

## Description of the MWrite Project

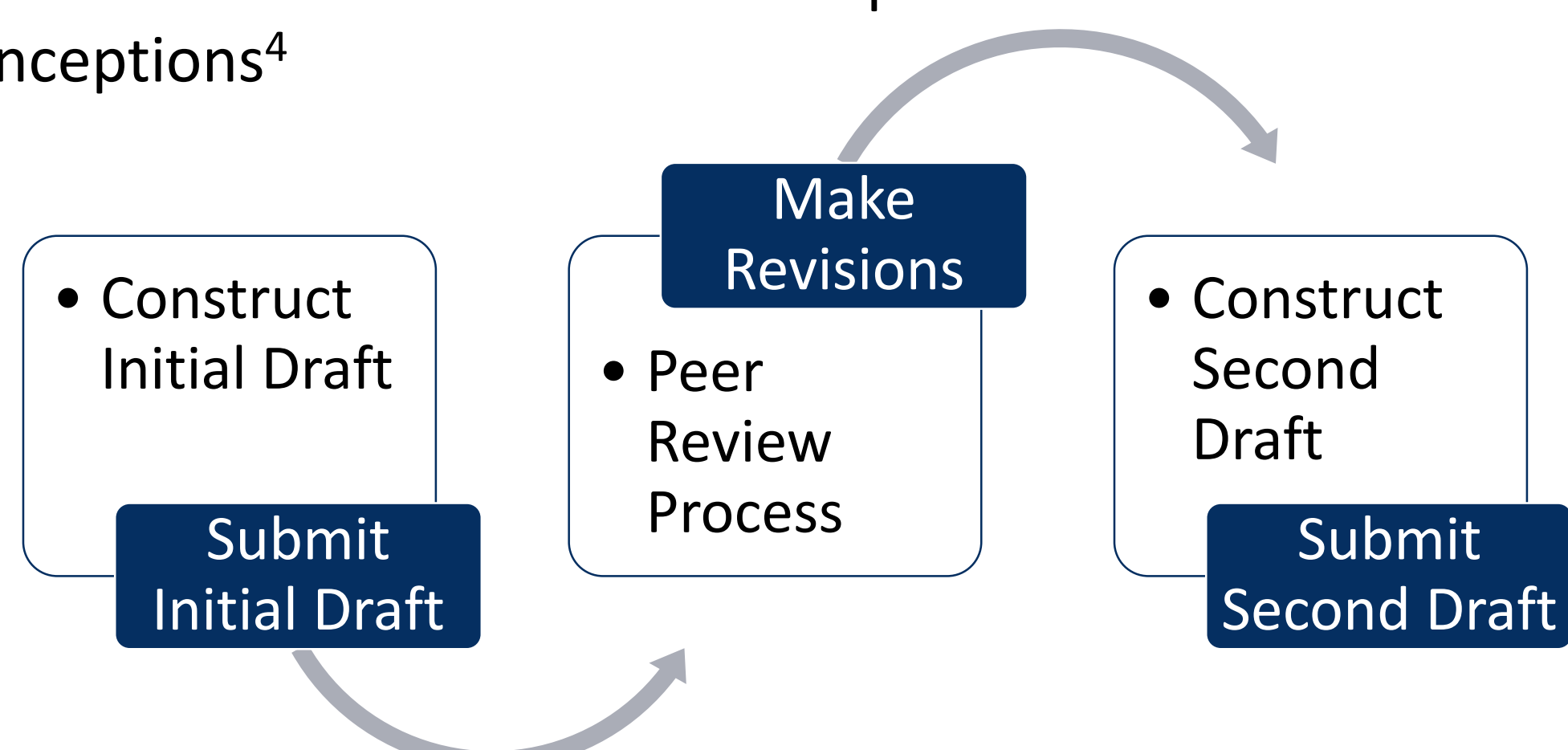
The goal of the MWrite program is to implement Writing-to-Learn (WTL) pedagogy in classrooms at the University of Michigan. WTL assignments are designed to promote deep conceptual learning of fundamental concepts.<sup>1-3</sup>

