Flexible and Flipped Delivery Modules for First-Year Chemistry

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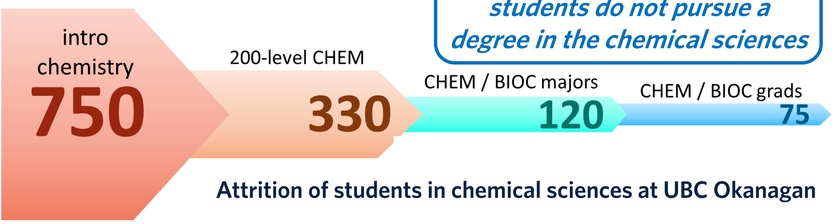
Rationale and Goals

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



Attrition of students in chemical sciences at UBC Okanagan

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]

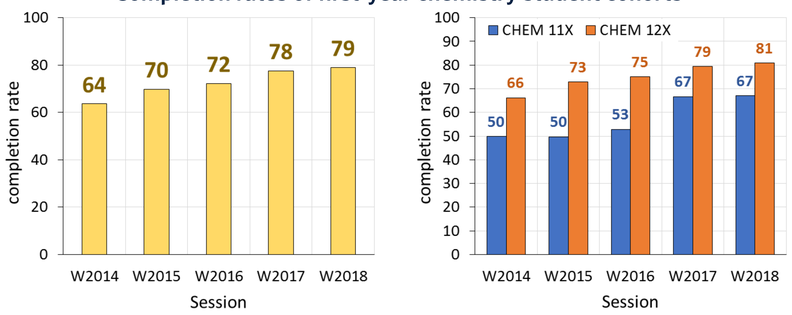
Impacts on Curriculum

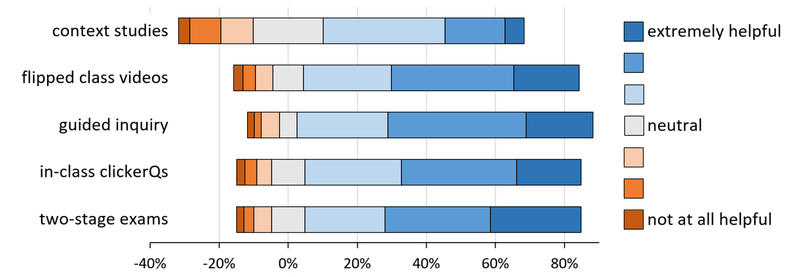
- revised objectives / concepts / topics for CHEM 113/123
- explicit cognitive and affective learning objectives
- thematic context of UN Sustainable Development Goals[2]

Impacts on Student Learning

- learning activities used with **> 10000 students** since W2016
- 2015 – 2019 success rates **+23%** overall, **+34%** among CHEM 11X students (with CHEM 11 entry)
- student perceptions of conceptual learning highly favourable for all activity module formats

Completion rates of first-year chemistry student cohorts





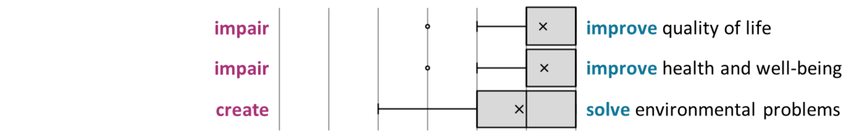
Responses (*N* = 497) to prompt "Rate how you believe [specified set of course activities] has helped you to understand and apply the concepts in this course"

