Chemistry Faculty Intentions toward Teaching with Representations

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Background

- Representational competence (RC) is key to the development of conceptual understanding and engagement in scientific practices.
- The ACS Examinations Institute include visualizations as one of ten anchoring concepts; more than 90% ACS exam items include representations.²
- Although multiple studies investigated student ability to reason with representations, ²⁻⁷ limited number of studies examined faculty intentions and strategies toward developing student RC.⁶⁻⁷

Research Question

What are chemistry faculty intentions toward developing student representational competence skills?

Theoretical Frameworks

- Variation Theory²
  - Intended object of learning – teacher’s perspective and intention for students to learn something specific, which is bound by the teacher’s knowledge, experience, and beliefs.
  - Enacted object of learning – what is actually presented to students and co-constructed through the interactions that occur between teacher and students and among students within the learning environment.
- Koza and Russell's representational competence⁴
  - Interpret representations
  - Generate representations
  - Translate between representations
  - Understand affordances and limitations of representations
  - Choose the most appropriate representation for a particular purpose
  - Use representations to make predictions, draw inferences, and/or solve problems

Conclusions

- Combination of inductive and deductive coding allowed for a richer analysis and interpretation of faculty perspectives, intentions, and beliefs.
- Additional analysis of the similarities and differences in the response patterns of our research participants afforded the identification of other key findings.
- Triangulation of the findings from various analyses above would allow for the identification of themes to synthesize the central ideas in the data.

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Methods and Results

**PHASE 1: Development of a coding rubric (emergent, data-driven codes)**
- Half of the transcripts were printed on paper and read by the two researchers.
- Initial Coding ⁶ to break data into segments to examine their comparable commonalities, differences, and relationships.
- Process Coding ⁶ that uses gerunds (words ending with “-ing”) to convey action in the data to capture strategies that faculty use to help their students develop representational competence.
  - “Introducing simple representations first and building complexity over time.”
  - “Describing how scientists came up with specific representations.”
  - “Explaining important features of representations.”
- Values Coding ⁶ to capture faculty values, attitudes, and beliefs about teaching and learning with representations.
  - “Abstract representations are more helpful for student learning than realistic representations.”
  - “Some people are visual learners.”
  - “Combination of multiple representations is helpful for student learning.”

**PHASE 2: Coding with the developed rubric (inductive coding)**
- Transcripts uploaded to NVivo 12 to be stored, coded, and organized
- New codes identified and added to the codebook
- Axial Coding ⁶ to combine similar codes together, delete redundant codes, further examine the relationships between the codes, and build a hierarchy of categories and codes
- Re-coded the entire data corpus with the second version of the codebook.

**PHASE 3: Coding with the Kozma and Russell’s RC Framework⁴ (deductive coding)**
- Aims is develop: “Being able to read the graphs is important. We also make them play with their model kit, cause there’s definitely a little bit of a learning curve to using the model kit. Um, and for drawing mechanisms, learning how to draw the arrows properly. Um, and so like those are things that we try to develop in them.” (P12)
- Teaches: “If you’ve got a new scatter plot, um, you take one point and explain it and uh say, you know, this is what we’re seeing on the x axis and on the y axis for this one data point. We say, all right, let’s just focus on one data point and understand what that means. And then once you’ve got one, you can apply that [understanding] to all the others.” (P7)
- Assesses: “I examine them. So I ask them to draw, let’s say a molecular orbital diagram where they show what the picture looks like. So there is definitely a portion of the exam that’s forcing them to draw.” (P2)

**PHASE 4: Identification of similarities and differences in the response patterns of the faculty participants**

- **Group 1: RC skills are intentional learning goals that these faculty aim to help students meet.** They use various strategies to support acquisition of these skills and assess mastery of these skills. There is an alignment between their learning goals, the instructional strategies that they use, and the skills they assess (2-4 skills aligned)
- **Group 2: RC skills are not intentional learning goals that these faculty aim to help students meet.** Without realizing it, they help their students develop several RC skills and assess some of these skills. There is some alignment between the skills that they are helping students develop and the skills that they assess (1-2 skills aligned).
- **Group 3: RC skills are not intentional learning goals that these faculty aim to help students meet.** Their assessments are also not targeting any RC skills. Without realizing it, they help their students develop several RC skills.