### MWrite prompt:

- Real world context based on news reports or scientific literature
- Non-expert audience
- Specified role relating to authentic context

### Writing process:

- Students write an initial draft in response to the prompt
- Students participate in anonymous peer review
- Students revise their writing
- Peer review and revision results in improved drafts and remediation of misconceptions<sup>4</sup>



1. Finkenstaedt-Quinn, S. A.; Halim, A. S.; Chambers, T. G.; Moon, A.; Goldman, R. S.; Gere, A. R.; Shultz, G. V., *Journal of Chemical Education* **2017**.
2. Reynolds, J. A.; Thaiss, C.; Katkin, W.; Thompson, R. J., *CBE-Life Sciences Education* **2012**, *11* (1), 17-25.
3. Rivard, L. O. P., *Journal of Research in Science Teaching* **1994**, *31* (9), 969-983.
4. Halim, A. S.; Finkenstaedt-Quinn, S.A.; Olsen, L. J.; Gere, A. R.; Shultz, G. V., *CBE-Life Sciences Education* **2018**.

## Research Objectives

The objective of this project was to see how the administration of a WTL assignment impacted students' conceptual understanding of acid-base concepts over the course of one semester.

- The WTL assignment was given in an Organic Chemistry II laboratory in Fall 2016
- Students enrolled in the Winter 2017 semester served as the comparison group
  - they completed a separate, non-WTL assignment.
- Students completed pre and post- three tiered surveys that tested their conceptual understanding of organic chemistry

### Research Questions

1. How does the implementation of a WTL assignment support the development of students' understanding of acid-base concepts?
2. How does the use of a WTL assignment in a second-semester organic chemistry course impact students' confidence when answering acid-base problems?

## Theoretical Framework: Vygotsky's Sociocultural Theory

The design, data collection, and findings of this study were informed by Vygotsky's Sociocultural Theory. By completing the WTL assignments, students are learning about organic chemistry concepts through the process of writing out their thoughts. This process affords them the ability to interact with the material and provides insight about their conceptual understanding. Since the MWrite process is social in nature, the students are able to receive feedback on their writing from their peers and incorporate this feedback on their final draft.

5. Prior, P., A sociocultural theory of writing. *Handbook of writing research* **2006**, 54-66.
6. Vygotsky, L. S., *Mind in society: The development of higher psychological processes*. Harvard university press: 1980.
7. Vygotsky, L., *Thought and language*. MIT Press: Cambridge, MA, US, 1962; p xxi, 168-xxi, 168.
8. Fulwiler, T., Writing: An act of cognition. *New directions for teaching and learning* **1982**, *1982* (12), 15-26.

## Acid-Base Assignment Description

**Contraindication of Levothyroxine**

**Context:** Certain medications can be dangerous or less effective when taken in combination. For example, Levothyroxine, which is used to treat hypothyroidism, is less effective when taken in combination with calcium carbonate. In contrast, calcium citrate, which is also an over the counter calcium supplement, causes little or no interference with the absorption of Levothyroxine by the body.