Impacts on Student Attitudes

- **99% of students** believe chemistry improves their lives

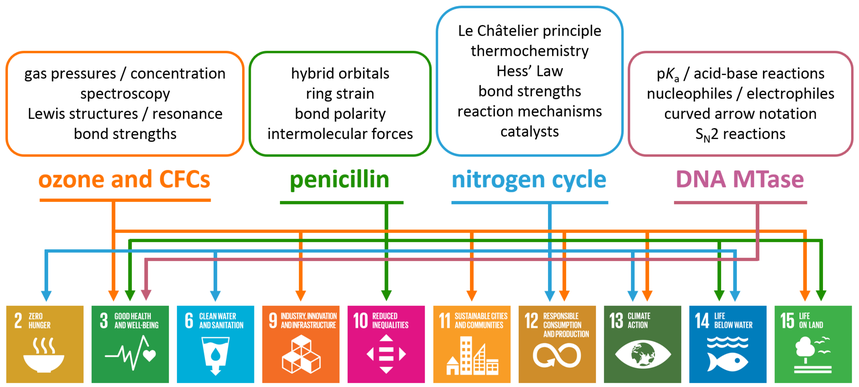
As a result of the context study activities, *my views of the impacts of chemistry* on...

I believe that overall, *discoveries and advances in chemistry*...

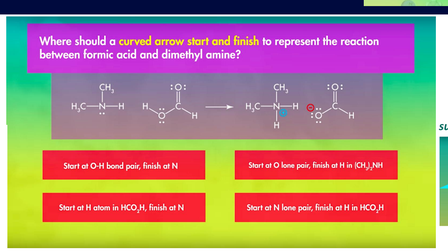


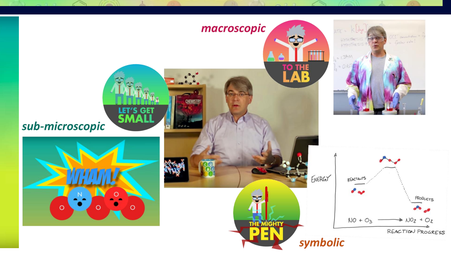
Impacts on Teaching Practice

- developed 17 large-class active- and peer-learning activity modules in different formats[3]
- ***guided inquiry modules***: foundational concepts students develop and apply themselves with scaffolding, in cycles of exploration, invention, application[4]
- ***flipped classroom modules***: challenging concepts in introduced in interactive video, then students apply / develop in class[5]
- ***context studies***: application of multiple course concepts to topics of societal / environmental / biological importance

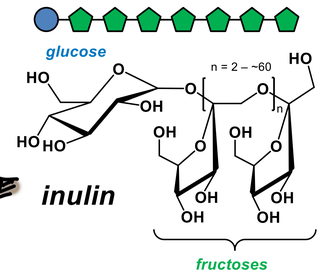


Course topics applied in context study activities with applications to UN SDGs

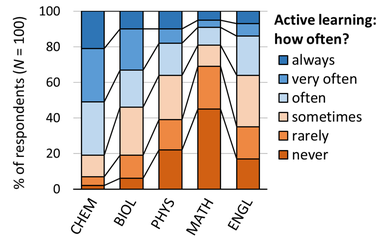




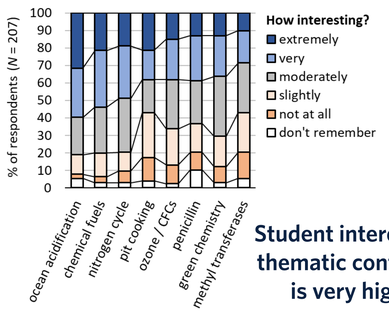
Sample interactive question and images from flipped module instructional videos



Context study exploring chemistry of regional Indigenous pit-cooking of balsamroot



Perceived frequency of active learning activities in first-year courses



Student interest in thematic contexts is very high

Outcomes and Future Work

- 2 publications[2,6] and >40 conference presentations / workshops, 4 further publications forthcoming
- 17 large-class active-learning activities redesigned as OER, released to UBC OER, OER Commons, MERLOT, National Center for Case Study Teaching in Science
- H5P interactivity in instructional videos improves student cognitive learning and engagement
- affective learning outcomes support highly positive student views toward societal impacts of chemistry
- *dramatic improvement in student completion rates*

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.

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Find the OER versions of our learning activities here!

guided inquiries | flipped modules | context studies

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