REAL CHEM | ASU Center for Education Through Exploration, Arizona State University | Open Learning Initiative, Carnegie Mellon University

Building Bonds: Research-Backed General Chemistry Courseware for Student Success

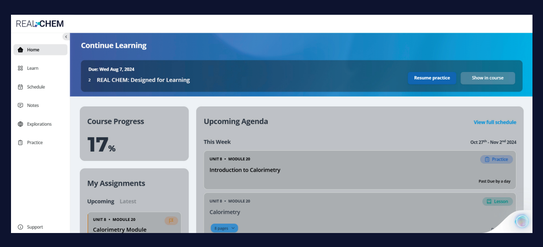
In collaboration with Arizona State University, and Carnegie Mellon University, REAL CHEM developed specialized courseware tailored to bringing success to all learners through relevant, active learning content with a focus on learning by doing and supporting students with fine grained personalized feedback. Early results suggest improved outcomes, including a 20 percentage point gain in exam scores and a shift towards higher retention rates for all students.

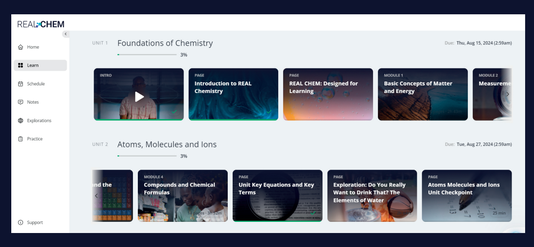
Under Rigorous Research, Real Results

Through extensive research, we've developed an innovative courseware for the General Chemistry course. REAL CHEM demonstrates significant improvements in student outcomes, ensuring that while every student is different, success for all can be achieved. This approach inspires and build confidence for the next generation of STEM leaders.

What is REAL CHEM?

REAL (Relevant, Engaging, Active Learning) CHEM delivers a blended learning experience at two-year and four-year institutions. With activities before, during, and after class, the courseware helps students connect chemistry to real-world applications while providing responsive, tailored support.





REAL CHEM courseware and curriculum features:

- **Engaging cinematic videos**
- **Flexible curriculum options**
- **Personalized feedback, hints, and practice**
- **Real-world challenges that make content relevant**
- **Opportunities for connection and reflection**
- **Continuous improvement through data-driven insights**

Curriculum Structure

REAL CHEM is designed for blended as well as fully online deployments. It includes features that can be used before class, in class, and after class.

Foundation

Industry-leading, evidence-based, active and adaptive learning, developed from OLI's legacy in learning engineering. Research shows that well-designed, adaptive activities improve learning, particularly for our focus population. REAL CHEM includes high-quality videos featuring chemists from diverse cultures and careers, making chemistry relatable. In addition, there is a "Class Notes" feature to enhance peer and faculty engagement.

Explorations

These opportunities allow students to apply their course knowledge and skills in real-world contexts, motivating them by highlighting chemistry's relevance to meaningful topics. Supported by formative assessments, scaffolding, authentic visuals, and interactive activities, these explorations follow ASU's "Education Through Exploration" digital learning model, developed with Smart Sparrow, fostering a journey from curiosity to exploration and discovery.

Collaborative Activities

Data-driven insights that support a blended classroom by helping instructors identify areas where students need assistance and by providing recommended in-class activities, some of which incorporate PhET simulations developed with PhET.

Deliberate Practice

Personalized guidance from instructors helps students use their time effectively, strengthening both learning and the instructor-student relationship. Torus's data-driven insights further support success by recommending deliberate practice activities tailored to building essential knowledge and skills.

Hypothesis

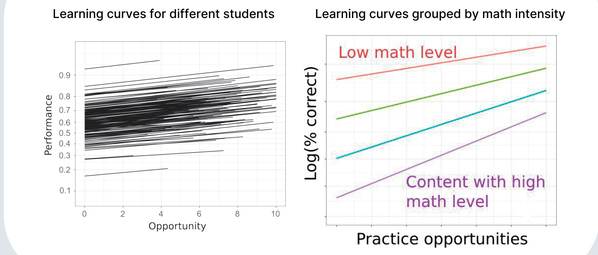
REAL CHEM hypothesizes that the combined effect of these curricular features will result in an increase in student success that benefits all students, recognizing that every student is different.

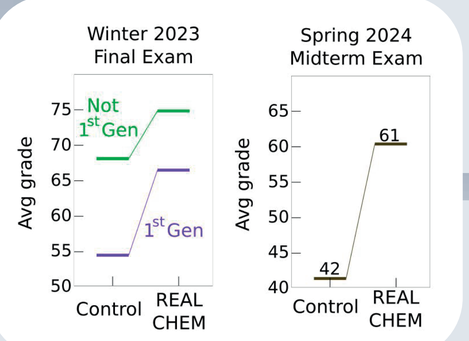
Quantitative Research

Multiple studies conducted across several institutions highlight the impact of REAL CHEM on student performance:

Study 1: At 4 community colleges, data from 183 students showed that while initial knowledge varies, all students learn at similar rates regardless of math preparation.

Study 2: A larger study with 279 students across 7 community colleges used logistic regression to model student performance and engagement with courseware. It found that **learning rate** remains consistent across the course and that this remains true for topics that require more math preparation.





UC Riverside: Midterm and final exam scores in REAL CHEM sections were higher, both overall and for 1st generation specifically.

CalState LA: REAL CHEM improved retention for prioritized students (92% vs. 75%).

Qualitative Research

Interviews using Cognitive Task Analysis (CTA) and cued recall methods revealed that students found REAL CHEM's Explorations effective and highly engaging, particularly the adaptive feedback. Other positives included the interactive elements, appealing visual design, and real-world relevance of the activities. One common criticism was the lessons' length and occasional repetitiveness.

> *Even when I got something wrong, I wasn't left in the dark. It told me why I got something wrong and how I can get it right."*

> *I like how [the Exploration] is structured and how it gives interesting examples about the topics we learn. It's kind of a wrap up to the unit."*

Conclusion

REAL CHEM's unique blend of adaptive learning, just-in-time math support, and real-world application effectively addresses learning outcome gaps in chemistry education. By prioritizing student engagement and retention, this approach ensures success for all learners, regardless of initial preparation levels.

Final Results

↑19% pt — **Increase in Midterm Scores**
At UC Riverside, students using REAL CHEM scored two letter grades higher on midterms compared to traditional sections (61% vs. 42%).

↑17% pt — **Boost in Retention Rates**
At CalState LA, REAL CHEM improved retention of students by 17% (92% vs. 75%).

75% — **of the Performance Gap Linked to Engagement**
Preliminary analysis suggests that most of the performance gap stems from the time students have to engage with REAL CHEM, while only 25% is due to gaps in prior preparation.