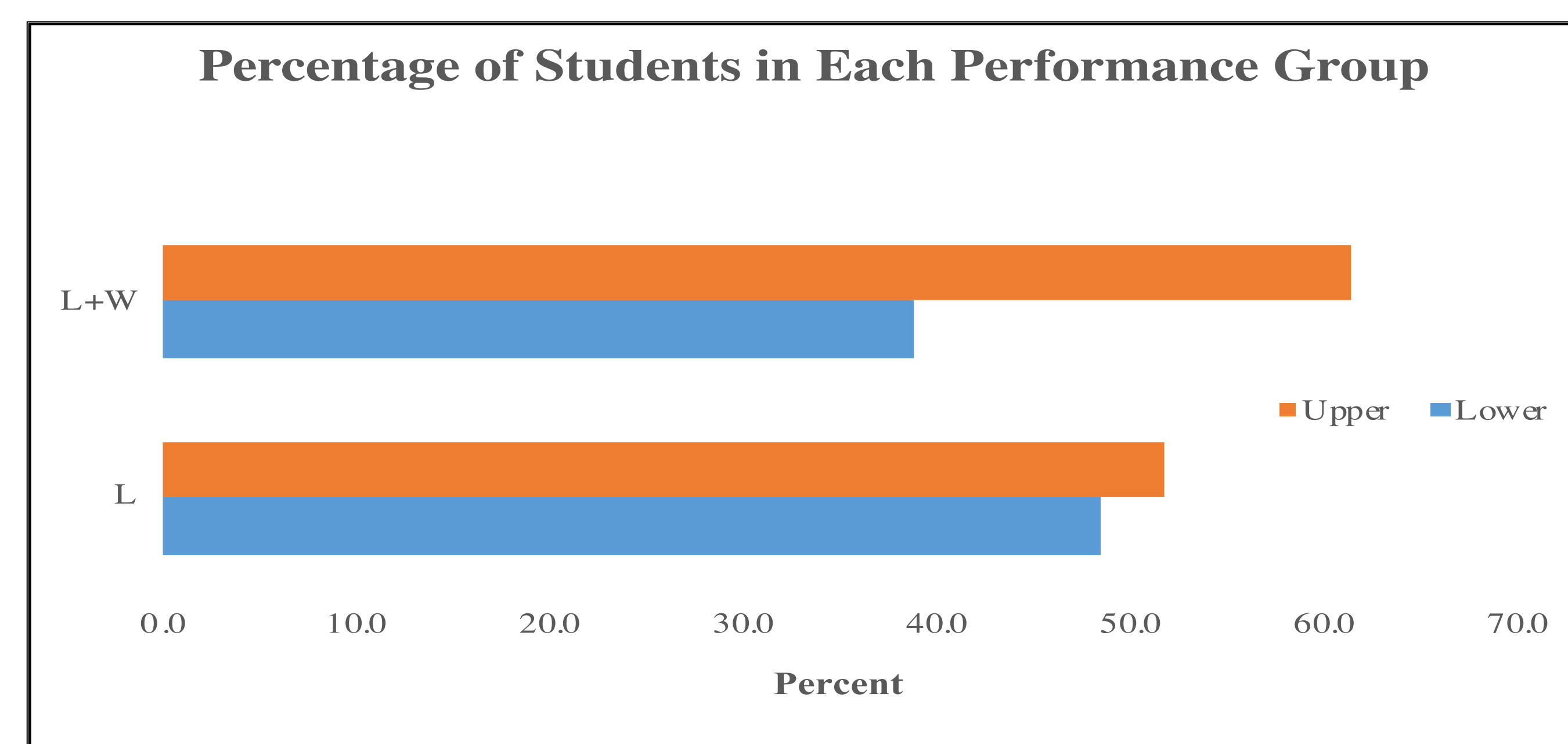


Figure 3. Comparisons of the percentages of students in each group for both lecture and lecturing plus writing. A significant increase in the number of students in the upper group was observed when the writing assignment was utilized.

