WORKSHOP TITLE	PRESENTER	INSTITUTIONS	WORKSHOP DESCRIPTION	AUDIENCE
3D printing and Computer-Aided Design (CAD) for engaging students in the exploration of instrument design and performance: Inexpensive and user-friendly instrument kits for STEM educators	Lon A Porter	1. Wabash College, Crawfordsville, IN, United States.	While much has been accomplished in developing low-cost instruments using children's building blocks and household items, greater access to 3D printing via community makerspaces and university fabrication centers allows educators to transcend the limitations of conventional tooling. The recent and accelerating advances in computer-aided design (CAD) and 3D printing methods provide access to innovative approaches in the development of new educational tools. While this evolving technology offers great potential, the barrier to entry is often intimidating for those unfamiliar with CAD software and fabrication equipment. This workshop will guide participants in the design of a colorimeter or fluorimeter instrument for lab use. Each participant will be provide with a 3D printed instrument kit to take home to use in their classrooms. Additionally, participants will receive a user-friendly set of computer-aided design (CAD) models and stereolithography (STL) files for the production of simple and inexpensive 3D printed analytical instruments. These designs allow educators to provide active learners with tools for constructing instruments in activities aimed at exploring the technology and fundamental principles related to quantitative analysis. These digital models are flexible in design, printed quickly, and each requires less than a dollar's worth of plastic filament. Once printed, the resulting instruments perform very well when compared to commercially available tools. No previous CAD, 3D printing, or electronics experience is required. This workshop welcomes both beginners and those with some experience.	College, High School, Middle School

A laboratory practical examination that rewards independence and accuracy	Jennifer Schmeisser	1. Chemistry, St. Lawrence University, Canton, NY, United States.	One of the fundamental learning outcomes in our department is acquiring proficiency in performing data analysis. Because many general chemistry students go on to major in other sciences, we chose a laboratory practical tasks focusing on standard curves as it is a data analysis tool important to all areas of science. We have created two hands-on lab practical assessment tools administered in the second semester evaluating: 1) preparation of solutions with precise concentrations and 2) creating and using a standard curve and 3) measuring pH to determine concentrations of acids and bases. The first year we used the assessment we only administered a final examination at the end of the second semester. Based on the results of the exam, the following year we implemented a midterm exam as an introduction to this type of active assessment. The midterm exam (1.5 hours) requires students to prepare two solutions. The final exam (3 hours) requires students to repeat the tasks from the midterm, as well as to perform visible spectroscopy and pH experiments using Vernier equipment. Both laboratory practical tasks are graded on the accuracy of student's solution preparation, and for the final, we also evaluate student's pH and absorbance measurements. In this workshop, participants will be work the laboratory practical examination executing the hands-on tasks, and perform data analysis to obtain experimental results as students would do. Afterwards, we will discuss the benefits and challenges of the workshop experience and how they might inform the general chemistry curriculum at your home institution.	College, High School

American Association of Chemistry Teachers (AACT) high school resources for topical units	Kimberly Duncan	1. Education Division, American Chemical Society, Washington, DC, United States. 2. American Association of Chemistry Teachers, Washington, DC, United States. 3. Harrington High School, Bryn Mawr, PA, United States. 4. Science, Chico High School, Chico, CA, United States. 5. Libertyville High School, Libertyville, IL, United States.	The AACT high school library has a wide variety or classroom resources you can use in topical units throughout the year. In the first session, Jenelle Ball and Heather Weck will show you how to put together a successful Periodic Table unit plan using the lessons, activities, labs, demonstrations, projects, videos, simulations, and animations that are available on the AACT website. Attendees will engage is several hands-on classroom activities and walk away with a complete unit plan for the Periodic Table to use with their students. Incorporating simulations, animations, and short videos into your lesson plans can help you introduce new topics, reinforce the material, and help you assess your students' understanding of chemistry concepts. In session two, Sherri Rukes will show you around our library of multimedia resources for many of the topics that you teach. Attendees will engage is several online activities and walk away with new ideas for helping their chemistry students learn important concepts. In the final session, Kim Duncan will show you how to elicit and develop students' initial ideas and models of ionic and covalent chemical compounds by engaging in a simple but effective phenomenon. Begin the session with a simple activity that focuses on the conductivity of solid sugar and salt, deionized water, and sugar and salt solutions. Observations are used to build a particle model of the dissolving process for ionic and covalent substances. The session also includes data sets that can be used to further develop student models, along with links to other resources that will engage students and allow them to build an understanding of the relationship between the structure and properties of ionic and covalent compounds.	High School
Absorbance, fluorescence, and emission spectroscopy with one device on any platform	Elaine Nam	1. Vernier Software and Technology, Portland, OR, United States.	See how one, affordable device can do all these things in your general chemistry laboratory. Perform a kinetics experiment including all the rate law analysis. Compare absorbance and fluorescence spectra on the same graph to study Stokes shift. Look at emission spectra from gas discharge tubes. All of this with the Vernier Go Direct SpectroVis Spectrophotometer on the platform of your choosing. This hands-on workshop would be applicable to general chemistry, physical chemistry, and biochemistry courses. Bring your own device (BYOD) such as your Chromebook, computer, tablet, or phone with the free Spectral Analysis 4 app installed, or use one of ours. Download information is available at www.vernier.com/downloads	College, High School

ACS and American Association of Chemistry Teachers (AACT) hands on activities to help teach K-12 chemistry	Kimberly Duncan	1. Education Division, American Chemical Society, Washington, DC, United States. 2. American Association of Chemistry Teachers, Washington, DC, United States. 3. Science, Miami Country Day School, Aventura, FL, United States. 4. Libertyville High School, Libertyville, IL, United States. 5. Harrington High School, Bryn Mawr, PA, United States.	ACS and AACT have an ever-growing collection of hands on activities to help K-12 teachers cover important and complex chemistry concepts. It is often difficult to find classroom activities that can help all levels of students understand chemistry concepts. In the first presentation, K-12 Demos on a Dime, Jesse Bernstein and Sherri Rules will demonstrate several engaging demonstrations, labs, and activities. Those who attend will walk away with resources to use with their students. AACT also has a large and varied collection of online resources available for teaching AP Chemistry that have been aligned to the topics and learning objectives by the new College Board CED. Join us for our second session when Heather Weck and Jesse Bernstein will explore the collection of lesson plans, labs, demonstrations, and multimedia resources, along with articles from *Chemistry Solutions* , AACT's online periodical, and webinars from our expanding archive. Finally, Emily Abbot will outline and demonstrate some of the activities from Inquiry in Action, a website for K-5 teachers, and MiddleSchoolChemistry.com, an ACS website that serves teachers in grades 6 – 8.	High School, Middle School
ACS and American Association of Chemistry Teachers (AACT) resources to improve science literacy	Kimberly Duncan	1. Education Division, American Chemical Society, Washington, DC, United States. 2. American Association of Chemistry Teachers, Washington, DC, United States. 3. Science, Chico High School, Chico, CA, United States.	The American Chemical Society (ACS) Education Division offers a range of resources to help improve the science literacy of high school chemistry students. In our first presentation, Jenelle Ball will outline the close read strategy, which is an active read of an article for depth of understanding. This helps students navigate and access challenging chemistry readings as well as introducing them to applications of chemistry. This strategy slows down the reading process, which is helpful for students with little interest or enthusiasm to read challenging expository text. Join us and learn about the process, hear strategies to help your students increase their science literacy, how to manage grading the close read, and explore a variety of articles that you can use with your chemistry classes. During the second presentation, AACT staff and former teachers, Kim Duncan and Monica Wixon, will give an overview of *ChemMatters* , a periodical written for high school chemistry students. You will then learn about lesson plans from AACT that incorporate *ChemMatters* articles and other similar media. These lessons will improve students' understanding of scientific concepts, allow them to relate chemistry to everyday life, and think critically.	High School