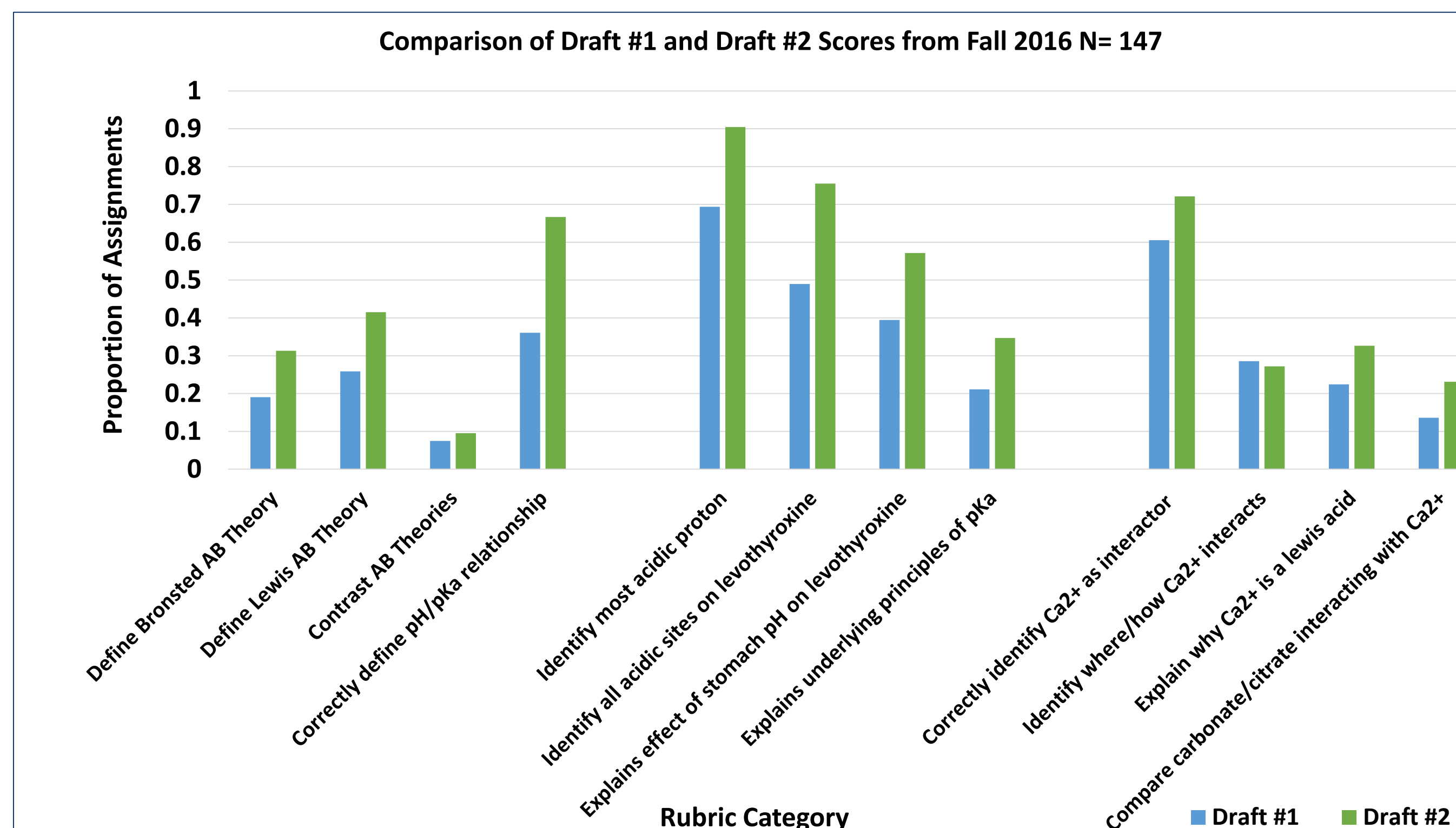
The WTL assignment focused on having students explain the acid-base interactions that are involved when Levothyroxine enters the stomach.

**Role:** For this assignment you'll take the role of a medicinal chemist writing a letter to a collaborator, who is a physician researcher planning a clinical trial. The goal of the trial is to investigate the co-administration of Levothyroxine with calcium supplements. The physician, who took organic chemistry several years ago, needs your help to understand the interactions between molecules like Levothyroxine and biological systems. Specifically, your collaborator needs to understand how neutral levothyroxine is deprotonated to its sodium salt form, which is more absorbable in the body, and how Ca<sup>2+</sup> as a Lewis acid may interact with levothyroxine to prevent its absorption. Finally, the physician will need to understand why Ca<sup>2+</sup> in calcium carbonate may interact with Levothyroxine, preventing its absorption, where Ca<sup>2+</sup> in calcium citrate will not.

