Chemistry in the field and chemistry in the classroom: A disconnect?

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Karen L. Evans & Gaea Leinhardt
LRDC, University of Pittsburgh
Michael Karabinos & David Yaron
Department of Chemistry, Carnegie Mellon University

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Pedagogical Organization of Academic Chemistry: Established Content and Process

- ❖Analytical chemistry
- ❖Biochemistry
- ❖Inorganic chemistry
- ❖Organic chemistry
- ❖Physical chemistry
- ❖Theoretical chemistry

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But "frontier science," which reflects the creativity and progress in academic and industrial research and development, occurs across such boundaries:

"…its [chemistry's] methods, concepts, and practitioners are penetrating virtually every nook and cranny of science and technology."
----I. Amato (*Science,* 1991)

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Two Centuries of Chemistry: From Discrete Field to Ubiquitous Presence

- What are the current valued activities of chemistry?
- Is the fundamental organization of the textbook based vision of chemistry up to date?

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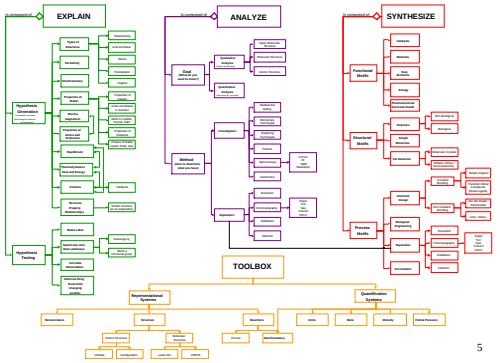
A Conceptual Framework for Chemistry



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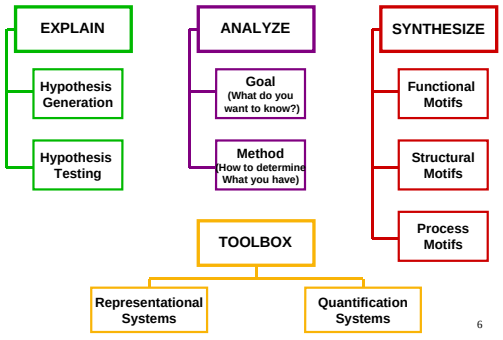
Conceptual Framework: "Upper Levels"



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Testing the Framework

- Are some activities missing from the framework?
- Are some activities present in the framework but not in the domain of chemistry?

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Evidence for the Domain of Chemistry Represented in the Conceptual Framework

- Nobel Prizes (1952-2002)
- 2002 *New York Times* Science Times (54 reports)
- 2002 *Scientific American* News Scan (32 reports)

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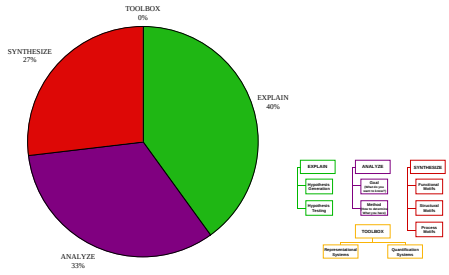
Chemistry Endeavors Honored by the Nobel Prizes (1952-2002)



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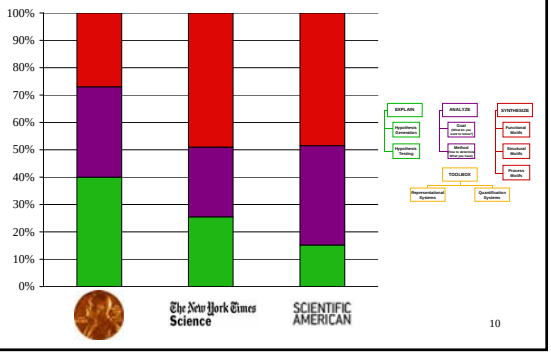
Chemistry Endeavors Reflected in News Reports (2002)



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Evidence from Textbooks

- Aligned with National Science Education Standards
  - *Modern Chemistry* (2002)
  - *Merrill Chemistry* (1998)
  - *ChemCom* (2002)
- Objectives reflect focus of classroom chemistry

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Textbook Coverage during a First High School Chemistry Course

Measure	Modern	Merrill	Chem Com
# pages	599	648	484
% of pages covered	66%	58%	100%
# objectives	291	195	120
% objectives covered	65%	53%	100%

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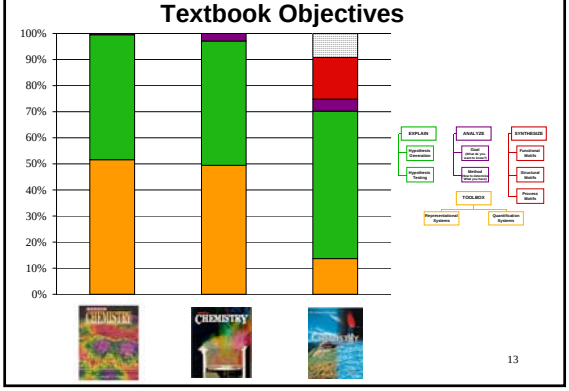
Chemistry Endeavors Reflected by Textbook Objectives