ACS Exams alignment processes and uses: How the item alignment process works at ACS Exams and how this can be used for other assessments	Kristen L Murphy	1. Chemistry and Biochemistry, University of Wisconsin-Milwaukee, Milwaukee, WI, United States. 2. #27, Bemidji State University, Bemidji, MN, United States. 3. Chemistry Department, Grand Valley State University, Allendale, MI, United States. 4. Chemistry, University of South Florida, Tampa, FL, United States. 5. Chemistry, Luther College, Decorah, IA, United States.	At ACS Exams, we have been evaluating the many test items developed for item characteristics including content, complexity, process type and image inclusion. The alignment process and how these are ultimately used to investigate performance and content coverage through a different lens have been used extensively at ACS Exams. This assessment workshop will take participants through the process of alignment and into evaluating how alignment information can be used. Included in this workshop will be: 1. Alignment parameters: what structures need to be considered and what information is sought, 2. Alignment processes: how will this be done and how will the results be vetted, and 3. Alignment information: how to synthesize the information from an alignment and how this can be used to develop new materials. Also included in this workshop will be the use of an automated alignment tool developed by UMass in collaboration with ACS Exams.	College, High School, General Audience
Activating your instruction with animations that conflict	Resa M Kelly	1. Dept of Chemistry, San Jose State University, San Jose, CA, United States. 2. Columbia Univ Chemistry Dept, New York, NY, United States. 3. Bogazici University, Istanbul, Bebek, Turkey. 4. Department of Chemistry, Sam Houston State University, Huntsville, TX, United States.	Challenging your students to think deeply about animations has always been considered challenging. Perhaps you have heard your students comment: “Animations, they are just a bunch of balls moving around. Who Cares!” Or maybe you have heard your colleagues brim with pride when they tell you that they never use animations because it’s not that important and they have these super awesome yellow transparencies that do just fine. All kidding aside, students struggle with their atomic level understanding, and they tell us, we don’t know what to think about the atomic level because no one shows us. Well, it’s time to change that! This workshop is designed to channel your Alex Johnstone triangle by presenting you with three experimental macroscopic contexts for three well-studied reaction events and an accompanying submicroscopic animation challenge: How do you deduce from conflicting molecular level animations which one is a best fit with the experimental evidence? What features in the animations are important to consider and why? Attend this workshop to brainstorm ways to empower your students to become critical consumers of animated models and to have fun networking on ways to enhance your instruction. We will share our research findings that support this instruction and eye-tracking considerations you may want to explore. These animation activities are designed for secondary and tertiary General Chemistry classes, some assembly is required, but not a school assembly that will pull you away from teaching. Some side effects such as an intense need for discussion and cognitive dissonance may occur.	College, High School

Active learning in organic chemistry with Alchemie Interactives	Sarah Wegwerth	1. Alchemie, Troy, MI, United States. 2. Alchemie, Troy, MI, United States.	Enhance your curriculum for organic chemistry through the incorporation of in-class activities that utilize the Mechanisms and ModelAR learning tools and instructor dashboard. In this workshop you will use new technology and collaborate with other instructors to create learning modules to engage students in concept exploration. Learn from other practitioners who have successfully implemented the software in their classes. You will also discover how you can monitor student progress in real time regardless of class size.	College
Active learning in organic chemistry: Backward design	Justin Houseknecht	1. Chemistry, Wittenberg University, Beavercreek, OH, United States. 2. Chemistry, Dartmouth College, Norwich, VT, United States.	Active, student-centered pedagogies can dramatically improve student outcomes, but before implementing new teaching methods it is essential to clarify, both to yourself and to the students, what students should be learning. This workshop will apply principles of backward design from Wiggins and McTighe's book *Understanding by Design* (2006) and Dee Fink's *Creating Significant Learning Experiences: An Integrated Approach to Designing College Courses* (2013) to the undergraduate organic chemistry curriculum. Participants will develop course and topic-level learning objectives as well as methods to assess student and course success. This clearer understanding of goals and assessment methods provides the foundation for instructional change. Results will be disseminated through the Organic Education Resources website at OrganicERs.org. While the backward design process aids in the development of any course, the workshop leaders will be focusing on the application of backward design to an organic chemistry course. High school teachers who wish to participate should be teachers of organic chemistry.	College, High School
Active learning in organic chemistry: Classroom assessment techniques and collaborative learning	Justin Houseknecht	1. Chemistry, Wittenberg University, Beavercreek, OH, United States. 2. Chemistry and Biochemistry, North Dakota State University, Fargo, ND, United States.	Many faculty are excited about using more technology and the "flipped" classroom is making headlines, but these alone don't improve student learning. This workshop will introduce proven active learning pedagogies, discuss why they are effective, and provide key characteristics of effective instruction that can use technology and work within the "flipped" paradigm. Participants will focus on developing activities and materials for a particular class session. The workshop facilitators will use examples from their experience teaching general and organic chemistry courses to classes ranging from 20-300 students. Particular emphasis will be placed on effective in-class use of collaborative learning and assessment techniques such as classroom polling, minute paper, muddiest point, categorization grid, student-generated exam questions, and scratch-off quizzes.	College, High School

Active learning in organic chemistry: Designing a class utilizing specifications grading	Joshua Roderick Ring	1. LR Box 7474, Lenoir-Rhyne University, Hickory, NC, United States. 2. Chemistry, Wittenberg University, Beavercreek, OH, United States.	This workshop will introduce participants to the basics of specifications grading, a system of course grading based on demonstrated mastery of discrete outcomes (specifications) developed by Linda B. Nilson. While the organizers have adapted specifications grading for their organic chemistry courses and therefore examples will come from that subject, the workshop is open to faculty considering the implementation of specs grading in any course. Participants will: Utilize Backward Design principles to cooperatively develop specifications for a non-majors chemistry course in order to experience the process and identify challenges. Hear examples of approaches to issues (including acceptable evidence of mastery, managing retakes, and grading major examinations) from the workshop organizers. Spend time in smaller groups working to plan parts of their own courses (e.g. faculty interested in implementing specs grading into the first semester of General Chemistry).	College, High School
Adopting and adapting LibreTexts for use in your classroom	Justin M Shorb	1. Chemistry, Hope College, Holland, MI, United States. 2. Department of Chemistry, Hope College, Holland, MI, United States. 3. Univ of Arkansas at Little Rck, Little Rock, AR, United States. 4. Department of Chemistry, Univ California Davis, Davis, CA, United States.	LibreTexts (formly ChemWiki) currently benefits over 60 million students per year and is the most visited chemistry website in the world. Central to its success is the construction and adoption of faculty specific and freely accessible course and instructor designed "LibreTexts" that substitute for costly conventional textbooks in post-secondary courses. Libretexts are assembled by incorporating content from an extensive network of existing chemistry and broader STEM materials. This workshop will serve as a collaborative hands-on development session to introduce faculty to the chemistry LibreTexts library with hands-on demonstrations of current capabilities including online homework capabilities, student assessment, numerical data analysis infrastructure, annotation, 3D visualization, inexpensive printing of copies and more as well as traditional course management capabilities (Blackboard or Moodle). The workshop will be organized around constructing individualized “course maps” from which custom LibreTexts can be remixed and revised. This will be facilitated by project development team membersinculding five hours of personalized support afterward to support continued adaption and adoption of the LibreTexts into individual classrooms. All participants will receive a printed copy of their LibreTexts after completion.	College, High School
Advanced leadership in green chemistry K-12 education part three	Janie Butle and Kate Anderson,	Beyond Benign, 100 Research Drive, Wilmington, MA 01887	A workshop for leaders in the field of green chemistry education who have been practicing its methods in their classroom for multiple years, in conjunction with creating resources for the K-12 green chemistry education community. This workshop will capitalize on the innovations and novelties shared within the chemistry community, and explore the possibilities for growth in green chemistry K-12 education.	K-12 teachers
Advanced leadership in green chemistry K-12 education parts one and two	Kate Anderson	Beyond Benign, 100 Research Drive, Wilmington, MA 01887	A workshop for leaders in the field of green chemistry education who have been practicing greener methods in their classroom for multiple years, in conjunction with creating resources for the K-12 green chemistry education community. The workshop will reflect on expansions and innovations made in the field, along with foster a community of like-minded teachers.	K-12 teachers who are part of Beyond Benign’s Lead Teacher program

