REBUILD-ing STEM Education at Michigan

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https://rebuild.lsa.umich.edu/

Stereotype Threat and Gender Differences

Despite generations of gradual progress, women and minorities remain underrepresented in the leadership of all STEM disciplines. The causes of this disparity are various, but one important factor is the existence of group performance differences (GPDs) in introductory STEM courses. These GPDs persist even when accounting for various measures of prior performance, including high school GPA, standardized tests, and prior college performance. We have uncovered a consistent pattern in GPDs: while they are ubiquitous and substantial in lecture courses evaluated by timed examinations, they are absent in lab courses evaluated through more authentic means. The pattern observed at Michigan has now been confirmed in data from other R1 universities. This pattern suggests that evaluative style might be responsible for substantial gendered performance differences, rather than subject matter or intrinsic ability. We hypothesize that stereotype threat (ST) plays a central role. When an individual is placed in an evaluative environment in which they know others might expect them to confirm a negative stereotype, they expend some cognitive resources on this concern, modestly reducing their ability to perform.
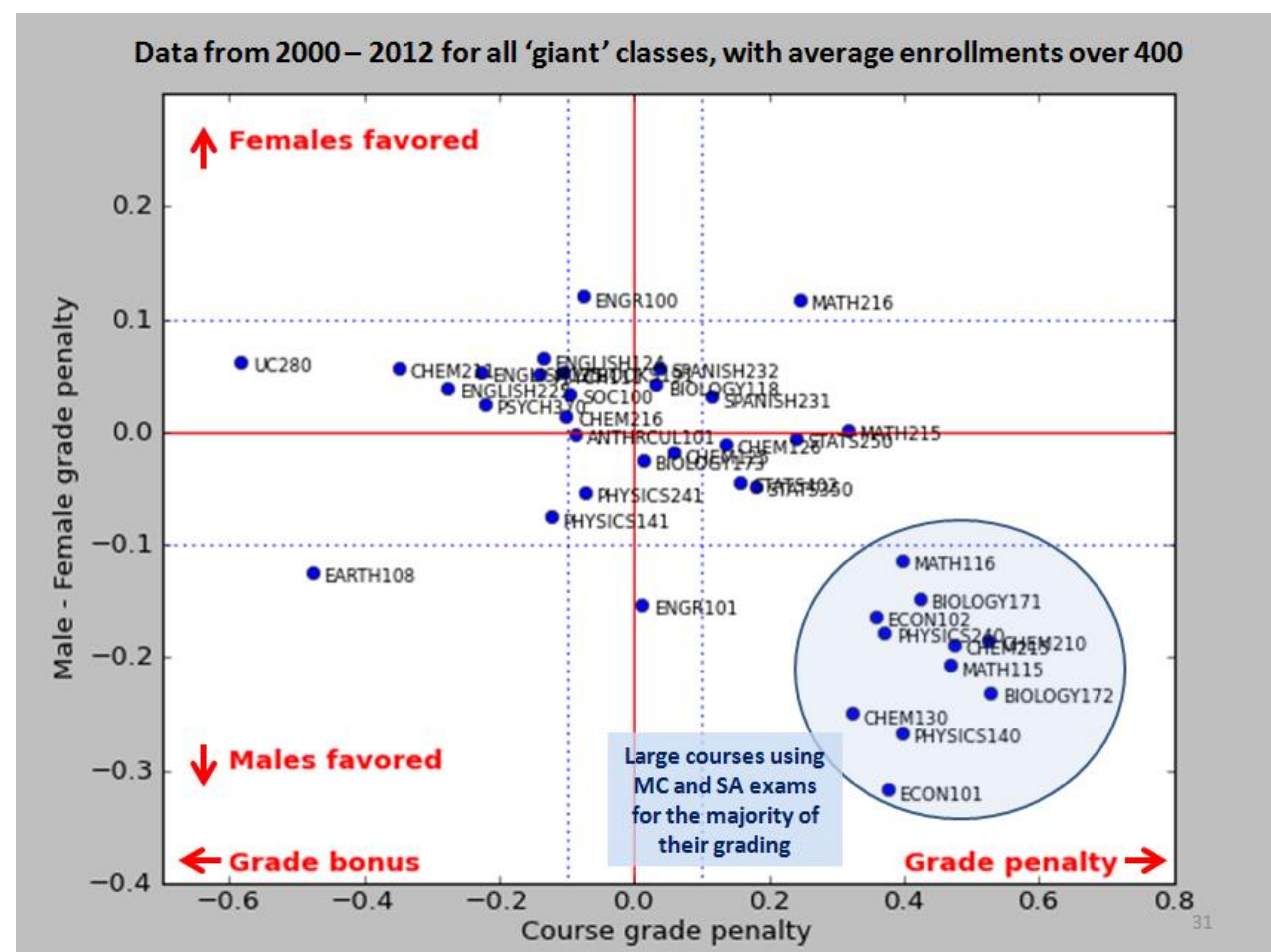
Authentic Research Design Labs

