

Green Chemistry Education Efforts at the University of Toronto

This contribution summarizes a poster and flash talk presented at the June 2024 Canadian Chemistry Conference and Exhibition in Winnipeg. We have been teaching concepts of green chemistry and sustainability in our department for two decades, and a major driver for curricular change was signing on to the Beyond Benign Green Chemistry Commitment (GCC) in 2016. In doing so we became the first international school to sign the GCC, which is a voluntary initiative set up to assist in the preparation of chemists whose skills are aligned with the needs of the planet and its inhabitants in the 21st century. This move provided great impetus for us to infuse more green principles into components of our undergraduate program separate from organic chemistry (most notably into first-year general chemistry and second-year inorganic courses, as well as introducing toxicology concepts into an upper-level environmental chemistry course), by adopting more of a systems-thinking approach to education. 14 Canadian institutions have now signed the GCC (Figure 1).

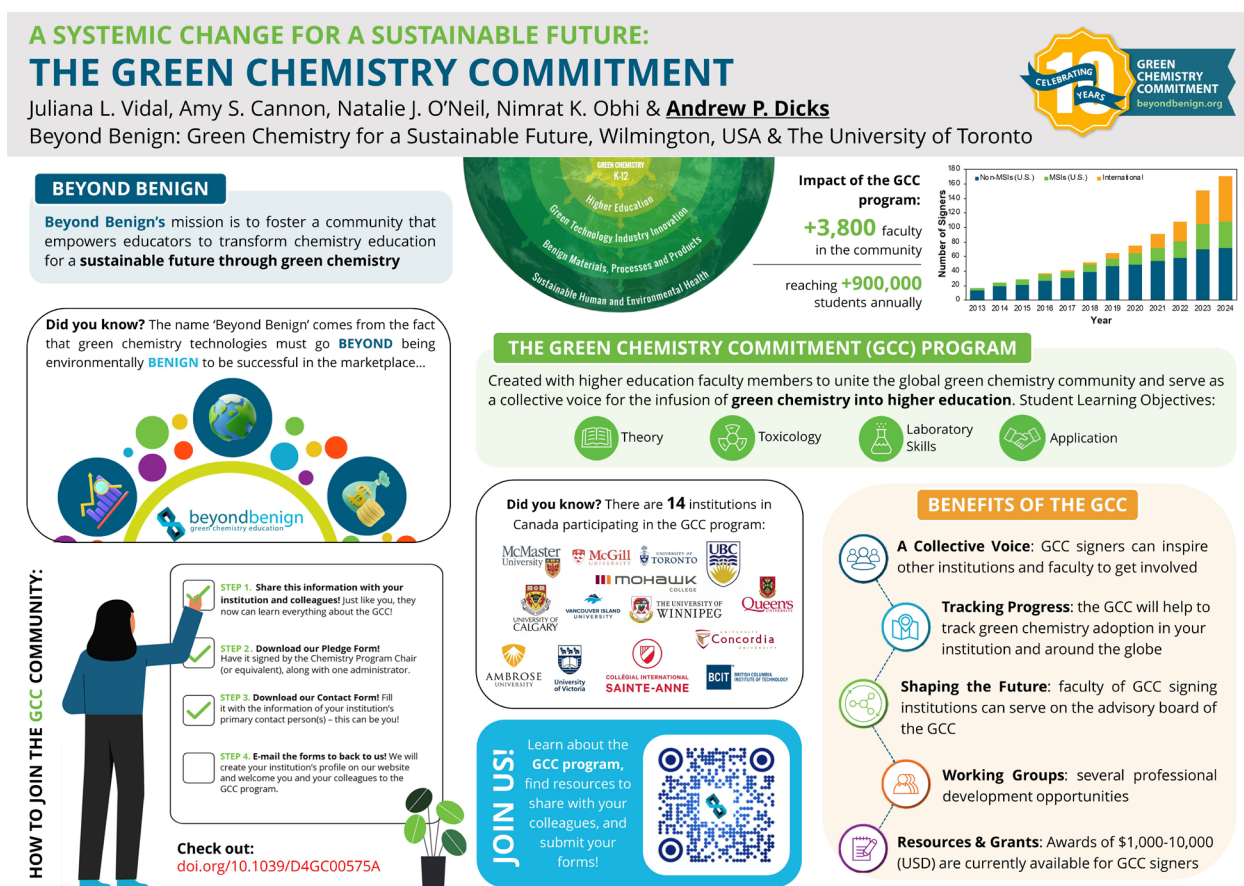


Figure 1: The Green Chemistry Commitment

We departmentally mount 10 undergraduate programs for students interested in studying chemistry in different areas and to varying extents: six Specialists, two Majors and two Minors (www.chemistry.utoronto.ca/programs-studies/overview). In 2021, a Focus in Green Chemistry designation was developed to recognize students who combine undergraduate courses that cover principles of toxicology, reaction metrics, safer chemicals/solvents, pollution prevention/recycling, catalysis, and energy