

Chemistry Students' Visual Model Comprehension

Chemistry BS - College of Natural Sciences and Mathematics

Step 1: Student Learning Outcome

Explain the various ways that chemists represent and test chemical knowledge in models, theories, mathematical relationships and symbolic notations.

Step 2: Methods and Measures

Scientists in the chemical sciences make use of models and representations to help them understand phenomena that cannot be directly observed. In addition to a technical language, chemical symbols, formulas, and structures are part of the lexicon that is the hallmark of biochemists and chemists.

The Department of Chemistry and Biochemistry's Assessment Committee adapted items from an external instrument to assess visual model comprehension and its relationship to academic success in chemistry.

Twelve items were selected to represent common representations used in chemistry and biochemistry. The Representation Competency Survey involves recognition, identification, interpretation and inference on the part of the subjects taking the survey.

Step 3: Criteria for Success

The criterion for success for the Representations Competence Survey is a mean score greater than or equal to 65 % correct on all of the items.

Step 4: Results

All chemistry spring 2020 candidates for graduation were invited by email to complete the Qualtrics survey, with up to three email reminders. The data were coded, scored and analyzed for measures of central tendency.

A total of 11 complete valid responses were obtained from the B.S. Chemistry graduation candidates. The response rate was poor, but a probable ramification of the rapid transition to virtual instruction across the campus in March 2020 as a response to the COVID-19 pandemic.

The mean percent of items correct on the Representational Competence Survey was 69%. The scores ranged from 83% to 50%. The median and mode scores were both 67%.

Four items received mean percent scores of 20% or lower:

- 1) Interpretation of the number of steps in the mechanism of a chemical reaction in organic chemistry.

- 2) Interpretation of the structures, not represented in detail, of a common visualization of an alpha helix.
- 3) Interpretation of a displayed model of a transmembrane alpha helix's ability to transport small molecules through the central vertical axis.
- 4) Interpretation of a molecular representation of the reactants in a closed vessel; one of which was the limiting reactant. NOTE: This item received the lowest percent score.*

*Limiting reactant is one of the most difficult concepts for undergraduates in chemistry, thus it is not surprising that this item had the lowest success of all twelve items for all of the undergraduate biochemistry and chemistry degree programs. Two of the most frequently missed items came from biochemistry, but these concepts are introduced many times in general and organic chemistry courses.

Overall, the mean of 69% indicates that the B.S. Chemistry candidates for graduation in the Department of Chemistry and Biochemistry in spring 2020 met the criteria for success of a mean score greater than 65%.

Step 5: Improvement Actions

Results were presented to the Assessment Committee in November 2020. The Assessment Committee will make recommendations to the faculty at the final department meeting of the year regarding steps to improve students' ability to use representations that convey limiting reactant reactants at the molecular level, as well as biochemistry structures and organic chemistry mechanism representations.