Advanced rubric development for the assessment of mechanism examination questions in the second-year organic chemistry course sequence	Jay W Wackerly	1. Chemistry, Augsburg University, Roseville, MN, United States. 2. Department of Chemistry, Central College, Pella, IA, United States. 3. Department of Chemistry and Biochemistry, Georgia Southern University, Savannah, GA, United States.	A follow-up workshop designed for attendees of the initial workshop run at BCCE 2018 or the identical one run earlier at BCCE 2020. Specifically, as a group we will review the data collected from attendees at the previous two workshops and discuss the results in the context of student learning as shown in the chemistry education literature. We intend to generate a working, tentative rubric for practitioners to utilize in the assessment of mechanism-focused problems in organic chemistry.	College
An ACS DivCHED Examinations Institute Committee experience: Developing a test specification and writing and editing items	Keith A Marek	1. Chemistry and Biochemistry, University of Wisconsin-Milwaukee, Milwaukee, WI, United States. 2. Chemistry, University of South Florida, Tampa, FL, United States. 3. Chemistry Department, Grand Valley State University, Allendale, MI, United States. 4. Department of Chemistry, Bemidji State University, Bemidji, MN, United States. 5. Department of Chemistry, Luther College, Decorah, IA, United States.	Exam committees for ACS Exams follow a process for exam development that includes test specifications through item writing, editing and selection. This assessment workshop will be a “mini-exam development experience” where we will go through the process of developing an exam replicating a similar model to that which we use for ACS Exams. Included in this workshop will be: 1. How do determine a test specification: what will a test cover and to what depth 2. Different types of assessment items: how to select the best item type(s) and best array of item types to suit your needs 3. Writing and editing assessment items including writing incorrect responses and including visual-spatial or reference components 4. Assessing the assessment: basic statistics to examine how the test items performed	College, High School, General Audience
Analysis of guided inquiry classroom and laboratory activities	Thomas James Greenbowe | John I. Gelder	1. Department of Chemistry & Biochemistry, University of Oregon, Eugene, OR, United States. 2. Department of Chemistry, Oklahoma State University, Stillwater, OK, United States	Participants in this workshop will bring their guided inquiry classroom or laboratory activities to be analyzed by peers and two experienced activity writers. The author of an activity will list the learning objectives and have components fit into a learning cycle: exploration, concept invention/term introduction, and application. Participants will have 10 minutes to introduce the activity and to have the participants work through one component of the activity. Peers will have 8 minutes to analyze the activity and two minutes to present their analysis.	College, High School
Analyzing hazards and risks in high school chemistry laboratories	Marta U Gmurczyk	1. ACS, Washington, DC, United States.	The American Chemical Society has produced *Guidelines for Chemical Laboratory Safety in Secondary Schools* . The guidelines also outline a protocol, designated by the acronym RAMP, for designing and writing improved safety procedures for chemistry experiments. We will explore examples and applications of the four principles of safety: Recognize the hazard; Analyze the risk of the hazard; Mitigate the risk; and Prepare for emergencies, as well as show examples on how to integrate RAMP into lab activities.	High School, Middle School

AP Chemistry inquiry: Oxidation-reduction potential titration of hydrogen peroxide	Greg Dodd	1. Science, George Washington High, Pennsboro, WV, United States.	Chemistry students have demonstrated on past AP Chemistry examinations that there are serious misconceptions about oxidation-reduction chemical reactions. Exam results for redox reactions have been consistently poor. AP Chemistry Unit 4 states: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons. This Inquiry Activity addresses AP Chemistry Topic 4.9-TRA-2.C and TRA-2.C.1. Participants will use an Oxidation-Reduction Potential Sensor to measure the potential of the reaction between acidified potassium permanganate and hydrogen peroxide from the grocery store. The purpose of the Inquiry is help students overcome misconceptions about oxidation-reduction reactions, stoichiometry, and oxidation-reduction potentials. Time will be allotted for discussion of the Inquiry.	College, High School
AP Chemistry inquiry: The kinetics of hydrogen peroxide decomposition	Greg Dodd	1. Science, George Washington High, Pennsboro, WV, United States.	Chemistry students have demonstrated on past AP Chemistry Examinations that there are serious misconceptions about kinetics. Exam results for kinetics questions have been consistently poor. AP Chemistry Unit 5 states that: Some reactions happen quickly, while others happen more slowly and depend on reactant concentrations and temperature. This Inquiry Activity addresses AP Chemistry topic 5.3-TRA-3.C, TRA-3.C.1-C.4. Participants will use a gas pressure sensor and temperature probe to determine the rate order, rate constant, and activation energy for the decomposition of hydrogen peroxide (from the graocery store) using a KI catalyst. The purpose of the Inquiry is help students overcome misconceptions about kinetics, rate constant, rate order, catalysis, and the effect that temperature has on a system. Time will be allotted for discussion of the Inquiry.	College, High School
AP Chemistry mock reading part one	Linda Cummings	1. Chemistry and Biochemistry, University of Colorado, Colorado Springs, Colorado Springs, CO, United States. 2. Ag, Science and Engineering, Northern Oklahoma College, Stillwater, OK, United States.	Come be trained as an AP Chemistry "Reader"! Linda Cummings, a Table Leader for the AP Chemistry Reading, will discuss the process of scoring at the AP Chemistry Reading and demonstrate how the training process works. Participants will answer a free-response question (FRQ), then go over the rubric. We will look at released sample responses as well as actual student samples to get "on rubric." We will look at question 1 (a FRQ) from the 2018 AP Chemistry exam, addressing oxidation states, stoichiometry, calorimetry, and net ionic equations. Bring a calculator!	High School
AP Chemistry mock reading part two	Lisa McGaw	1. Ag, Science and Engineering, Northern Oklahoma College, Stillwater, OK, United States. 2. Chemistry and Biochemistry, University of Colorado Colorado Springs, Colorado Springs, CO, United States.	Come be trained as an AP Chemistry "Reader"! Lisa McGaw, a Table Leader for the AP Chemistry Reading will discuss the process of scoring at the AP Chemistry Reading and demonstrate how the training process works. Participants will answer a free response question (FRQ), review the rubric and look at released sample responses to learn how to apply the scoring standards. In this session participants will explore question 3 from the 2019 AP Chemistry operational examination which includes topics such as net ionic equations, particulate drawings, stoichiometry and equilibrium.	College, High School

Are your students' struggles with numeracy holding them back? How to help students attain the skills necessary for success in general chemistry	Michael W. Burand	1. Chemistry, Oregon State University, Corvallis, OR, United States. 2. Oregon State University, Corvallis, OR, United States.	At Oregon State University, we found that many of our general chemistry students were struggling due almost entirely to inadequate numeracy skills. Thus, we created a one-term foundational skills course, CH 101, to be taken prior to enrollment in the general chemistry sequence. We have found that a program involving mathematics remediation along with a significant “mental math” component has shown to be effective in preparing our students for general chemistry. Whether you would like to create a stand-alone course (as we have), a supplementary companion course, or are simply interested in integrating parts of our curriculum into your general chemistry course, this workshop will help you devise an effective way to do it. We will discuss implementation strategies and actively explore our course from the student perspective. Workshop participants will be provided with electronic copies of many of our course materials.	College, High School
Assessing competency and easing grading loads: Developing a specifications grading scheme for your course	Mary Beth Anzovino	1. Georgia Gwinnett College, Lawrenceville, GA, United States.	Are you tired of being unsure whether your assessment and feedback efforts are really helping your students learn chemistry? In specifications grading, the grade earned in a course is a direct measure of student competency in the course’s requisite knowledge and skills. This system involves a list of course objectives, each with a targeted assessment. Students have full control over the grades earned by demonstrating minimum competency of course objectives on a pass/fail basis. These assessments can be retaken (with stipulations) until mastery is demonstrated. By focusing students’ attention on smaller, well-defined objectives, course expectations are clear and students can self-regulate what learning they must accomplish to reach the standard of minimum competency. Specifications grading also communicates to all stakeholders which objectives are truly essential to passing the course and to be truly proficient in chemistry, since students who achieve higher grades can demonstrate that they have met the standards for minimum competency through this assessment methodology. In this workshop, participants will: a) Learn about specifications grading and its implementation and receive hands-on guidance in the development or revision of course learning objectives for their course(s), b) Explore in a scaffolded way the development of effective assessment activities/questions that can accurately address various facets of each objective, c) Discuss and decide on a blueprint for implementing specifications grading in their chosen course and educational level, d) At the end of the workshop, participants will have completed a set of primary course objectives and a preliminary assessment plan that can be immediately implemented in their class.	College

