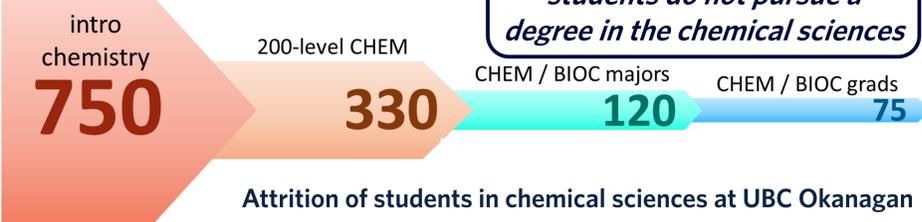


Flexible and Flipped Delivery Modules for First-Year Chemistry

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Rationale and Goals



90% of first-year chemistry students do not pursue a degree in the chemical sciences

An introductory chemistry course should:

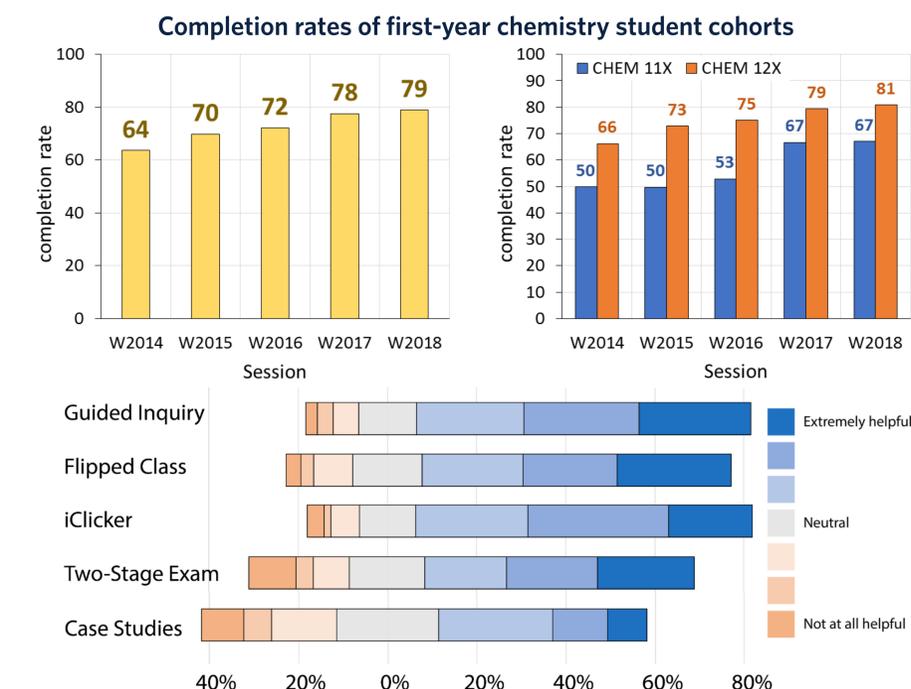
- teach a *last* chemistry course, not a first one
- prepare scientifically-informed, critically-thinking citizens
- explain relevance of chemistry to global and societal issues^[1]

Impact on Curriculum

- revised objectives / concepts / topics for CHEM 11X/12X
- explicit cognitive and affective learning objectives
- thematic context of UN Sustainable Development Goals^[2]

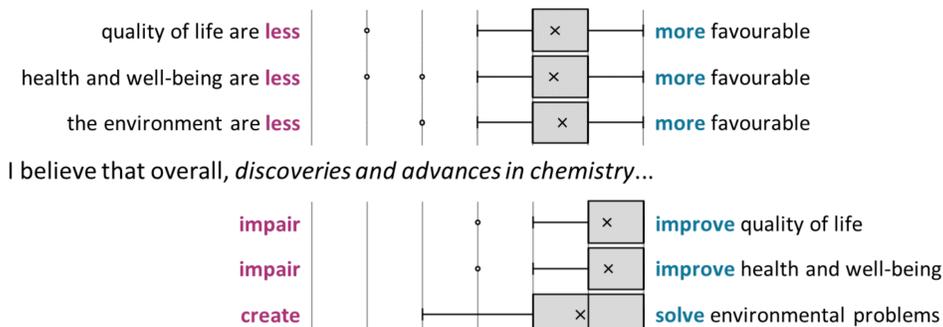
Impact on Student Learning

- learning activities used with > 7800 students since 2016
- 2015 - 2019 success rates +23% overall, +34% among CHEM 11X students (with CHEM 11 entry)
- student perception of conceptual learning favourable for all module formats