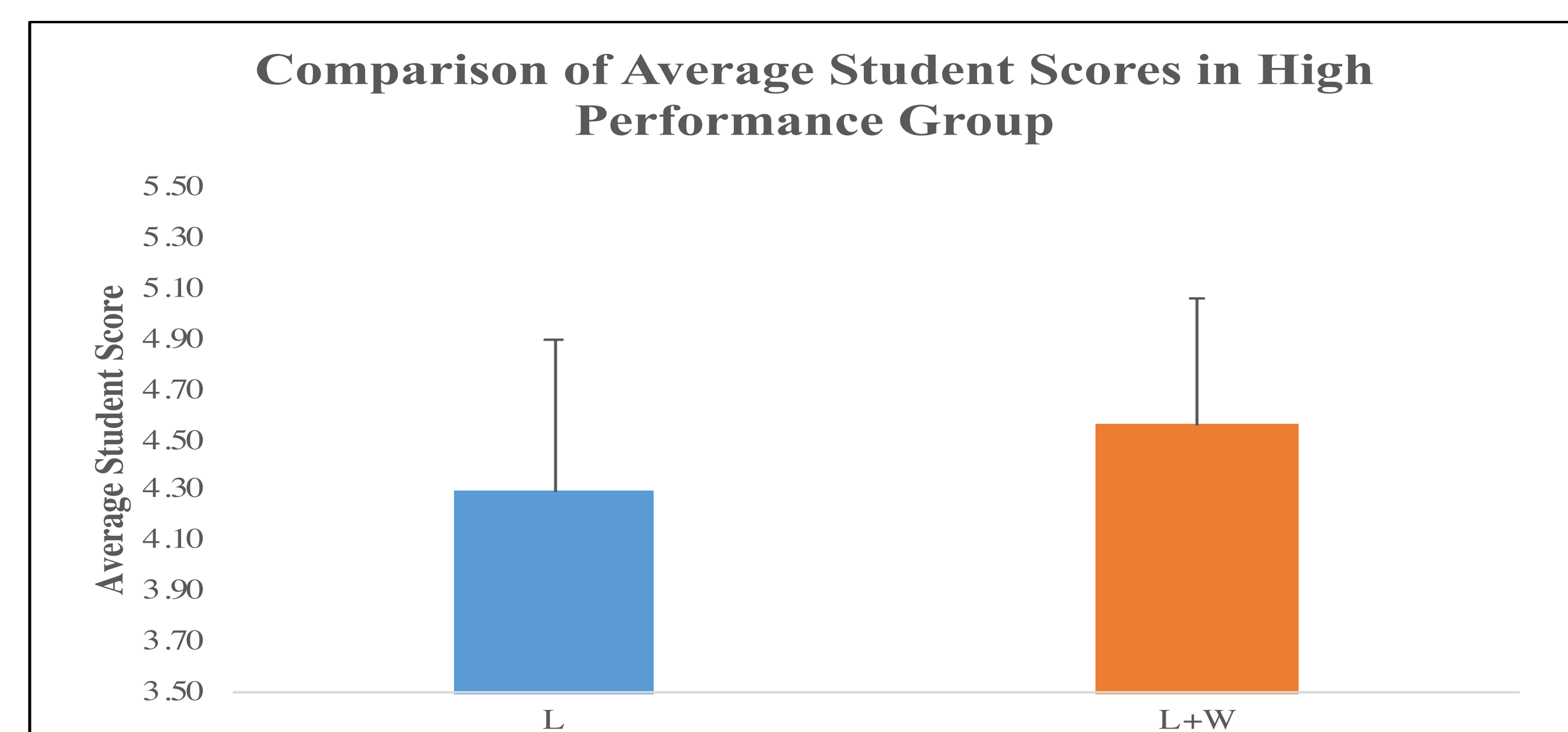


Figure 4. Comparison of the average student scores of students in the high-performance group for both lecture and lecture plus writing. An overall increase in student average score in the higher performance group was observed when a writing assignment is included.

Student average scores:

1. After three semesters the average scores of all three concepts have shown higher averages when the student completes a WTL assignment in addition to receiving a lecture covering the concept.

Analysis of performance groups:

1. When students receive both the lecture and the writing assignment, the percent of students who fall into the low performing changes from 48.4% to 38.7%, a decrease of almost 10%.
2. When both lecture and a writing assignment are implemented, the average score of students who fall into the high-performance group increases significantly from 4.30 up to 4.56 ($p = 0.018$) with an effect size of 0.47 (Cohen's d).

Discussion

- Results to date suggest the following:

1. Including writing assignments that contain the four constructs associated with enhanced student learning is a **valuable tool for promoting deep understanding of various Biochemistry concepts**.
 2. The utilization of writing assignments in addition to lecturing has the potential to **increase the percentage of students demonstrating a deeper understanding (high performance) of concepts**.
 3. The utilization of writing assignments in addition to lecturing has the potential to **further deepen conceptual understanding for students who were high performing with just lecture instruction alone**.
- Additional questions that can be addressed from the artifacts of the data collected include:
 1. What are the roadblocks that may prevent students from crossing into the high performing group from the low performing group?
 2. Are there any interventions, in terms of content or instruction, already existing or that could be developed to help students navigate these roadblocks?

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