Assessment item writing based on a developmental perspective	Alena Christine Moon	1. Chemistry, University of Nebraska Lincoln, Lincoln, NE, United States. 2. Chemistry, Portland State University, Portland, OR, United States.	Assessing what students know and can do is a challenging task. Multiple-choice items can potentially offer quick and efficient characterizations of students' knowledge of a topic. The potential of these items to offer valid and reliable evidence of students' understanding depends on how the item is constructed and how students respond to the item. This workshop will focus on how to construct MC items. The workshop will be separated into three sections: theoretical considerations/qualitative model, item components and construction, and item evaluation. All three sections will be contextualized in an instrument on wave-particle duality (WPD) that was developed by the workshop facilitators. In each section, the facilitators will briefly introduce the topic, provide examples from the WPD instrument, and provide attendees an opportunity to practice.	College, High School, Middle School, General Audience
Authentic research in the chemistry classroom: Sharing ideas and tools	Benjamin J McFarland	1. Seattle Pacific Univ, Seattle, WA, United States.	Authentic research immerses students in the processes of science, providing a rich experience that promotes interdisciplinary, exploratory learning while generating new knowledge. However, like most worthwhile things, it is not easy, and it presents unique challenges for both instructors and students. For a decade, I have addressed these challenges in undergraduate biochemistry and physical chemistry courses using the online GENI-ACT platform, which provides interactive and collaborative virtual laboratory manuals and data collection tools that help organize and share data and protocols. This workshop will discuss examples of the authentic research projects we have adapted to a classroom context. We will describe how these have been used for diverse levels of students and disciplines and discuss the benefits and challenges of adding real-world research to the classroom. For example, on GENI-ACT, bioinformatics projects have been shared among college classes and are being developed as online laboratory research exercises for high school students. Many different projects have been translated from research labs to teaching labs. Research experiences, ranging from post-doctoral research projects to summer science mentor programs, have been brought into classes at liberal arts universities, community colleges, and high schools. We will discuss how to adapt past research experiences to different teaching contexts. Participants should bring laptops if possible in order to participate in bioinformatics research during the workshop. This program is supported by a RCN-UBE grant from the National Science Foundation that provides extended faculty training and support for teachers who would choose to incorporate authentic research into the classroom.	College, High School

beSocratic: An online system for the assessment of student constructed models, explanations, and arguments	Melanie Cooper	1. Michigan State University, East Lansing, MI, United States.	Learning environments where core ideas, and scientific practices such as constructing and using models, and developing arguments and explanations are emphasized are more likely to lead to the development of expertise, than those where assessments focus on fragments of knowledge and isolated skills. We have developed the beSocratic system to address the need for large-scale formative assessment of such activities. "BeSocratic" is a cross-platform, web-based formative tutorial and assessment system. It can recognize and respond contextually to student-generated graphs and simple diagrams and allows students to construct written explanations and arguments. It has recently been completely rebuilt and redesigned, and new modules will be added over the next year or two. This workshop will focus on the use of "Be Socratic", the development of new activities, and the analysis of student work.	College, High School, Middle School
Best practices for teaching chemical nomenclature, terminology, and symbols	Sally Button Mitchell	1. Science, Rye High School, Rye, NY, United States. 2. Chemistry, The College of Saint Scholastica, Duluth, MN, United States.	This workshop will demonstrate different ways to teach chemical nomenclature, terminology, and symbols for use in chemistry field focusing on inorganic chemistry and the IUPAC Brief Guide to nomenclature series. This workshop is a complement to both the symposium on "Best practices for teaching chemical nomenclature, terminology, and symbols" and the workshop on "Organic nomenclature, terminology, and symbols". This workshop is supported and organized in part by the American Chemical Society's Committee on Nomenclature, Terminology, & Symbols.	College, High School
Best practices for teaching chemical nomenclature, terminology, and symbols: General chemistry and organic chemistry	Timothy M. Trygstad	1. Chemistry, The College of Saint Scholastica, Duluth, MN, United States. 2. Science, Rye High School, Rye, NY, United States.	Do your students recognize the importance of learning the language of chemistry? Do your students enjoy learning about chemical nomenclature, terminology, and symbols? How confident are you in teaching chemical nomenclature, terminology, and symbols both in a correct manner and in a way that engages your students? This workshop will focus on best practices for teaching chemical nomenclature, terminology, and symbols in general chemistry and organic chemistry and is a complement to both the symposium on "Best Practices for teaching chemical nomenclature, terminology, and symbols" and the workshop on Inorganic "Nomenclature, terminology, and symbols". This workshop is supported and organized in part by the American Chemical Society's Committee on Nomenclature, Terminology, & Symbols.	College, High School, General Audience

Beyond general chemistry: Cost-effective instruments for your laboratory course	Melissa P Hill	1. Vernier Software and Technology, Beaverton, OR, United States.	These laboratory instruments for your biochemistry, physical, analytical, inorganic, and organic chemistry labs are affordable and easy to use on a variety of platforms. Use the Vernier Go Direct Chemical Polarimeter to measure chiral properties of optically active samples. Try our Fluorescence/UV-VIS Spectrophotometer to measure the fluorescence, absorbance, and emission spectra from 220 nm to 900 nm. See how easy it is to perform gas chromatography with the Vernier Mini GC Plus Gas Chromatograph. Measure the melting point of a substance on your iPad with our Go Direct Melt Station. All these devices and more will be available for you to try hands-on in this workshop. Bring your own device (BYOD) such as your Chromebook, computer, tablet or phone with free software installed, or use one of ours in the workshop. Graphical Analysis 4 and Spectral Analysis download information are available at www.vernier.com/downloads	College
Building a free online assessment system for chemistry using Moodle	Glenn Lo	1. Chemistry, Nicholls State University, Thibodaux, LA, United States.	The escalating cost of college education has led to widespread support for the development of open educational resources (OERs) such as textbooks that are available for free or at low cost by organizations such as OpenStax. However, OER versions of online assessment systems for Chemistry seem to be nonexistent. The popularity of online assessment systems reflects the generally accepted pedagogical merits of various instructional strategies that utilize these systems. However, their cost is prohibitive for high schools and commercial systems are also unavailable for upper level chemistry courses (presumably due to a low ROI for publishers). The purpose of this workshop is to gather faculty who are interested in collaborating to develop a free OER online assessment system using Moodle, the world's most popular open-source learning management system. The workshop facilitator has developed a question bank and assessment-driven tutorials that cover at least 90% of General Chemistry topics and at least 70% of undergraduate physical chemistry topics, and has used these to successfully implement flipped instruction. These question banks are freely available to interested teachers and can be perused at chemistry.moodlecloud.com, a free hosting service provided by the creators of Moodle. Participants will be taught how to efficiently use the Moodle question authoring tool, manage and share question banks, and use Excel tools developed by the facilitator to easily generate multiple versions of a question, which would be useful for creating individualized assessments. The Excel tools can generate files in XML format that can be easily imported into a Moodle question bank. Deployment strategies inspired by research on cognitive science and pedagogy will also be demonstrated. Free and inexpensive Moodle-hosting services will be recommended for teachers whose institutions do not use Moodle.	College, High School

Chemical demonstration discussion forum	Angela Miller	1. Chemistry and Biochemistry, Ohio State University, Columbus, OH, United States.	This workshop seeks to bring chemistry demonstration experts together to trade ideas and help problem solve specific demo problems. Participation would be limited to 30 people per session, with 10 people per session invited to bring a slide presention containing the following: 1 example of a demonstration that works well and that you want to share, 1 example of a resource (website, store, or item) that you think is particularly useful, and 1 example of a demonstration that is not working the way you want. After each presentation, the audience will attempt to trouble shoot the demonstration and provide the presenter with experience-based feedback on what works and what doesn't. All participants will receive a beaker mug, and after the BCCE, all participants will receive the slides from the workshop sessions as well as a summary of options discussed during the troubleshooting section. After signing up for the workshop, the workshop facilitator will contact the participants for their ideas and select 10 per session to focus the discussion.	College, High School, Middle School
Chemistry of color in art	Don Warner	Don L. Warner, Ph.D., Dept. of Chemistry and Biochemistry, Boise State University, Boise, ID, United States	The aim of the workshop is to provide situational and tactile exposure to chemistry and science through the lens of art. Participants will prepare pigments in teams and use their synthesized pigments to create their own works of art. We hope that our format will be adaptable to participants' home institutions to encourage conversation and shared experiences that can cross disciplines and perceived boundaries, and bring people together in an inclusive and fun environment.	College, High School, General Audience
Chemistry, Life, the Universe and Everything (CLUE)	Sonia Miller Underwood	1. Michigan State University, East Lansing, MI, United States. 2. Chemistry & Biochemistry, Florida International University, Miami, FL, United States. 3. Chemistry, Florida International University, Miami, FL, United States.	CLUE is an evidence-based approach to general chemistry based on four core ideas: Electrostatic and bonding Interactions, atomic/molecular structure and properties, energy – macroscopic, atomic/molecular, quantum – and change in and stability of chemical systems. The curriculum was developed by answering five questions: 1. What do we want students to know? 2. In what order should they learn it? 3. What do students bring with them? 4. What materials are most appropriate for learning different concepts and skills? 5. How will we measure what students have learned? Participants in the workshop will answer these questions for their own institutional settings and students to determine how CLUE might work within their institution. In addition, they will have the opportunity to work with the materials developed for the CLUE curriculum, including online "beSocratic" activities. Participants will be provided with CLUE materials, including an electronic version of the text and student activities.	College
Classroom management: Paramount to success	Jon Schade	Riverside Jr/Sr High School	Positive, appropriate, productive classroom behavior can be taught systematically. It's worth the time and effort to show science students and teachers a better way to interact in the classroom. During this workshop, participants will learn strategies for classroom management to minimize student-teacher power struggles, and greatly reduce the need for discipline referrals. Discover how to foster a more positive and productive science classroom through interactive role-playing exercises.	High School

