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Addressing Human Outcomes in Chemistry Education through a Systems Thinking Orientation – An IUPAC *Systems Thinking in Chemistry Education (STICE)* Project Update

Peter G. Mahaffy
The King's University

Stephen Alan Matlin
Institute of Global Health Innovation, Imperial College London

The purpose of reorienting chemistry education through systems thinking is to help learners move from fragmented knowledge of chemical reactions and processes to a more holistic understanding of the field. Moving beyond the reductionist elements of learning chemistry, systems thinking can be used both to describe complex interactions of chemicals and their reactions, as well as prescribe ways that knowledge of chemistry can be leveraged to address planetary and human needs. *Systems Thinking in Chemistry Education (STICE)* is a multi-year IUPAC project that brings together a distinguished task force of global chemistry and chemistry education leaders to analyze and highlight the interconnected, complex systems that are at work for learners of chemistry.

A literature review of systems thinking in other STEM disciplines, and particularly in engineering and biology education suggests attributes of systems thinking that may be particularly relevant for chemistry education. Despite the fact that chemical reactions and processes, both in nature and industry, function as parts of complex, dynamic, and interconnected systems, the term 'systems thinking' is relatively unfamiliar to chemists and chemistry educators. The learning objectives for chemistry programs at both the high school and university level rarely include substantial and explicit emphases on strategies to move beyond understanding isolated chemical reactions and processes to envelop systems thinking.

A report will be given on progress to date by the *STICE* project in working toward a goal of articulating learning objectives for infusing systems thinking, cross cutting concepts, and sustainability considerations into the formal teaching of chemistry, with a primary focus on gate-keeper general chemistry courses. The project will also suggest strategies to guide the use of these learning objectives in the design of curriculum and selection of engaging pedagogies.