Research Results: Balancing Chemical Equations
Quantum Artificial Intelligence Tutoring Software Improves Student Test Scores by Full Letter Grade

Carmichaels Area Junior/Senior High School, Carmichaels, Pennsylvania

QUANTUM®

INTELLIGENT
TUTORING
ENGINES

"The group of students using the Tutor drastically improved performance even with the most difficult problems."

— **Kevin Willis**
Chemistry Teacher
Carmichaels Area
Junior/Senior High School

Research Objectives

- Evaluate effectiveness of the Quantum Tutor for Balancing Chemical Equations on performance of high school chemistry students.

- Measure accuracy and reliability of new artificial intelligence (AI) automatic grading and assessment technology.

Methodology

The one-week study included 51 high school students from Carmichaels Area Junior/Senior High School. Students were divided into two groups:

- Treatment group (31 students) used the Quantum Tutors for at-home study.

- Control group (20 students) received the same classroom instruction as the Tutor group but did not use the Quantum Tutors.

- Tutor and control groups took pre- and post-tests to benchmark and evaluate performance in understanding balancing chemical equations.

To provide an accurate assessment of student knowledge and comprehension, all work was graded using Quantum's automatic grading and assessment technology. Rather than simply grading whether an answer was right or wrong as with a multiple-choice test, the tool evaluated every step in the student's work and assigned partial credit when deserved.

Results

	Tutor Group	Control Group
Pre-Test Score	53.9	53.6
Post-Test Score	74.3	61.5
Improvement	**+20.4**	**+7.9**

Out of a maximum 100 points.

Key Findings

- Students using the Quantum Tutors as part of their at-home study outperformed the control group on the post-test by an average of 12.8 points, or just over a full letter grade.

- The difference between the Tutor and control group increased as the problems became more difficult — a clear indication that understanding and comprehension significantly improved for students using the Quantum Tutors.

Conclusions

- The clear differences in the Tutor and control group's performance observed in this study indicated that the Quantum Tutor improved students ability to balance chemical equations, further validating the AI-based approach Quantum has developed.

- In this study as well as other research, the automatic grading and assessment technology has been established as a time-saving tool for teachers that is significantly more accurate and reliable than grading by hand.

Inspiring students to learn *why*