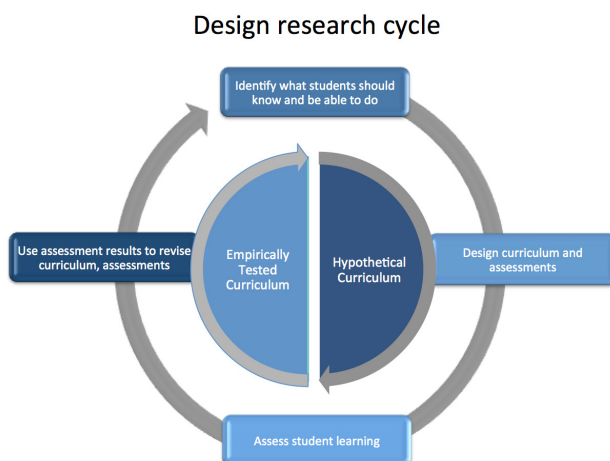


The focus of our research is to develop evidence based approaches to teaching, learning and assessment. Our work involves a wide range of activities and methods including designing ways to assess both what students know and how they use their knowledge, developing curriculum materials, and evaluating the effects of transformation efforts both within and across disciplines.

To design effective curricula we need to know what students bring to the table both in their prior knowledge and what they are able to do with that knowledge. We also must understand how and why students develop ideas that are not scientifically sound. For example we have shown that for many students, when they consider how the molecular level structure of a substance can be used to predict macroscopic properties, their ideas are often a loosely woven tapestry of concepts, facts and skills, rather than a useful framework of ideas.

Our approach to curriculum transformation uses a design based research cycle in which we identify what students should know and be able to do, design and implement a curriculum that would meet these goals, assess student achievement and use the results of the assessments to revise the curriculum and accompanying assessment materials. These assessments require students to construct (free form) structures, diagrams, and models, and to develop explanations for phenomena. Our formative assessment system, beSocratic (<http://besocratic.chemistry.msu.edu>), is designed to recognize and respond to student input.

Examples of this process are **Chemistry, Life, the Universe and Everything (CLUE)**, an NSF supported general chemistry curriculum, and the current design project **Organic Chemistry, Life, the Universe and Everything (OCLUE)** (both developed in collaboration with Mike Klymkowsky, University of Colorado at Boulder).



Using this system we have evaluated how students in both traditional and CLUE curricula understand a range of chemical ideas and phenomena. For example we have shown that CLUE students are more likely to understand that intermolecular forces are interactions between small molecules (not within) as shown in the Sankey diagram below. We have also shown improvements in understanding structure property relationships, and understanding of acid base reactions. 🌱



Melanie M. Cooper

Evidence-based Approaches to Improving Chemistry Education

LAPPAN-PHILLIPS PROFESSOR OF SCIENCE EDUCATION AND PROFESSOR OF CHEMISTRY

(b. 1954)
B.S., 1975, Univ. of Manchester, England;
M.S., 1976, Univ. of Manchester, England;
Ph.D., 1978, Univ. of Manchester, England;
Professor, 1987-2012, Clemson University;
Honorary Doctor of Science, 2016, Univ. of South Florida;
Fellow, 2017, Royal Society of Chemistry.

517-353-1114



SELECTED PUBLICATIONS

Reasoning about Reactions in Organic Chemistry: Starting It in General Chemistry, Crandell, O. M.; Kouyoumdjian, H.; Underwood, S. M.; Cooper, M. M., *J. Chem. Educ.* **2019**, 96 (2), 213-226.

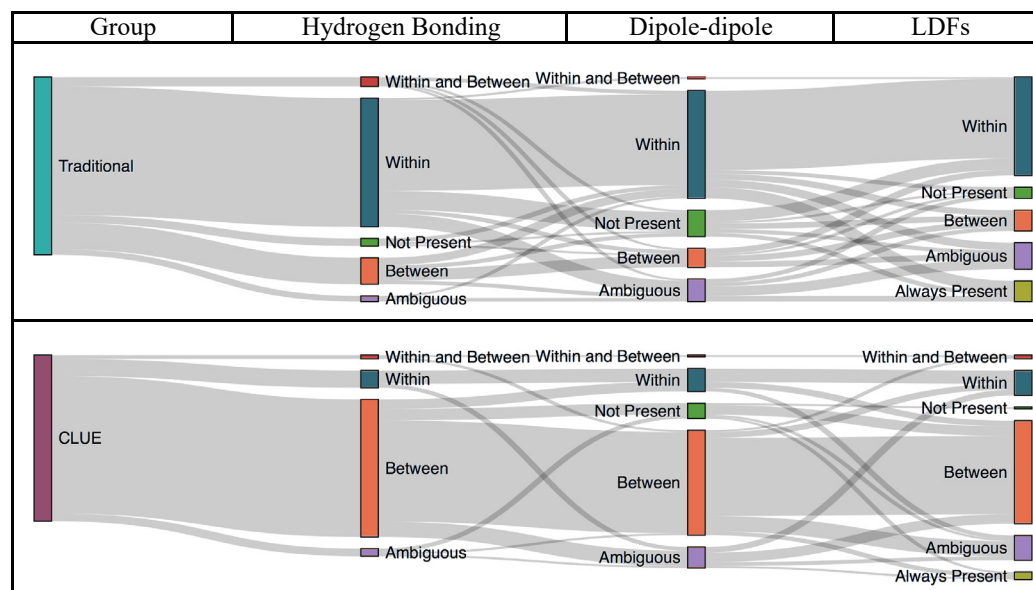
Evaluating the extent of a large-scale transformation in gateway science courses, Rebecca L. Matz, Cori L. Fata-Hartley, Lynmarie A. Posey, James T. Laverty, Sonia M. Underwood, Justin H. Carne, Deborah G. Herrington, Ryan L. Stowe, Marcos D. Caballero, Diane Ebert-May, Melanie M. Cooper, *Science Advances* **2018**, 4 : eaau0554.

Chemistry Education Research—From Personal Empiricism to Evidence, Theory, and Informed Practice, Melanie Cooper and Ryan Stowe, *Chem. Rev.* **2018**, 118(12), 6053-6087.

Connecting Structure-Property and Structure-Function Relationships across the Disciplines of Chemistry and Biology: Exploring Student Perceptions, Kathryn P. Kohn; Sonia M. Underwood; Melanie M. Cooper, *CBE—Life Sci. Edu.* **2018**, 17(2) <https://doi.org/10.1187/cbe.18-01-0004>.

Adapting Assessment Tasks To Support Three-Dimensional Learning, Sonia M. Underwood, Lynmarie A. Posey, Deborah G. Herrington, Justin H. Carmel, Melanie M. Cooper, *J. Chem. Educ.*, **2018**, 95(2), 207-217.

Are Noncovalent Interactions an Achilles Heel in Chemistry Education? A Comparison of Instructional Approaches, Williams, Leah C.; Underwood, Sonia M.; Klymkowsky, M. W.; Cooper, M. M., *J. Chem Educ.* **2015**, 92(12), 1979-1987.



Sankey diagram showing how CLUE and traditional students represent intermolecular forces as within or between molecules.