**Audience:** Targeted Concepts

## Findings from the Scoring of the WTL Assignments and Survey

Students' assignment drafts were scored using a 12-category rubric. Students received a 0 if that criteria was not present and a 1 if that criteria was present in their writing.



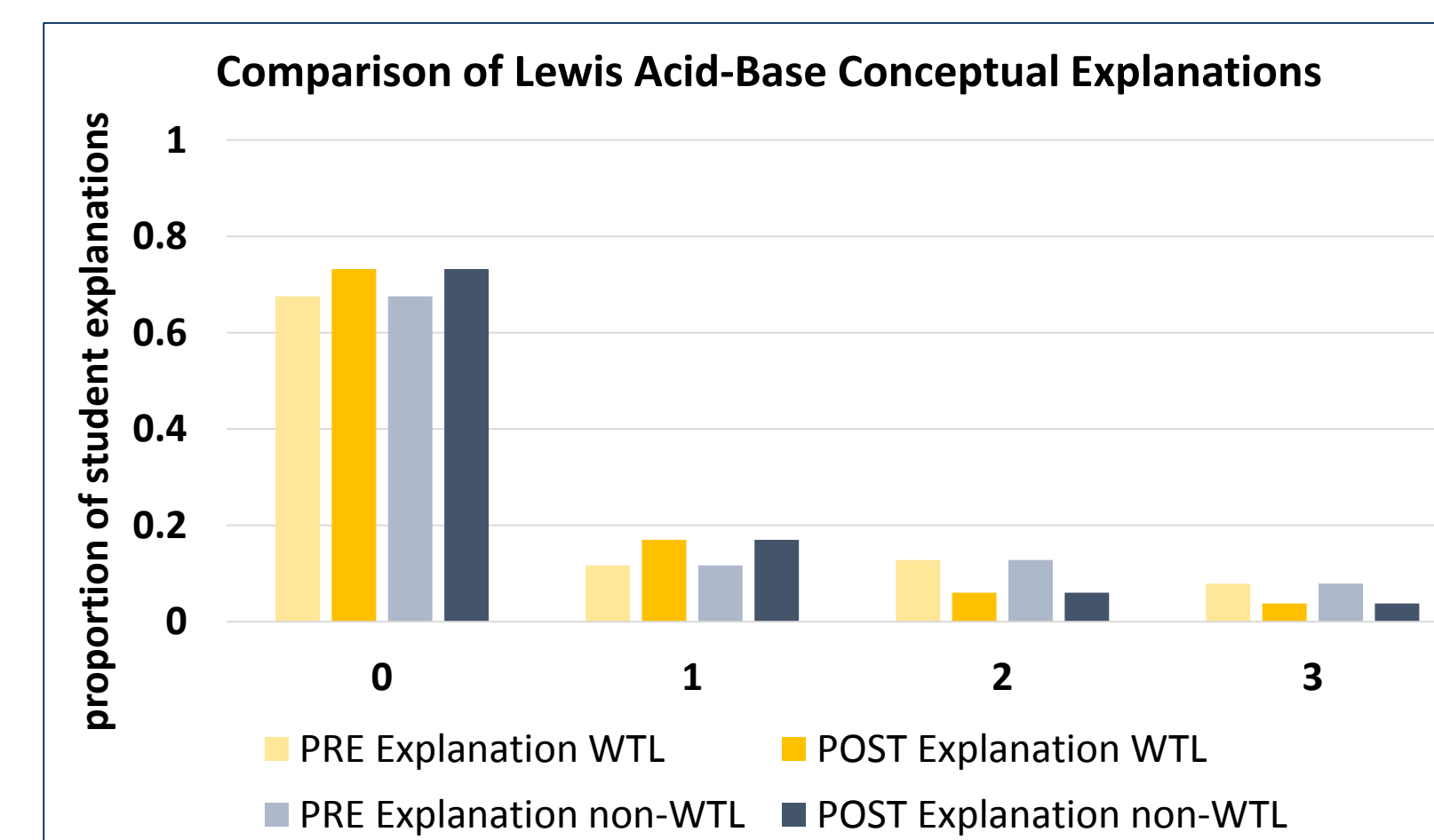