Climate change and high school chemistry in the Earth system	Sarah Pedemonte	1. Learning and Teaching, Lawrence Hall of Science, Berkeley, CA, United States.	As a result of our work with secondary teachers across the country, the Lawrence Hall of Science has revised and refined course development tools for the *Chemistry in the Earth System* course, to support implementation of the high school three-course model as recommended by the California Science Framework. These newly refined documents and associated instructional resources will be introduced, modeled and provided to workshop participants.	High School
Contextualized chemistry: How to foster student motivation and engagement	Brad D. Fahlman	1. Department of Chemistry & Biochemistry, Central Michigan University, Mount Pleasant, MI, United States. 2. ACS, Lake Worth, FL, United States.	As more institutions develop contextualized content for introductory chemistry courses, it is often a challenge to retain student motivation and interest throughout the semester. Herein, we will present a hands-on workshop to introduce techniques that instructors can use to enhance student engagement. We will describe how a variety of resources (e.g., videos, simulations, laboratory actvities, demonstrations) can be used to initiate in-class discussions and assist students with retaining knowledge outside of the classroom.	College, High School, Middle School, General Audience
Cracking the code of atomic scale thinking through nanoscience	Cara Hale Hanes	1. Basic Sciences, Southern California University of Health Sciences, Long Beach, CA, United States. 2. Ernest McBride High School, Long Beach, CA, United States.	In this workshop I will share my pedagogy using nanoscience as a tool to help students make the paradigm shift to the atomic scale. Students operate at the macroscopic scale and are more successful in chemical learning when they shift their thinking to the atomic scale. Over the past 5 years I have used nanoscience in high school and college classroom settings to help my students understand chemistry at the nanoscale. We will look at how to enhance understanding of intermolecular attractions, as well as size and scale of the atom. Self- assembly with intermolecular forces is the activity, using a lab that models self assembly. This activity is nested within other smaller scale experiences and has embedded within project based learning for high school level.	College, High School, General Audience
Crafting learning objectives: How to create meaningful and usable learning objectives at the program, course, and assignment level	Kelly Y. Neiles	1. Chemistry and Biochemistry, St. Mary's College of Maryland, St Marys City, MD, United States.	One major goal of instructors is to determine whether our students are learning what we intend them to learn. To do that, however, we must first be able to articulate both to ourselves and to our students what we want them to learn. Faculty often struggle with determining the optimal number, type, and measurability of learning objectives and can easily become overwhelmed by the process. This workshop will lead faculty through the writing of quality learning objectives at multiple levels utilizing a backward design model. In addition, alignment of learning objectives across levels to create a coherent, scaffolded curriculum will be discussed. The workshop is suggested for both individual faculty interested in developing these skills and those who will lead others through this process (such as department chairs).	College, High School, General Audience

Crafting meaningful tasks based on contemporary literature	Chorng Shin Wee	1. Chemistry, Hwa Chong Institution, Singapore, Singapore. 2. Chemistry, Hwa Chong Institution, Singapore, Singapore.	The use of chemical literature for teaching and learning was heavily encouraged in tertiary education (for example JCE, 1993, H. Beall; JCE, 2009, K. Forest & S. Rayne ; JCE, 2015, I. J. Ferrer-Vinent, M. Brruehl, D. Pan & G. L. Jones) but it was less emphasised for pre-university education, largely due the complexity of the content covered. *Chemical Reviews* published by the Royal Society of Chemistry and *Scientific American* by Springer Nature offer more accessible and general readings for students, but many students will probably not read them on their own accord. These articles offer a great opportunity for educators to craft them into meaningful activities used for performance-based assessment. Students working on these activities will get to experience authentic learning, making learning chemistry more interesting and 'real'. Working together in groups also promotes collaborative learning. Moreover, the data and information provided in these articles (or literature in general) could also be used to craft into suitable assessment questions in order to test high order thinking. Such questions are often seen in GCE 'O' and 'A' level papers. Literature thus served as important resources for both authentic learning and for assessment. It is thus crucial to distil information in a versatile manner so that they can be used to the educators' advantage. In this workshop, we will first share how this literature could be can be used to create activities. In particular, we will demonstrate how information from one piece of literature could be crafted into four different types of performance-based assessments – constructed-response, stand-alone, unit-embedded and project-based (2019, Wren, D & Gareis, C. R.). In the remaining time, the participants will have hands-on experience in crafting similar tasks using different scientific literature provided. This workshop is relevant for chemistry instructors who teach at the secondary level and the college level.	College, High School, Middle School, General Audience

CRISPR science: Reshaping the molecular biosciences	Tim Herman	1. BioMolecular Modeling, MSOE, Wauwatosa, WI, United States.	The recent discovery of a CRISPR-based adaptive immunity system in bacteria has revealed the existence of RNA-guided endonucleases capable of targeting a unique nucleotide sequence in a eukaryotic genome. CRISPR researchers are now engineering these endonucleases – such as Cas9 – to be even more useful in applications ranging from plant and animal genome editing, cancer therapeutics and infectious disease diagnostics. This workshop will feature a range of physical models of CRISPR proteins and other schematic models of this adaptive immunity system – created in support of an NIH-funded SEPA (Science Education Partnership Award) project entitled "The Science and Ethics of Genome Editing". Examples of instructional materials used in this workshop include: An interactive timeline providing a historical context for CRISPR-based genome editing , The CRISPR-based Adaptive Immunity Kit, 3D-printed models of CRISPR Cas9, Schematic, foam-based models of the Cas9 protein. These instructional materials will be available for workshop participants to borrow from the MSOE Model Lending Library. Participants will also be introduced to an ongoing series of summer courses devoted to CRISPR Science (http://cbm.msoe.edu/teacherWorkshops/ge.php) and digital resources supporting student-based protein modeling projects related to CRISPR systems (http://cbm.msoe.edu/scienceOlympiad/participant2.php).	College, High School
Designing a user-friendly departmental assessment plan	Kelly Y. Neiles	1. Chemistry and Biochemistry, St. Mary's College of Maryland, St Marys City, MD, United States.	Is assessment considered a four letter word on your campus or in your department? Do you feel like your assessment plan is only checking boxes for some externally mandated system? This workshop will walk participants through the development of an assessment system that is meaningful, useful, and ultimately an integral piece of your teaching practice (but also checks the necessary boxes). Topics will include: identification of program learning outcomes that actually mean something to the department; identifying assignments and measures; mapping learning objectives onto courses and assignments; creating a feasible assessment cycle; and finally, managing and utilizing data to inform teaching practice and curricular reform. This workshop will provide an overview of these topics with actionable steps provided for each. Participants are also encouraged to attend the “Crafting Learning Objectives” workshop where the topic of creating high quality learning objectives will be discussed in greater depth.	College, General Audience