Two new HHMI grants are supporting the development of Authentic Research Design labs for undergraduates in introductory biology and chemistry courses at Michigan. These labs expose students to authentic science from their earliest classes. Two models are in use.

1. Faculty Research based labs: Research questions of authentic importance to faculty members are brought into introductory lab sections.
2. Student designed labs: Students spend the first half of the term learning how to pose an authentic research question of their own.

Abstract

The University of Michigan began a campus-wide program to reinvent introductory teaching and learning in the core STEM disciplines in January 2014. The Researching Evidence Based Undergraduate Instructional Learning Developments (REBUILD) project brings together the Departments of Physics, Chemistry, Biology, Math, and Astronomy in a multi-year effort to change the culture around intro STEM teaching. Our goal is to make evidence-based, scholarly teaching the new normal, replacing our longstanding reliance on tradition. Since REBUILD launched, we have engaged in a wide range of reform and analytics efforts. In this poster we will report on a few of our recent efforts.

REBUILD team members: Tim McKay, Aaron Pierce, Trisha Wittkopp, Laura Olsen, Ken Cadigan, John Wolfe, Eric Bell, Karen Smith, Ralf Spatzier, Anne McNeil, Lisa Latucca, Mary Wright, Maybeth Bauer, Ben Koester, Gina Shereda.


University of Minnesota Biology Professor Robin Wright speaks at the fall 2014 Provost's Seminar on Teaching. Her topic: "Start Where You Are: Incorporating Scientific Teaching Approaches in Your Existing Lectures."

Active Learning and Studio Instruction

Many of the large STEM lecture courses at Michigan are making increasing use of active learning methods. Time spent in large group meetings (what used to be lectures) is often dedicated to in class work, while content is presented in advance. Biology 171 has been substantially revamped, leading to significant increases in both student learning and satisfaction. Physics 140 and its accompanying 141 lab are also the subject of a major reform effort to begin in January 2016. Students will use computation to engage with real world problems and conduct experiments using sensors they take out into the world.