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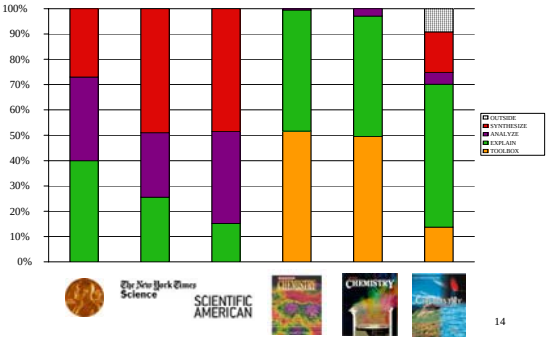
Chemistry Endeavors as Reflected by the Nobel Prizes, News Reports, and Textbooks



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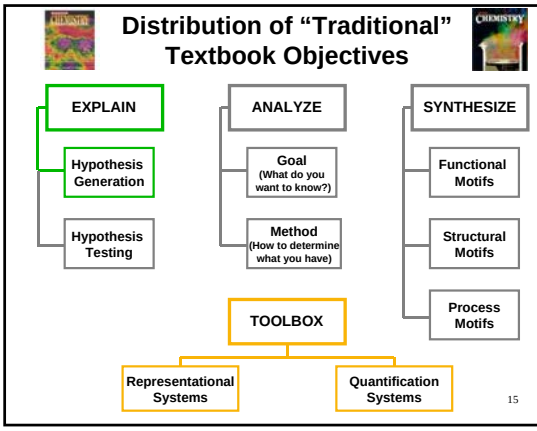
Distribution of "Traditional" Textbook Objectives



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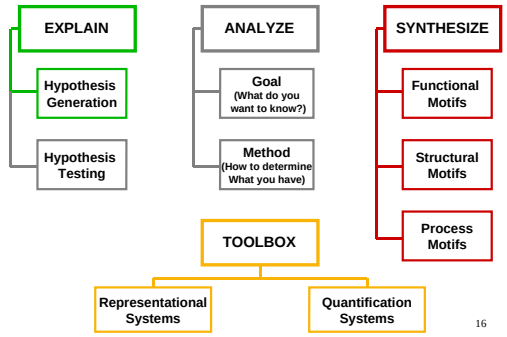
Distribution *of ChemCom* Objectives



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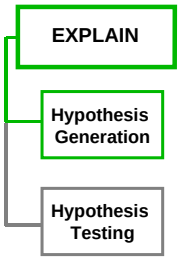
Scope of EXPLAIN Objectives



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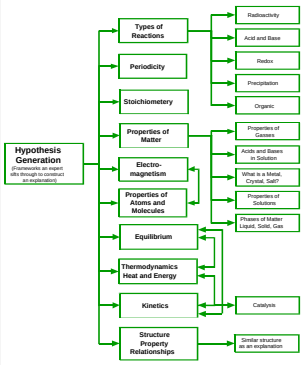
Hypothesis Generation Themes



- Textbook **EXPLAIN** activity is presented as well-established content skills to be mastered by student
- Authentic **EXPLAIN** chemistry activity couples hypothesis generation with hypothesis testing

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Hypothesis Generation Themes: News Reports vs. Textbook Objectives

Theme	News Reports	Merrill Chem	Modern Chem	ChemCom
Reaction Type	**25%**	4%	14%	**24%**
EM & Prop. of Atoms & Molecules	31%	10%	12%	13%
Stoichiometry	2%	6%	7%	5%
Prop. of Matter	**23%**	51%	44%	**24%**

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Hypothesis Generation Themes: News Reports vs. Textbook Objectives, cont.'

Theme	News Reports	Merrill Chem	Modern Chem	ChemCom
Periodicity	**1%**	18%	15%	**2.5%**
Equilibrium & Kinetics & Thermo	8%	8%	4%	17%
Struct.-Prop. Relationships	**11%**	0	%1	**14.5%**

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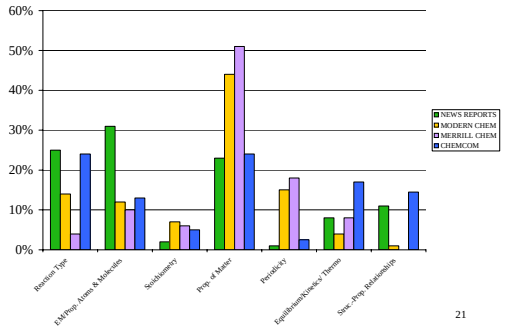
Hypothesis Generation Themes: News Reports vs. Textbook Objectives



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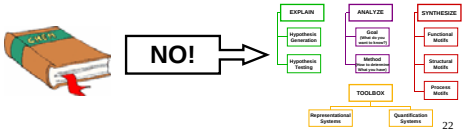
CONCLUSION

There is a disconnect between the focus of high school chemistry and what chemists do



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Effects of the Disconnect

- Educational goal of a coherent knowledge base **not met** since a "skills-first" agenda yields inert knowledge that is rarely usable or memorable.
- Educational goal of basic scientific literacy **not met** since current instruction ignores 2/3 of the domain of chemistry.
- Beginning students are **not engaged** in the wonder and excitement of the discovery and creativity at the heart of chemistry.

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"Repairing" the disconnect: Use evidence in deciding what to teach

- Realize that most students do not study any chemistry after high school.
- Introduce tools and skills on a need-to-know basis
- Emulate the domain's valued activities in instruction by provding scaffolded problem-solving scenarios situated within the context of frontier science storylines*

* Using and Authoring Virtual Lab Activities for Introductory Chemistry. A workshop presented Wednesday at 2 PM by David Yaron and Michael Karabinos, Carnegie Mellon University (http://ir.chem.cmu.edu)

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