Designing effective assessment strategies for Course-based Undergraduate Research Experience (CURE) courses	Arthur Sikora	1. Chemistry and Physics, Nova Southeastern University, Fort Lauderdale , FL, United States. 2. Chemistry Physics, Grand View University, Des Moines, IA, United States.	This workshop will focus on assessment design for Course-based Undergraduate Research Experience (CURE) classes. Research based courses are notoriously difficult to assess effectively and this difficulty can serve as a hurdle away from adoption. Assessments designed based on the Biochemistry Authentic Scientific Inquiry Lab (BASIL) framework will be shared and discussed. Participants will design learning objectives and outcomes for an assessment and subsequently work to develop assessments that align with those objectives. We will also highlight the power of CUREs, providing a complete framework and implementation strategies for the introduction of this type of instruction into the curriculum. The modules for the entire BASIL based biochemistry lab course are available to any interested instructor. This workshop is aimed at increasing awareness of this student-centered, career focused style of instruction.	College, High School
Designing green chemistry experiments for high school and middle school	Kenneth Hoffman	1. Beyond Benign, Somerville, MA, United States. 2. University of Toronto, Toronto, ON, Canada. 3. Strathcona-Tweedsmuir School, Okotoks, AB, Canada.	A day will come when we no longer have to preface "chemistry" with "green". This hands-on workshop hastens that day by providing teachers with classroom resources to mitigate the environmental impact of student chemistry experiments and develop a more sustainable course of study. The history of green chemistry principles and their application to high school instructional design will be covered. Teachers will be introduced to Beyond Benign as a means for support.	High School, Middle School
Designing modeling-based activities for chemistry and biochemistry courses that optimize cognitive load	Cassidy Terrell	1. Center for Learning Innovation, University of Minnesota, Rochester, Rochester, MN, United States. 2. Chemistry and Biochemistry, Kennesaw State University, Kennesaw, GA, United States.	This workshop will provide chemistry and biochemistry educators an opportunity to learn about using biometric methods to measure cognitive load and how to use these data to better design modeling activities. We will begin by presenting our findings from the NSF-funded project titled “Modeling for the Enhancement of Learning Chemistry (ModEL-C) where we use electroencephalographic (EEG), eye-tracking tools, observational and activity performance analysis to refine 3D physical and virtual modeling activities that optimize cognitive load for the learner. We will also provide time and guidance for attendees to design or refine modeling activities for their chemistry and biochemistry courses. This project is supported by the National Science Foundation under award number IUSE 1711402/1711425 to the University of Minnesota, Rochester, and Kennesaw State University.	College

Developing a green chemistry theme for the Anchoring Concept Content Maps (ACCM) for organic chemistry	Jennifer MacKellar	1. American Chemical Society, Washington, DC, United States. 2. Chemistry and Biochemistry, University of Wisconsin-Milwaukee, Milwaukee, WI, United States.	Over the past several years the ACS Exams has been constructing Anchoring Concept Content Maps (ACCM) for the foundational chemistry courses. These maps provide a content framework for the entire undergraduate chemistry curriculum using a four-tiered structure. The first two tiers are broad and subdiscipline independent. The third and fourth tiers get progressively more detailed and are subdiscipline specific. More recently ACS Exams has partnered with the ACS Green Chemistry Institute to develop a green chemistry theme for the published organic chemistry ACCM. Through several workshops, green chemistry content has been added to the third and fourth tiers of the organic content map. This workshop will focus on further green chemistry additions to the third and fourth tier of the organic content map and culminate with an alignment process to the green chemistry core competencies.	College
Developing a safety program in the undergraduate curriculum	David Carl Finster	1. Chemistry, Wittenberg University (retired), Springfield, OH, United States.	This workshop will explore 1) the desirable context of undergraduate safety instruction, 2) methods and resources for program implementation, and 3) various rationales to convince faculty to develop good safety instruction. Thus, participants will consider what to teach, how to teach it, and why to teach it. The goal is not to create a “one size fits all” instructional program, but to develop institution- and department-based programs from the array of options. Since the development of good safety programs is often evolutionary in nature, long-term goals will be considered with the creation of phasing in programs over time.	College

Developing assessments that characterize how students use their knowledge	Lynmarie A. Posey	1. Chemistry, Michigan State University, East Lansing, MI, United States. 2. Chemistry, Western Washington University, Bellingham, WA, United States. 3. Science, Math, and Technology Education (SMATE) Program, Western Washington University, Bellingham, WA, United States. 4. CREATE for STEM Institute, Michigan State University, East Lansing, MI, United States. 5. Chemistry and Biochemistry, Florida International University, Miami, FL, United States. 6. Hub for Innovation in Learning and Technology, Michigan State University, East Lansing, MI, United States.	The 2012 National Research Council report, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas,* introduced the idea of three-dimensional learning as a guide to help students develop a robust understanding of science. Three-dimensional learning helps instructors to define what they want students to learn (core ideas), what they want students to do with their knowledge (scientific practices), and how they want students to focus their knowledge through multiple lenses (crosscutting concepts). However, effectively supporting 3D learning requires assessments that incorporate all three dimensions. For this workshop, participants will engage in groups to redesign and develop both open-ended and multiple-choice assessment items using the criteria we have developed as part of the Three-Dimensional Learning Assessment Protocol (3D-LAP). Within this workshop facilitators will assist participants by answering questions about the protocol and providing guidance for item development with respect to scientific practices. Participants will leave with a copy of the 3D-LAP and a working knowledge of how to apply it to modify existing assessment items and build new ones.	College, High School
Developing cross-disciplinary assessments that measure three-dimensional learning	Zahilyn Roche Allred	1. Michigan State University, East Lansing, MI, United States. 2. Chemistry & Biochemistry, Florida International University, Miami, FL, United States.	Research has shown that students often compartmentalize their knowledge from one topic to another within the same course course, much less connect their knowledge across disciplines. This siloing of ideas can be further reinforced by assessments often encouraging rote memorization and assessing factual recall and algorithmic skills. During this workshop participants will engage in the development of assessments that incorporate core chemistry ideas with biology-based phenomenon using the three dimensions outlined in the *Framework for K-12 Science Education* . These three dimensions will guide the process on the design of the assessments by helping participants to identify what students need to learn (core ideas), what they want students to do with their knowledge (scientific practices), and how they want students to integrate their knowledge with other fields (crosscutting concepts). Using these three dimensions as well as connections between chemistry and biology, participants will first identify connections between the disciplines, followed by the development of assessment items. Participants will leave with a copy of the 3D-LAP and a working knowledge of how to apply it to modify existing assessment items and build new ones.	College

Developing questions to facilitate and assess student process skills	Suzanne M Ruder	1. Chemistry, Virginia Commonwealth University, Henrico, VA, United States. 2. Virginia Commonwealth Univ, Richmond, VA, United States. 3. Department of Chemistry, University of Iowa, Iowa City, IA, United States. 4. Chemistry, Drew University, Madison, NJ, United States.	Instructors focus on the development of student's content mastery in chemistry courses, often providing feedback and evaluation of student's work. However, there is rarely a parallel process for the development of student process skills. Process skills (also known as transferable, professional, or soft skills) such as communication, teamwork, critical thinking, and problem solving are frequently cited as key components of undergraduate degree programs; indeed, they are included in the ACS Guidelines. Assessing these skills is necessary to measure how students are developing these skills, but recent research on process-rich exam questions has shown that it is not enough to write questions that cause students to USE particular process skills. Questions and tasks must also compel students to reveal their use of these process skills in their written work or group interactions. If students are using process skills, but instructors are unable to see evidence of these skills, then the instructors will not have a full picture of students' abilities. When these skills are called for and revealed, students can be provided with feedback that supports their continued development, and an instructor can assess the efficacy of pedagogical strategies. In this workshop, participants will: Develop strategies for writing questions and constructing tasks that facilitate the development of process skills such as teamwork, information processing and critical thinking in their classrooms. Evaluate questions and tasks for their ability to elicit evidence of particular process skills and facilitate their development. Use rubric-based strategies to assess student development of these process skills and provide students with feedback on ways that they can improve.	College, High School