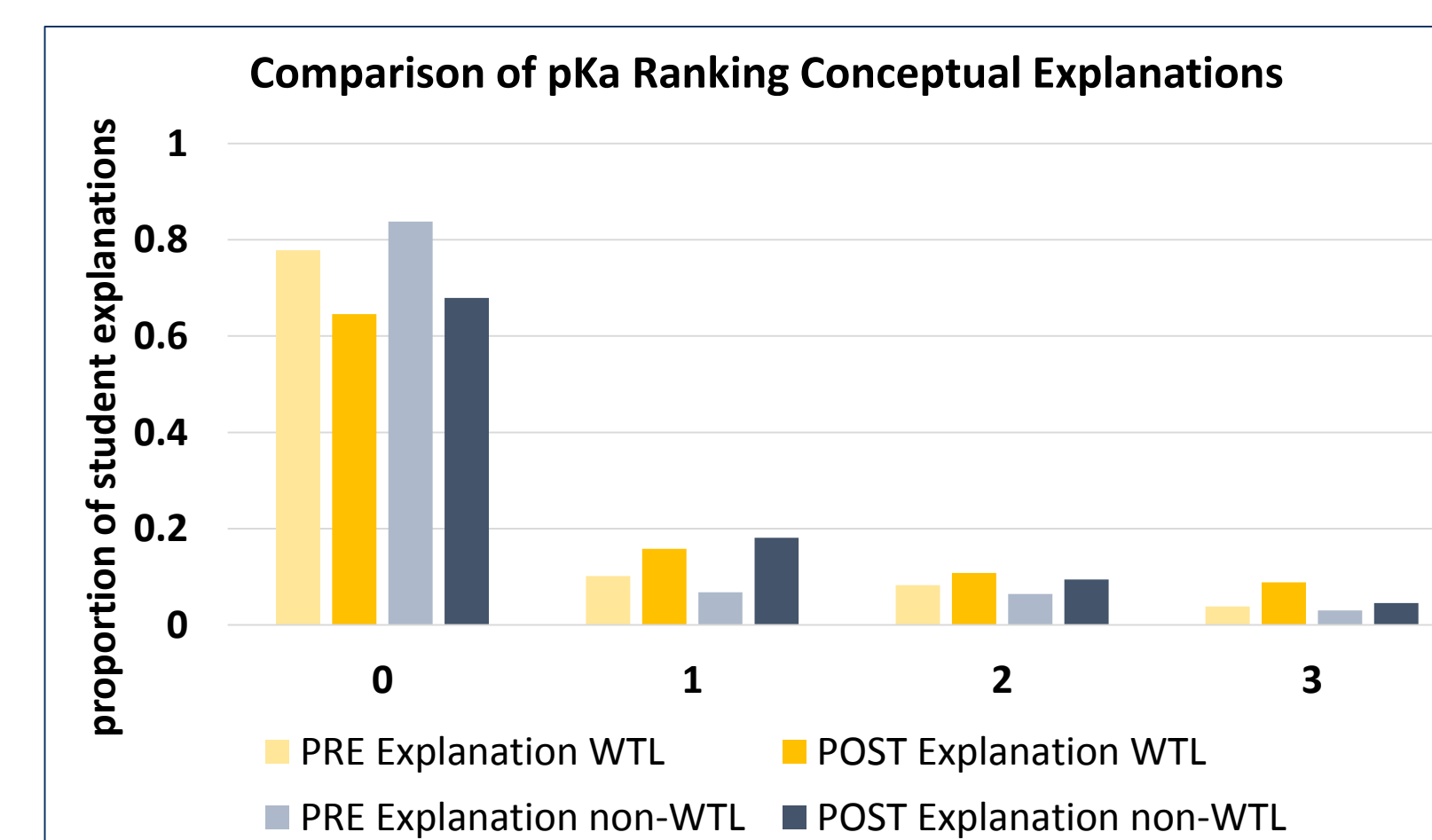
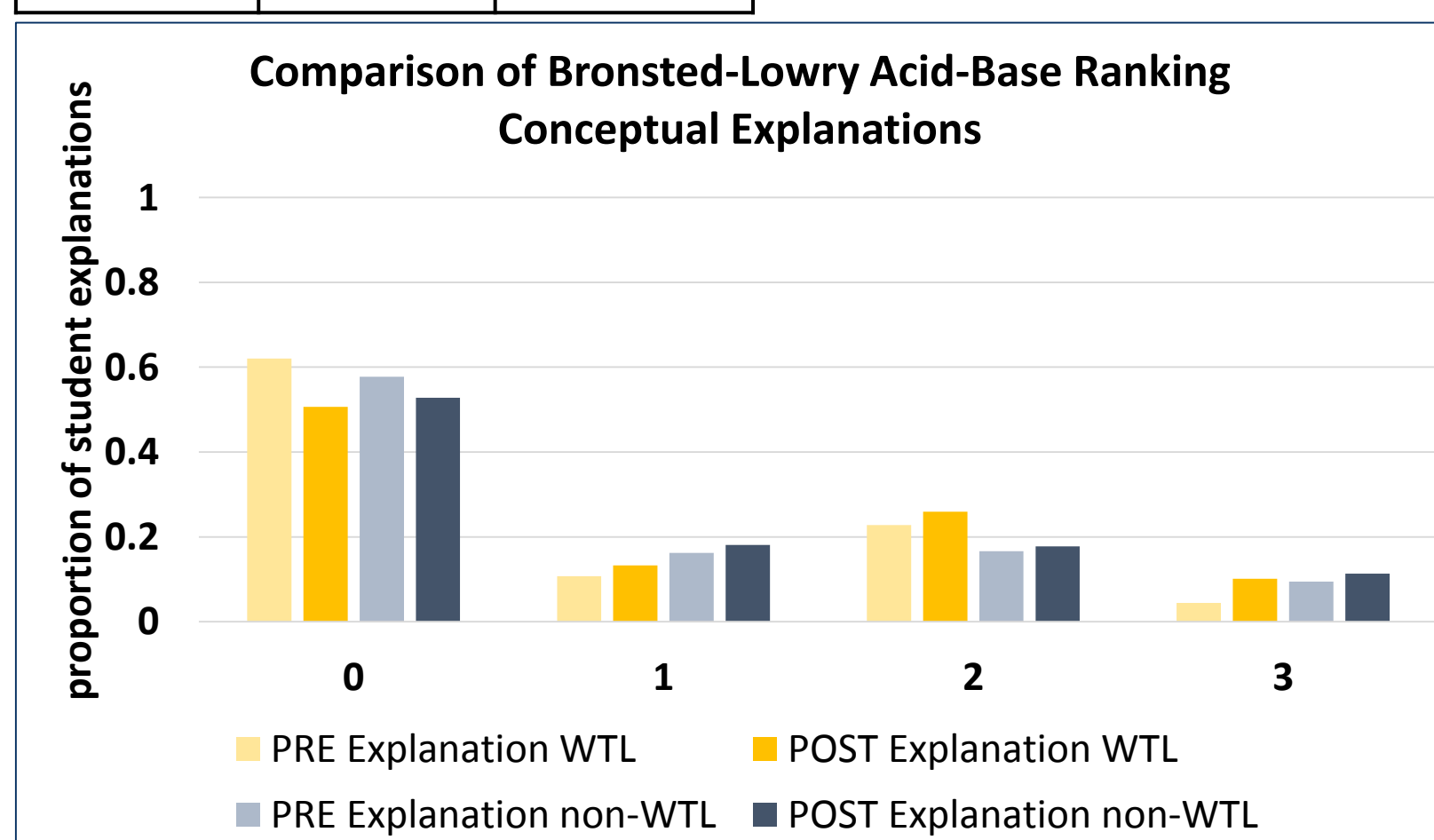
A pre and post-survey was used to measure students' conceptual learning of acid-base chemistry. The conceptual questions were three-tiered and covered multiple choice and open-ended explanations questions, along with students' ranking of their confidence. The open-ended explanations were analyzed with a rubric, with scores ranging from the lowest of 0 and a highest of 3. Differences in pre and post survey for the explanations and total confidence rankings were calculated using a non-parametric statistical test, the Wilcoxon Signed Rank test.