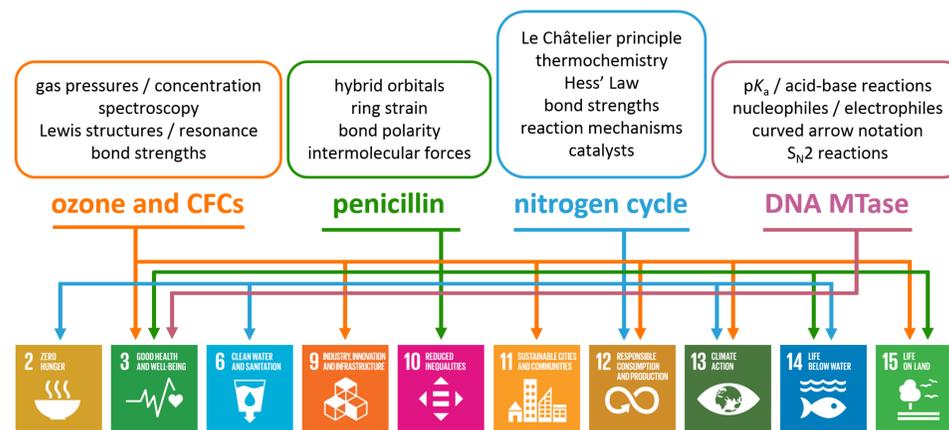
Impact on Student Attitudes

- 99% of students believe chemistry improves their lives
- As a result of the context study activities, *my views of the impacts of chemistry on...*



Impact on Teaching Practice

- developed 16 large-class active- and peer-learning activity modules in different formats^[3]
- guided inquiry modules**: foundational concepts students develop / apply themselves with scaffolding, in cycles of exploration, invention, application^[4]
- flipped classroom modules**: challenging concepts in H5P interactive instructional video, students apply in class^[5]
- context studies**: application of multiple course concepts to a topic of societal / environmental / biological importance

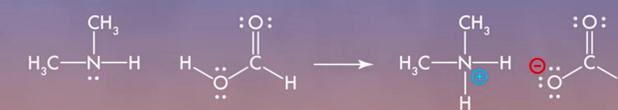


Course topics applied in context study activities with applications to UN SDGs

References / Bibliography

- [1] The Chemical Element: Chemistry's Contribution to Our Global Future; Garcia-Martinez, J., Serrano-Torregrosa, E., Eds.; Wiley-VCH: 2011. [2] Petillion, R. J.; Freeman, T. K.; McNeil, W. S. The United Nations Sustainable Development Goals as a Thematic Framework for an Introductory Chemistry Curriculum. *J. Chem. Educ.* 2019, 96, 2845-2851. [3] Freeman, S. et al. Active learning increases student performance in science, engineering, and mathematics. *Proc. Nat. Acad. Sci.* 2014, 111, 8410-8415. [4] Abraham, M. R. Inquiry and the Learning Cycle Approach. In *Chemist's Guide to Effective Teaching*; Pienta, N. J., Cooper, M. M., Greenbowe, T. J., Eds.; Prentice-Hall: 2005; pp 41-52. [5] Bancroft, S. F.; Jalaeian, M.; John, S. R. Systematic Review of Flipped Instruction in Undergraduate Chemistry Lectures: Facilitation, Independent Practice, Accountability, and Measure Type Matter. *J. Chem. Educ.* 2021, 98, 2143-2155. [6] Petillion, R. J.; McNeil, W. S. Johnstone's Triangle as a Pedagogical Framework for Flipped-Class Instructional Videos in Introductory Chemistry. *J. Chem. Educ.* 2020, 97, 1536-1542.

Where should a **curved arrow** start and finish to represent the reaction between formic acid and dimethyl amine?

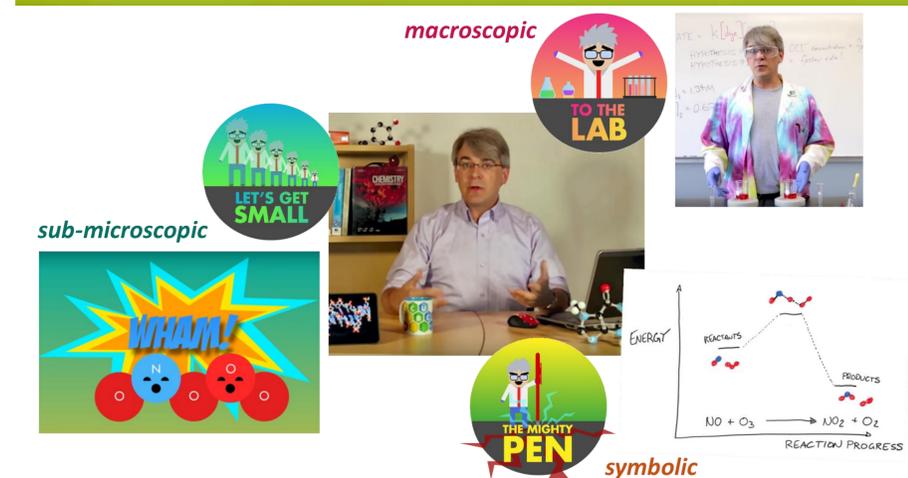


Start at O-H bond pair, finish at N

Start at O lone pair, finish at H in (CH₃)₂NH

Start at H atom in HCO₂H, finish at N

Start at N lone pair, finish at H in HCO₂H



Sample interactive question and images from flipped module instructional videos

Outcomes and Future Work

- 2 publications^[2,6] and >30 conference presentations / workshops, 4 further publications forthcoming
- 16 large-class active-learning activities redesigned as OER, to be released to UBC OER, OER Commons, MERLOT, National Center for Case Study Teaching in Science
- UN SDGs as thematic framework promotes highly positive attitudes and beliefs toward societal impacts of chemistry
- H5P interactivity in instructional videos improves student cognitive learning and engagement
- dramatic improvement in student completion rates



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