Research conducted at other institutions makes it clear that a **studio mode of instruction**, in which students spend all their time in class working collaboratively in small groups, can have a major impact on both student performance and persistence in STEM. REBUILD team members are exploring ways to experiment with studio instruction now, and hoping to collaborate with the University on the creation of studio spaces adequate for teaching at our scale.
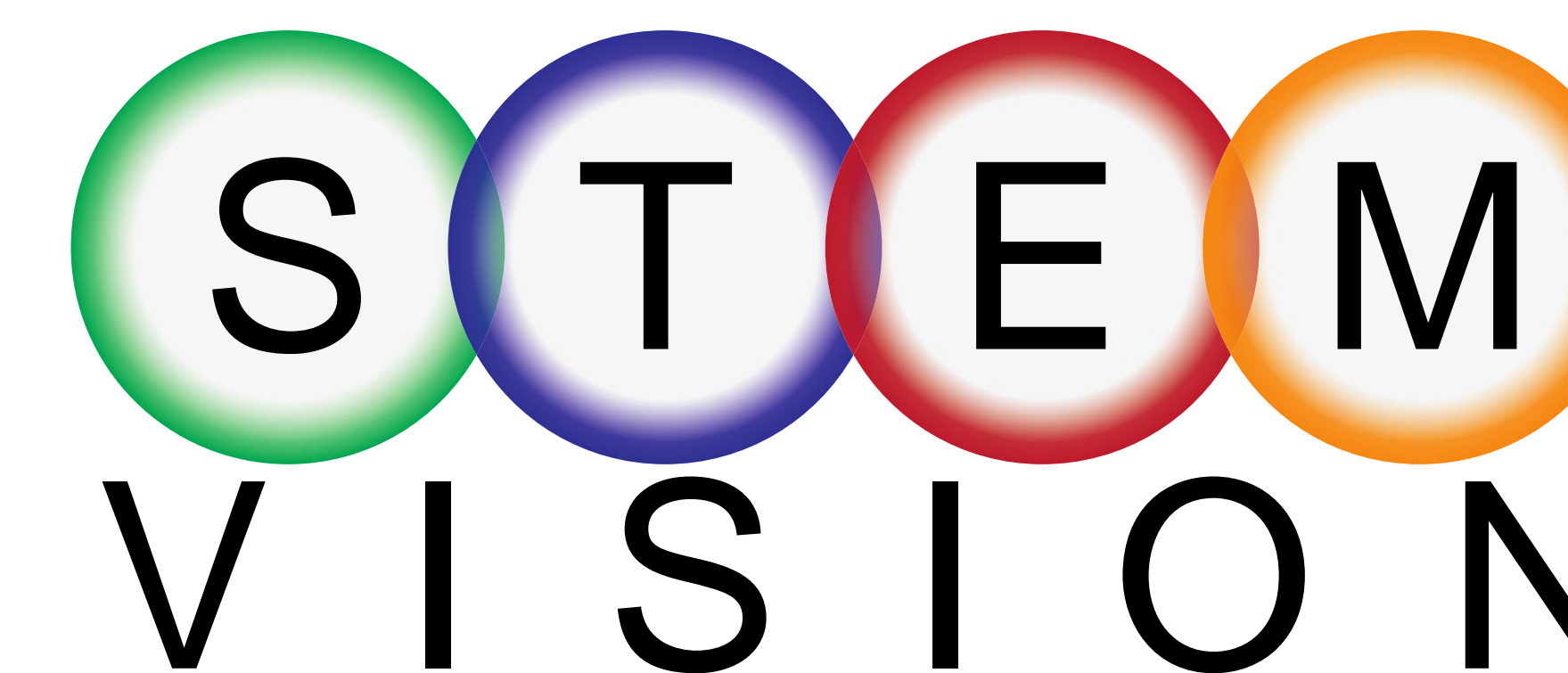
Campus-Wide STEM Planning Process

