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Perspective

Systems thinking in chemistry: A key competency for a sustainable future

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In 2016, an IOCD group[1] proposed[2] that chemistry should adopt systems thinking (ST), both as a means to reorient chemistry[3] as a discipline and to optimise the contributions[4] it can, and must, make to sustainable development. Subsequently an international project (2017-2019) on the infusion of systems thinking into general chemistry education was established by IUPAC,[5] also supported by IOCD and co-chaired by Peter Mahaffy and Stephen Matlin.

Attracting many experts in chemistry education from around the world as members of the Task Group, the project concluded[6] in 2019. It established the importance of systems thinking in chemistry education (STICE) both as a way of integrating the fragmented knowledge and understanding of chemistry that is typical in many general chemistry courses, and as a means to elucidate the interconnections between the system of chemistry and Earth and societal systems that are critical to addressing the challenges of sustainable development in the 21st Century.[7]

The project organized a Special Issue[8] of the *Journal of Chemical Education*, published in December 2019, which attracted 43 papers related to ST and Green and Sustainable Chemistry from around the world and included several published by members of the STICE Task Group. Importantly, this project succeeded in making the case for STICE to a wide international audience, highlighted the skills and competencies that it provides (Figure 1), offered examples of ST in different chemistry education settings, and helped build bridges with existing sustainability movements such as those concerned with circular, green and sustainable chemistry.

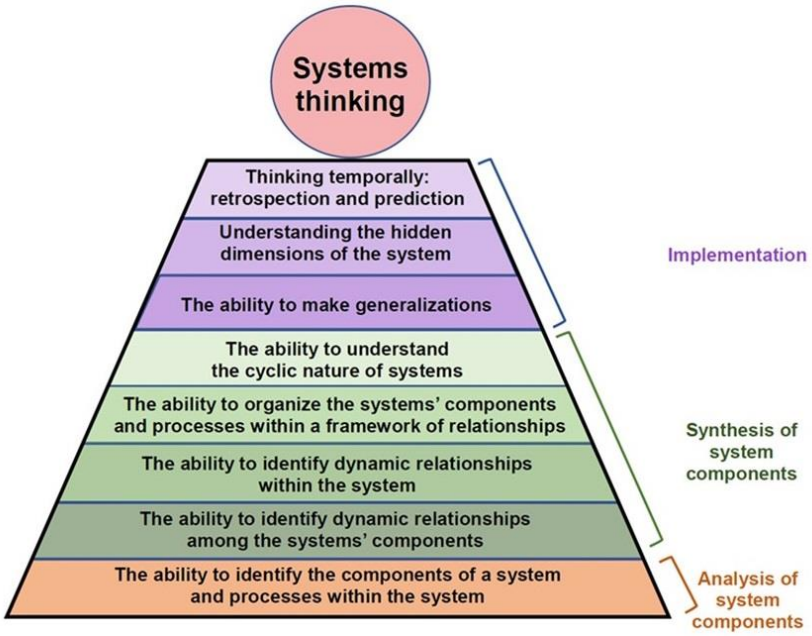

Figure 1 **Systems thinking skills and competencies**
Adapted from Orgill, York & Mackellar[9]

Addressing complex sustainability challenges requires considering multiple effects that cut across disciplines and systems.[10] Systems science tools are indispensable for understanding and responding to these sustainability challenges and it has been concluded that ST is one of five key competencies for a sustainable future.[11]

As part of the project, a new visualization tool– the Systems-Oriented Concept Map Extension, SOCME[12] – was developed to assist in teaching and learning about STICE. The SOCME tool can aid exploring and depicting cross-system interactions and managing complexity.[13]

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