

Reflective Review of "A Historical Analysis of the Curriculum
of Organic Chemistry Using ACS Exams as Artifacts"

Lynne N. Cohen

Describe

In this 2013 article from the *Journal of Chemical Education*, Raker and Holme evaluate changes in standardized exams produced by the American Chemical Society (hereafter referred to as "ACS") for the assessment of organic chemistry. The exams were chosen from a 64-year period ranging from 1949 and 2012, and are evaluated using four different frameworks meant to observe different pedagogical trends. The authors posit that ACS exams are uniquely suited to offer insights into nationwide trends because of the nature of their development; questions are written by volunteers who teach the subject in various nationwide institutions, and a similarly varied committee chooses the topics for each exam, which is developed anew every four years (Raker & Holme, 2013). Because of the committee-based development, topics that have fallen out of favor "would not have psychometric properties during trial testing that would merit their inclusion in the final, released version of the exam" (p. 1437).

Raker and Holme make observations using four distinct frameworks. They first examine question types (the type of intellectual skill used to answer each question: "conceptual," "algorithmic," or "recall") and observe that from 1949 until the early 80's, analytical questions increased in popularity (from 50% to 90%), corresponding with a decrease in the proportion of recall questions on each exam (2013). Analytical questions retained their popularity thereafter. Secondly, the authors examined use of representations (visual aids such as graphs and molecular drawings). They observed an upward trend in representation use from 1958 on, then a sudden

increase in the 1970s, and thereafter a consistent use of representations in over 90% of exam questions from 1986 to 2012 (as compared to 33% in 1949) (Raker & Holme, 2013).

The third framework examines the content areas represented on each exam. For example, an increase in spectroscopy questions over time correlates with a decrease in qualitative analysis questions, a trend explained by a change in chemical instrumentation: "Qualitative analysis predated spectroscopic methods as a technique for determining structural information" (Raker & Holme, 2013, p. 1440). Finally, Raker and Holme conclude their paper with an exploration of normed reference scores, used as indicators for the relative difficulty of the exams through the years. From 1962-1971, grades in the 80th percentile only earned a raw score of 50-60%, whereas in the 70's, students in the same percentile earned a raw score closer to 70% (2013).

Analyze/Reflect

The purpose of this article is to show changing trends in the ACS organic chemistry exam from 1949 to 2012, to use them as indicators of pedagogical trends based on the authors' assertion that the ACS exam can be used to provide a "realistic view of the breadth of actual coverage at any moment in time" (p. 1437). I find the article fascinating, as it shows clear trends that coincide with what I've learned about pedagogical shifts in the United States, such as the shift in learning from rote memorization to critical thinking tasks (shown, for example, in the shift in popularity from the "recall" problems to the domination of "conceptual" problems). The near-universal popularity of representation use in questions, as compared to a scant 13% use in 1962, clearly displays another trend towards offering students additional resources for comprehension. The fact that both of these frameworks experience dramatic upheavals around the 1970s strongly suggests a change in learning theory at that time. I'm interested to read more

about that period to see what was happening at that time, including what theories and practices were being popularized that laid the framework for the teaching methods we have today.

Raker and Holme discuss some factors that may have influenced the changes, such as the publication of articles in the *Journal of Chemical Education* in the 1970's which laid out a standardized guideline for organic chemistry teachers leading to the trends shown (2013). They suggest that the shift towards representation and shifting content area topics may be a result of a change in research practice and expectations of students to participate in research: "several recent educational research initiatives in organic chemistry and biochemistry have focused on student understanding of representations" (p. 1438). As a teacher, I can make use of this knowledge in my own classroom by ensuring I provide my students with a solid foundation in general chemistry by offering an excellent conceptual framework with plenty of visual representations and real-world examples. In doing so, I will prepare them well for higher learning.

ESOL and/or Special Needs

While the article does not explicitly state implications for ESOL or special needs learners, the trends displayed in these analysis are clearly to the benefit of all levels of learners, as indicated by the increase in raw score percentages corresponding with the shift toward analytical questions including visual representations (Raker & Holme, 2013). Students of all levels benefit from learning material using visual representations as well as conceptual explanations to assist memorization. Students facing intellectual challenges benefit from carefully-constructed assessments which make use of representation and content which is interesting and relevant to real-world research and instrumentation. Visual representations also aid special needs students, and ease the burden of language interpretation for ESOL students.

References

- Raker, J., & Holme, T. (2013). A Historical Analysis of the Curriculum of Organic Chemistry Using ACS Exams as Artifacts. *Journal of Chemical Education*, *90*, 1437-1442. doi: 10.1021/ed400327b