	Pre and Post Bronsted-Lowry Acid-Base Conceptual Explanations		Pre and Post Total Confidence Ranking	
	WTL	Non-WTL	WTL	Non-WTL
p-value	0.019*	0.248	<0.000*	<0.000*
Effect Size	0.20	0.09	0.46	0.25

	Pre and Post pKa Ranking Conceptual Explanations	
	WTL	Non-WTL
p-value	0.010*	0.001*
Effect Size	0.29	0.28

	Pre and Post Lewis Acid-Base Conceptual Explanations	
	WTL	Non-WTL
p-value	0.341	0.003*
Effect Size	0.11	-0.23

An \* indicates statistical significance with  $p < 0.050$ . There were 158 survey responses collected in 2016 (WTL) and 265 collected in 2017 (non-WTL).



9. Cohen, J., *Psychological bulletin* **1992**, *112* (1), 155.

## Reflective Student Interview Findings

Reflective interviews were conducted with three students (Abbey, Aaron, and Margaret) in the Fall of 2016 after they had completed all three components of the assignment.

### Findings showed...

- All three students were able to summarize the objectives of the prompt which provided proof for the construct validity of the WTL assignment.

*Aaron: The way that I saw it was it was to take our experiences and what we learned in Orgo I and Orgo II, pretty much apply them to a real world concept of levothyroxine, which is a medication used to treat hypothyroidism. So, it was more or less just trying to get us to see how acidity is involved with medications and how they're absorbed by the body.*

- The students seemed to be able to verbally explain the relationship between the pKa values of the levothyroxine and how it would interact in the stomach pH.

*Margaret: Okay, which one's going to be deprotonated to form that salt that's then going to be absorbed? That basically means look at the pKa of all of the protons, and see which one's going to come off first.*

- Students struggled with explaining how the Ca<sup>2+</sup> acted as Lewis acid and interacted with Levothyroxine.

*Margaret: Person four...had the best review...They're the only ones I believe that discussed ... Yeah, so it says the [Margaret's] letter is slightly complex and hard to understand when describing the Lewis acid base interaction, which yeah, because I didn't really know what I was talking about, so it wasn't something I can explain easily.*

- Confidence seemed to be related to how well they perceived (and how well they actually did) on Draft #2.

*Abbey: I felt a little bit better after reading a few more explanations with the pKa's but I already said I'm super shaky on that.*

*Margaret: Yeah, that was my only problem. I really could not answer that [referring to the Ca<sup>2+</sup> and levothyroxine] interaction question with confidence.*

## Conclusions

- Initial findings indicate that the WTL assignment increased students' ability to write about conceptual ideas on Draft #2
- Completing the WTL assignments increased students' conceptual explanation ability
- Students struggled with Lewis-Acid base chemistry conceptual explanations, even after doing an assignment with this concept
- Participation in WTL assignments can help increase students' confidence

## Acknowledgements

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