Developing Systems Thinking learning objectives for the general chemistry courses	Jennifer MacKellar	1. American Chemical Society, Washington, DC, United States. 2. Chemistry Department, Mail Stop 4003, University of Nevada, Las Vegas, Las Vegas, NV, United States. 3. Chemistry , SUNY Albany , Glenville, NY, United States. 4. University of Nevada, Las Vegas, Las Vegas, NV, United States.	Recent high profile global initiatives highlight the crucial role of chemistry in finding solutions to multiple emerging global challenges. The IUPAC working group on Systems Thinking in Chemistry Education (STICE) has been working to take the first steps to guide efforts, at an international level, by chemistry educators to equip their students to more visibly and meaningfully address multiple emerging global challenges through the application of chemistry at its many interfaces. To do so requires a new emphasis on student learning objectives that incorporate systems thinking. Students need guidance in seeing the relevance of their education in and through chemistry for addressing challenges such as sustainability, alternative energy, planetary boundaries, and the UN Sustainable Development Goals. Yet many chemistry students still experience education in chemistry as somewhat isolated from other systems, such as the biosphere, human and animal health, and economic and social systems. Progress toward solutions by the profession of chemistry will require a more visible and consistent integration of systems thinking into chemistry education at various levels. The primary focus of this half-day workshop will be to articulate learning objectives and strategies to infuse systems thinking into the teaching of general chemistry. The workshop will also explore strategies to guide the use of these learning objectives in the design of curriculum, selection of engaging pedagogies, and approaches to designing meaningful assessments.	College
Discover outreach tips and tricks through the ACS Outreach Training Program	David Horwitz	1. American Chemical Society, Washington, DC, United States.	The ACS Outreach Training Program (OTP) is designed to help educators passionate about outreach further develop their planning, communicating, and analyzing skills and maximize ACS resources. The OTP includes seven units which cover an introduction and history of ACS outreach programs, event planning and fundraising, safety in outreach settings, communicating through hands-on activities, marketing and partnerships, leading volunteers, and monitoring and sustaining success. The OTP builds upon the success of ACS's two public awareness campaigns, National Chemistry Week (NCW) and Chemists Celebrate Earth Week (CCEW). These campaigns reach over 175,000 people annually through grassroots events and contests, and receive over 25 million digital impressions through social media and online publications.	College, High School, Middle School, General Audience
Dynamics of chemical reactions: Kinetics, equilibria, pH, and ocean acidification	Caroline Hsia Tsuyuki	1. Curriculum and Professional Development, PASCO Scientific, Roseville, CA, United States.	Can you change how fast reactions occur? What does it mean for a reaction to be in equilibrium? Can acid-base reactions help us understand the chemistry of ocean acidification? In this hands-on workshop, you will use wireless temperature, pressure, pH and drop counter sensors to determine what factors alter the rate and direction of chemical reactions. Extend your understanding of the effect of ocean acidification on aquatic environments by performing a titration activity with antacids.	High School

Electrochemistry: Bring redox reactions out of the textbook and into your laboratory	Elaine Nam	1. Vernier Software and Technology, Portland, OR, United States.	Electrify your students with activities and instruments that teach electrochemistry in terms of concentration and potential change. Half reactions take on new meaning for your students when they can visualize the changes occurring in solution. Students will be able to see and measure the effects of oxidation and reduction in real time. In one activity, use a redox titration to determine the concentration of a commercial product. This hands-on workshop would be applicable from general chemistry up to inorganic and analytical chemistry labs. Bring your own device (BYOD) such as your Chromebook, computer, tablet, or phone with free software installed, or use one of ours. Graphical Analysis 4 download information is available at www.vernier.com/downloads.	College, High School
Empowering students to design solutions to global problems through chemistry	Elizabeth Schmitz	1. Learning and Teaching, Office of Superintendent of Public Instruction, Olympia, WA, United States. 2. Department of Ecology, Washington State, Lacey, WA, United States. 3. Pullman High School, Pullman, WA, United States. 4. High School Chemistry, Colville School District, Colville, WA, United States.	What could a couch, a water bottle and Mardi Gras beads have in common? We will use Ambitious Science Teaching (AST) methods to explore the phenomenon of The Great Pacific Garbage Patch from the products (plastics) we use everyday. Through demonstrations, hands-on activities, and discussion, participants will explore ways to help students design innovative products using green chemistry and engineering. We will introduce green chemistry principles and explore the related topics of green engineering, product life cycle, and circular economy. How can students help solve problems like climate change and plastics in our oceans by redesigning the products we use? At the end of the session, participants will practice aligning activities to physical science disciplinary core ideas, science and engineering practices, and crosscutting concepts of the *Next Generation Science Standards* (NGSS). Participants will also gain access to resources for achieving NGSS objectives in chemistry while reducing or eliminating classroom hazardous waste and improving student safety in laboratory activities.	High School, Middle School

Engaging organic chemistry students in an active learning process that promotes development of critical thinking, analysis, and application skills	Barbara Van Kuiken	1. 145 Main, Southern Virginia University, Buena Vista, VA, United States.	A major goal when educating organic chemistry students is to help those students gain a knowledge base of fundamental concepts as well as to build their analytical and application skills. However, it is well known that many organic chemistry students try to memorize a limited set of reactions and facts just long enough to spit them back on a test paper. Other students work enough problems to be able to solve a limited number of reactions by rote. Many students don't develop the ability to think through a problem. They never really understand organic chemistry. They are generally unable to apply organic chemistry outside the course. The facts memorized by each type of student are of little long-term value. In this workshop, you will gain hands-on experience using an innovative and objectively assessed method for improving student engagement and true learning. These teaching techniques help organic chemistry students deeply understand essential concepts and build analysis skills. By learning and using these techniques, your students will be better able to work organic reactions, retain information in long term memory, seamlessly correlate concepts, and apply information and analysis skills to newly encountered situations. In addition, your students will become much more proficient at working with complex ideas, engaging as life-long learners, interpreting new discoveries, tackling new questions in research, and applying organic chemistry to other disciplines. Participants will receive a sample workbook that illustrates this teaching method.	College
Engaging students with content-rich chemistry games	Edward Wang	1. PlayMada Games, New York, NY, United States.	Looking to increase student engagement in your classroom without sacrificing content? Unsure of how to integrate games into your lessons? Come explore Collisions™, a system of interconnected digital chemistry games designed specifically for the classroom, and experience gameplay that is both fun and exploratory for students. Strategies to use games to introduce, teach and review key chemistry concepts will be shared. Participants will also be provided with student materials designed to explicitly connect gameplay with content learning objectives. Bring a laptop or tablet or use one of our devices to participate in several classroom-ready game activities.	College, High School, Middle School
Expanding the repertoire of chemical simulation models	Steve G Sogo	1. Science, Laguna Beach High School, Laguna Hills, CA, United States.	Two newly-developed web-based simulation platforms will be presented: StarLogo Nova, developed by MIT computer scientists, is an easy-to-use, visually appealing simulation engine, great for modeling population dynamics, specifically chemical equilibria and collision-based kinetics. IC2020, developed at Laguna Beach High School, is a user-friendly 2-dimensional molecular dynamics simulator, useful for exploring chemical bonding and intermolecular attractions. Both of these platforms are free to use and can be modified/engineered by faculty to suit their individual classroom needs. Participants should bring a laptop or tablet to interact effectively with the simulation software.	College, High School, Middle School, General Audience

Faculty learning program: Integrating more active learning into your classroom	Jessica A Parr	1. Chemistry, University of Southern California, Culver City, CA, United States. 2. Chemistry, UC-Berkeley, Richmond, CA, United States. 3. Chemical Engineering, University of Southern California, Los Angeles, CA, United States.	This interactive workshop introduces the Transforming STEM Teaching Faculty Learning Program (FLP) developed by University of Califonia, Berkeley and Lawrence Hall of Science faculty and staff. The FLP was developed to address the need for STEM faculty to learn how to effectively integrate active/student-centered learning strategies into their classrooms. The program models the strategies and encourages faculty to make small systematic changes in their classrooms. Attendees of this workshop will learn about the full program and be introduced to several active learning strategies. Any instructor who is interested in making their classroom more learner centered will gain a lot from this experience, even if they use some of the strategies in their own lectures, labs or discussions.	College
Flipped and active chemistry: Creating a dynamic, interactive learning environment to engage all learners	Eric Pantano	1. Science, Edgewood High School, Madison, WI, United States.	Both the College Board AP Program, as well as the Next Generation Science Standards outline a number of skills used by scientists and engineers as they perform investigations, build models, and explore our world. These science practices are plentiful and specific, and require that most precious of resources, TIME! Given that much of the time spent in a chemistry classroom is spent on lecture, how do we find the time to explore and strengthen these science practices? How do we carve precious minutes out of our instructional time to engage students in meaningful, active science learning, given the breadth of material we must cover? One answer is, teach flipped and active chemistry. In this workshop, you will learn strategies to more than double available time for active learning in the chemistry classroom. By having students receive their initial direct instruction at home, class time is available for investigations, explorations, guided inquiry, and robust discussions. Flipped and active chemistry increases student understanding, student engagement, and student success. The twenty-first century student is a different kind of learner; we must evolve in kind.	College, High School, Middle School
Flipped? blended? mastery? active? What underlies the buzzwords: How to design your course to improve student success	Jaclyn Jeanette Stewart	1. Department of Chemistry, University of British Columbia, Vancouver, BC, Canada. 2. Centre for Teaching, Learning and Technology, University of British Columbia, Vancouver, BC, Canada.	Flipped? Blended? Mastery? Active? Current teaching trends are more similar than they might first appear because they only work if they are designed with sound learning principles in mind. This workshop will uncover the psychological principles of long-term, meaningful learning and show how to use these principles in chemistry instructional design. In the first part of the workshop, participants will experience a highly-structured activity that requires them to examine research evidence and draw conclusions about effective educational practices. The debrief that follows will discuss the instructional practices that were demonstrated in the activity. In the second part of the workshop, participants will plan for refining their courses to encourage their students to think in ways that lead to lasting, deep learning. Many of the learning principles discussed can be incorporated into existing courses easily and with no cost. Participants will have time to consider new ideas for chemistry activities, assignments, and assessments and will leave with a plan to incorporate the strategies discussed. The workshop content is relevant to educators who use any instructional method.	College, High School, Middle School, General Audience