efficiency. This Focus appears on the academic transcript of any student graduating from a Specialist program (Biological Chemistry, Chemical Physics, Chemistry, Material Science, Pharmaceutical Chemistry, and Synthetic & Catalytic Chemistry) or a Major program (Chemistry and Environmental Chemistry). This is a concrete notation for potential employers that a student has learned the fundamentals of green chemistry in the context of

different courses (www.chemistry.utoronto.ca/undergraduate/current-students/undergraduate-courses, Figure 2).

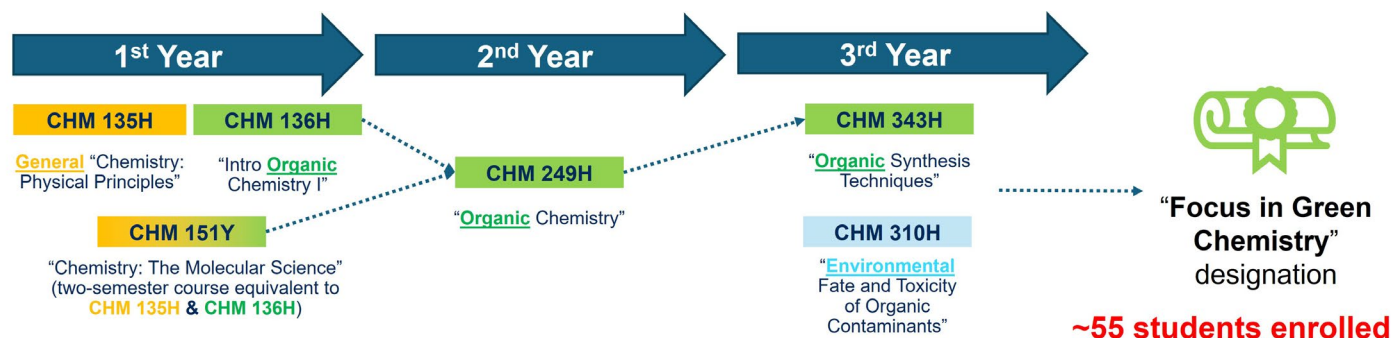


Figure 2: Focus in Green Chemistry Pathway at the University of Toronto

Sample References

1. Putting the Squeeze on Imine Synthesis: Citrus Juice as a Reaction Medium in the Introductory Organic Laboratory. Nigam, M.; Tuttle, D.; Morra, B.; Dicks, A. P.; Rodriguez, J. *Green Chem. Lett. Rev.* **2023**, *16*, DOI: [10.1080/17518253.2023.2185107](https://doi.org/10.1080/17518253.2023.2185107).
2. A Systems Thinking Department: Fostering a Culture of Green Chemistry Practice among Students Dicks, A. P.; D'eon, J. C.; Morra, B.; Chisu, C. K.; Quinlan, K. B.; Cannon, A. S. *J. Chem. Educ.* **2019**, *96*, 2836-2844. DOI: [10.1021/acs.jchemed.9b00287](https://doi.org/10.1021/acs.jchemed.9b00287).
3. The Green Chemistry Initiative's Contributions to Education at the University of Toronto and Beyond Waked, A. E.; Demmans, K. Z.; Hems, R. F.; Reyes, L. M.; Mallov, I.; Daley, E.; Hoch, L. B.; Mastronardi, M. L.; De La Franier, B. J.; Borduas-Dedekind, N.; Dicks, A. P. *Green Chem. Lett. Rev.* **2019**, *12*, 187-195. DOI: [10.1080/17518253.2019.1609597](https://doi.org/10.1080/17518253.2019.1609597).