I: Background

Rationale

To evaluate the effectiveness of “transformed” chemistry instruction (instruction focused on conceptual understanding in addition to problem solving ability) we must have appropriate measures of student conceptual understanding. This poster describes our efforts at developing this type of assessment for covalent bonding and molecular structure.

CHEM 1111 at CU

Largest 5 credit class on campus

~ 1000 students fall semester

Students are science majors (separate engineering chemistry course)

II: Development Process

Construct Map / Learning Progression

A probabilistic model that allows differentiation of student conceptual understanding in addition to problem solving ability. The log of the odds of a correct response, \( \log \left( \frac{P(X=1)}{P(X=0)} \right) \), depends on the difficulty of the item and the ability (knowledge of the construct) of the subject, \( \theta \).

Construct Modeling Process: Four step process used to develop the instrument (Wilson, 2005).

Measurement Model

Sample items from the Fall 2007 survey were adapted for this new instrument. Additional items were developed and subjected to expert review.

Item Design

Some items from the Fall 2007 survey were adapted for this new instrument. Additional items were developed and subjected to expert review.

Outcome Space

Range of possible item responses that will allow us to place students on continuum of the construct. For this instrument, these are the possible response choices in each item.

III: Analysis and Conclusions

ConstructMap software was used to complete the IRT analysis:

http://bearcenter.berkeley.edu/GradeMap

Analysis and Sample

The inventory was administered to a sample of first-semester general chemistry students during the recitation session following the third exam. Our sample is an adequate representation of the class. Responses were anonymous.

Sample demographics (n = 87)

<table>
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<th>Male</th>
<th>Female</th>
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<td>51%</td>
<td>49%</td>
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Average self-reported grade on 3rd exam = 78

Class average on Exam 3 = 74

Overall, the calculated item difficulties agree with our proposed order of difficulty. This supports our proposed learning progression for understanding of molecular bonding and polarity. A few notes about items that don’t fit a prior expectations:

- The survey lacks items of sufficient difficulty to measure students at high ability levels.
- Item 2 should be one of the easiest items. No real explanation for why it is not. We are in the process of analyzing some think-aloud interview data to investigate this.
- Item 7 should have been more difficult. We believe the problem lies with the item and not the progression. The example used in the item stem is easily recognized by students.

Evidence of Validity

Instrument and analysis support the proposed learning progression. Test content: Items used from literature. Need more items at higher difficulty.

Response processes: Good person fit to model. Possibly some construct irrelevant issues with recognition of terms/examples.

Internal test structure: Good reliability (alpha = 0.78), good item fit to model and construct map.

Relation to other variables: Correlation between individual ability estimates and exam score = 0.44.

Conclusions

We believe that we have evidence supporting our proposed learning progression for covalent bonding and structure. The instrument can be used to place students on the continuum of understanding of covalent bonding. The instrument also has the potential for use in pre/post evaluations of instructional innovations.

References