REBUILD is leading a campus-wide planning process incorporating input from diverse voices – administration, faculty, staff, and undergraduate and graduate students. We welcome broad-based participation in the Provost's Seminar on Teaching on October 5th, 2016, where we will unveil and discuss the STEM Community's proposal for transformation.
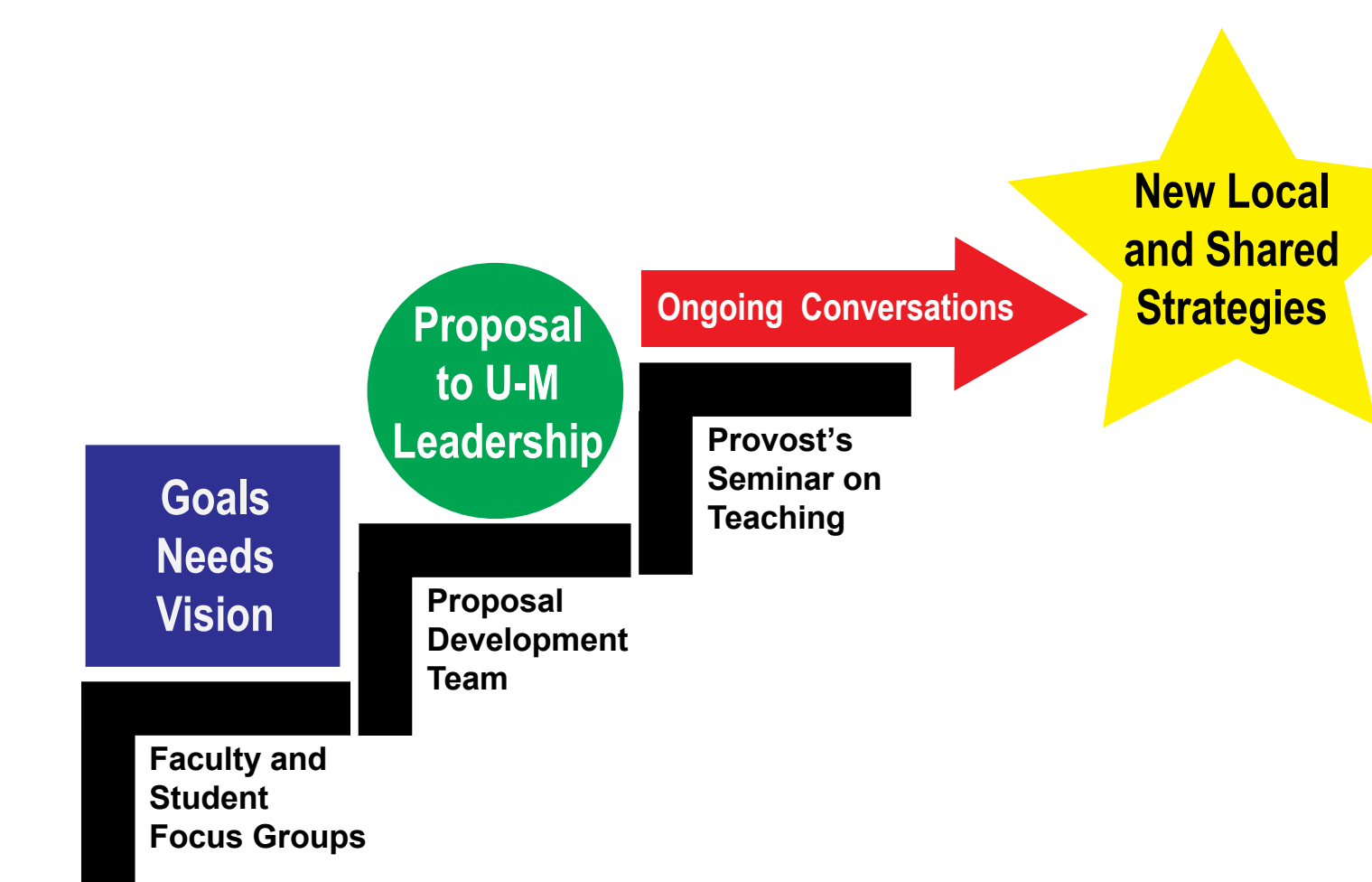
Writing to Learn in Introductory STEM Courses

Writing to Learning has long been known to be a very effective approach for supporting higher level learning across the disciplines. Despite this, students in introductory STEM courses are very rarely asked to write what they know, mostly because of perceived practical barriers to providing meaningful feedback to this work or assessing it for a grade.

At Michigan, Presidential Postdoctoral Fellow Ginger Shultz has been working with Professor Anne Gere – Director of the Sweetland Center for Writing – to develop MWrite, a toolkit of technologies and practices designed to support the inclusion of serious writing in large introductory STEM courses. This toolkit will rely on two key approaches – technology supported peer evaluation of writing, especially useful for developing student understanding of difficult concepts, and the use of natural language processing and latent semantic analysis for giving instructors a collective understanding of what students are writing.

They have piloted this approach in General Chemistry, where students are asked to read Lewis's original 1916 paper in which he proposed the ideas for the 'dot structure'. After reading this, students respond in writing to a series of prompts aimed at eliciting their own understanding, then review one another's work. They show real gains in understanding: results were recently published in the *Journal of Chemistry Education*.