Laboratory-Based Instructional Innovations

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Abstract

This presentation describes the design, development, and educational outcomes of three laboratory-based instructional innovations implemented or to be included in *Chem24300 (Quantitative Analysis Laboratory)* at the City College of New York.

The first experiment, **Determining Avogadro's Number by Electrolysis,** was originally developed more than two decades ago at the College of Staten Island and has since been extensively refined. Through systematic redesign and optimization, the relative error of the experiment has been reduced from an original range of approximately 10–30% to 0.5–5%, resulting in a robust and accessible method for introducing students to quantitative electrochemical measurement of a fundamental physical constant.

The second experiment, **Battery Disassembly and Battery Recycling,** is a newly developed electrochemistry laboratory focused on environmental sustainability, advanced materials separation, waste treatment, and reverse engineering. This experiment exposes students to modern battery technologies and emphasizes both practical engineering considerations and the environmental implications of large-scale energy storage systems.

The third featured innovation, **AI Lab Coach,** introduces artificial intelligence–assisted instruction into the laboratory environment. The platform integrates experimental data analysis, error detection, conceptual diagnostics, and guided feedback to support student learning. AI assisted instruction is emerging as a high-impact educational strategy, especially in laboratory education where real-time feedback and individualized guidance are often limited. This work demonstrates how the integration of AI into course design and laboratory instruction can significantly enhance experimental reasoning, conceptual understanding, and student engagement across scientific disciplines.

Keywords

Electrochemistry, AI for Education, Lab Design and Development.