MODEL-BASED INQUIRY IN THE HIGH SCHOOL CHEMISTRY CLASSROOM: HOW DOES MODEL-BASED INQUIRY AFFECT CONTENT RETENTION?

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Introduction

In my teaching career, I have anecdotally observed that students experience learning loss after the culmination of topic-specific units of learning. Constructivist learning theory lends itself to the teaching and learning approach of Model-Based Inquiry (MBI), in which students develop and refine models to explain scientific phenomena. My action research applies this pedagogical approach with a more structured design for an introductory chemistry class. The aim of this research was to identify the possible use of MBI as a tool to promote learning retention.

Focus Questions and Data Collection Methods

1. How can MBI impact learning retention in a high school chemistry class?
   - Pre-test, Unit test, and Post-test data
2. How do students' attitudes about chemistry relate to their learning?
   - CLASS Pre-test and Post-test Data
   - Confidence Data
3. How does MBI impact student understanding of the purpose and use of scientific models?
   - Model-based assessment
   - Student Interviews
   - Themes in formative assessment

Methodology

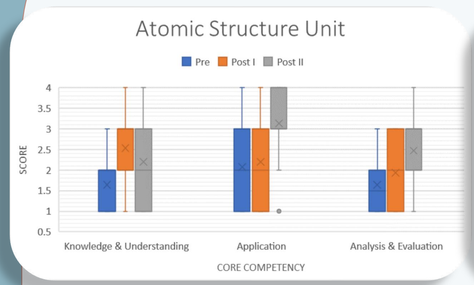
To answer my research questions, I implemented two treatment units with the entire sample group (*N*=15).

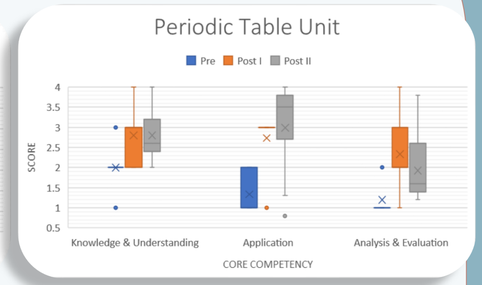
Treatment Unit 1: This unit centered on the development of atomic theory. Students learned about the structure of atoms by working through the historical experiments that developed the model of the atom. *Guided Inquiry*

Treatment Unit 2: This unit centered on the periodic table as a model of atomic structure and properties. Students engaged in the creation and analysis of physical and mathematical models. *Limited Inquiry*

Key Findings

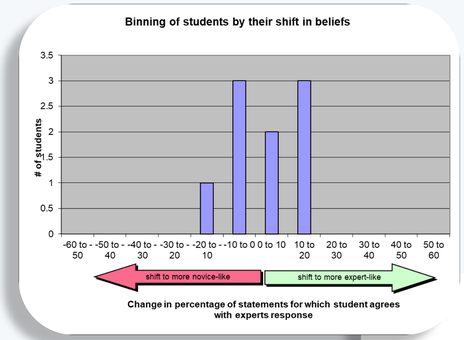
MBI and Learning Retention





These histograms summarize student learning as measured by the Pre, Post I, and Post II tests in each unit (Atomic Structure on the left and Periodic Table on the right), categorized by the core competencies used within the school assessment system. These data, alongside other measurements taken in the treatment units, indicate that learning was generally retained several weeks after the end of each unit, with some room for improvement.

Learning Attitudes



"It is so much more beneficial for me to understand the whole concept not just what I NEED to know."
– Student Quote collected through CLASS

	Normalized Gains in Confidence by Core Competency		
	Knowledge & Understanding	Application	Analysis & Evaluation
Atomic Structure Unit	0	0.7	0.5
Periodic Table Unit	0.4	0.6	0.3

Between the Pre and Post II tests, considerable gains in confidence were observed in most of the core competencies for each unit. At the same time, the Colorado Learning Attitudes about Science Survey indicated only minor changes in student attitudes toward a more "expert-like" view, as well as similar magnitude changes toward a more "novice-like" view.

Key Findings

Understanding of Scientific Models

"[Bohr's Model] showed the evolution of how the structure of the atom had formed and it showed progress."
– Student Quote

"…sometimes your understanding is changing, so you can learn from mistakes. There can be incorrect models, if you know why they're incorrect that can be helpful."
– Student Quote

Students benefitted from learning experiences like the Rutherford Gold Foil Experiment Simulation (pictured) but struggled to apply their learning formally to analyze and evaluate scientific models. Themes emerged from student interviews that indicated students primarily consider models to be used to display information, though some recognized many types of models. Some also demonstrated a strong understanding of the iterative process of revising models based on new discoveries in science.

Conclusions

1. Analysis of quantitative and qualitative data across both treatment units suggests that Model-Based Inquiry is an effective teaching tool with a reasonable capacity to limit learning loss.
2. Learning through Model-Based Inquiry had a limited positive effect on students' attitudes about science, from the way they view chemistry to how they view their participation and success in science class.
3. This application of Model-Based Inquiry was effective in increasing students' exposure to the concept of scientific modeling, but there was room for improvement when it came to student understanding of the broader benefits and limitations of scientific models.