Food chemistry: True colors in soft drink beverages	Angie Harr	1. Vernier Software & Technology, Beaverton, OR, United States.	Combine chromatography with spectroscopy when teaching food chemistry. The food dyes in grape soft drink will be separated using column chromatography. The spectra of the drink, the component dyes, and FD&C standards will be analyzed using a Vernier Go Direct SpectroVis Plus Spectrophotometer. Your students will learn about intermolecular forces and absorbance spectra while use something very familiar to them; food. Each participant will receive a chromatography column and complete experiment instructions. This activity would be most appropriate for high school and college general chemistry. Bring your own device (BYOD) such as your Chromebook, computer, tablet, or phone with the free Spectral Analysis 4 app installed, or use one of ours. Download information is available at www.vernier.com/downloads	College, High School
Food in the chemistry curriculum	Sunil Malapati	1. Chemistry, Clarke University, Dubuque, IA, United States. 2. Stockton College, Stockton, NJ, United States.	Exploring chemistry through food makes science fun and approachable to a student while providing an endless array of everyday examples to teach chemical concepts. This mini-workshop will provide the participants with hands-on activities, demonstrations, discovery-based lessons, and small experiments that will focus on chemical transformations using food. Basic chemical concepts such as pH, gas laws, reaction rates, nature of heat & energy will be explored in addition to cutting-edge molecular gastronomy techniques that will excite faculty and students alike. Participants will take home classroom and laboratory activities that have been tested and can be plugged into their chemistry courses. The materials shared here are featured in an upcoming book titled "Food in the Chemistry Class".	College, High School
Forensic chemistry: Poisoned wine at the dinner party	Angie Harr	1. Vernier Software & Technology, Beaverton, OR, United States.	Guests become sick at a dinner party. Some die and others are just slightly affected. Use a Vernier Go Direct SpectroVis Plus Spectrophotometer to analyze poisoned wine and determine what is going on. Was the wine tainted? What poison was used? Why were some guests affected more adversely than others? Your students will learn about absorbance spectra, Beer's law, and molar calculations while solving a puzzle. This activity would be most appropriate for high school and college general chemistry. Bring your own device (BYOD) with free Spectral Analysis 4 app installed, or use one of ours. Download information is available at www.vernier.com/downloads	College, High School

General chemistry in three dimensions (GCin3D)	Samuel Pazicni	1. Department of Chemistry, University of Wisconsin-Madison, Madison, WI, United States.	There is compelling evidence that engaging students with core chemistry ideas in ways that practicing chemists do should lead to deeper learning. For example, doing so not only mirrors how expert chemists think about chemistry, but also permits students to apply knowledge to new situations and gain insight into the processes by which chemistry's disciplinary ideas were generated. The goal of this full day workshop is to provide faculty the tools to embed these strategies, vis-à-vis the creation of Learning Performances, into their own assessment, learning, and teaching practices. Learning Performances describe what a learner should be able to do with her knowledge, a subtle (but profound) shift from traditional course learning goals/objectives. In this workshop, we will develop Learning Performances and associated learning materials by combining three dimensions (chemistry disciplinary core ideas; science and engineering practices; and cross-cutting concepts or reasoning models), a process informed by the National Research Council's *A Framework for K-12 Science Education* and evidence centered design principles. Although all higher education instructors are welcome, the workshop will focus on content and examples from general chemistry. This workshop is produced in conjunction with the American Chemical Society's GCin3D project.	College
Get the facts out: Changing the conversation around STEM teacher recruitment	Terri M Chambers	1. American Chemical Society, Washington, DC, United States.	Nearly 50% of chemistry undergraduates express some interest in secondary STEM teaching; however, there remains a nationwide shortage of secondary STEM teachers of chemistry, physics, and mathematics. Faculty members are influential advisors who can provide students with facts that facilitate an informed exploration of careers in secondary STEM teaching. In this interactive workshop, participants will actively investigate data about careers in secondary STEM teaching (i.e. satisfaction, salaries, retirement benefits, loan forgiveness). Participants will also discuss strategies and tools for effectively and accurately talking to students about secondary STEM teaching as a career. This workshop is an activity of "Get the Facts Out", a National Science Foundation-funded project to change the conversation around STEM teacher recruitment.	College, High School

Getting the most from R (a programming language for statistical computing): Effective visualizations	Jordan Harshman	1. Chemistry and Biochemistry, Auburn University, Auburn, AL, United States. 2. Chemistry & Biochemistry , San Diego State University, San Diego, CA, United States. 3. Chemistry Department, Grand Valley State University, Allendale, MI, United States.	Many chemistry education researchers are familiar with the one-letter-program called R, but aren't sure if the benefits are worth the learning curve associated with it. This workshop will provide a showcase of the beautiful publication-worthy visualization possible with R. Participants will be guided by experienced R instructors and provided with materials they can use to continue creating plots in R with their own data. The emphasis of the workshop will be a series of vignettes focused on recreating visuals from the chemistry education literature utilizing the workshop leaders' own data and expertise. These vignettes include making beautiful, completely customized, and effective visualizations, running statistical analyses with ease, and writing custom programs that will complete monotonous data tasks quickly and efficiently. For each vignette, participants will "decode the code" by reasoning through the full code in groups. Then, scaffolds will be removed as participants will be challenged to supply a few missing lines of code followed by modifying the code to produce a certain result. This active style of instruction encourages participants to see the power of R in data exploration while simultaneously learning the concepts behind the programming language. This introduction to the R language will put participants in a position to continue learning R even after the workshop. Following the philosophy that coding in R has the potential to change the way researchers think about data, this workshop is designed to invite researchers to the expansive world of data exploration and visualization in R. Participants with all levels of experience are welcomed, including those with no previous coding experience.	General Audience
Graphical representations of equilibria systems	George Lisensky	1. Beloit Colg, Beloit, WI, United States.	When teaching chemical equilibria should we spend more time on math or chemistry? A graphical tools approach allows analysis of complex systems to find the principal species and clarify the chemical story as a function of the master species concentration. Balanced conservation equations then enable finding numerical concentrations. This hands-on computer workshop addresses the large number of graphical representations (logarithmic concentration, distribution, and titration plots for acid-base, solubility, metal-ligand, and redox equilibria) used to "simplify" equilibrium systems. It will be useful for those who need high-quality figures for problem sets and tests, or for those who wish to have students ask "What if?" questions to see how variables affect the graphs. We will use program Kplot, a free equilibrium graphing program that runs on OSX, Windows, Linux and Raspberry. Topics which can be simplified include acid rain and soil equilibria, ocean acidification, amino acids, EDTA titrations with pH and buffer complexation, and pH dependent redox titrations.	College, High School

Green chemistry commitment summit	Irv Levy and Amy Cannon	Beyond Benign, 100 Research Drive, Wilmington, MA 01887	The Green Chemistry Commitment is a consortium program of colleges and universities who are working to advance green chemistry in their chemistry courses and programs. This workshop will include faculty from signing institutions, along with faculty members interested in learning more about the program. The workshop will review the current state of the program, provide updates to signers and prospective signers, include a peer-to-peer session for sharing green chemistry best practices, and discuss strategic initiatives for the coming academic year. The workshop is open to all college faculty who are interested in green chemistry education, or interested in learning more about the Green Chemistry Commitment program.	College faculty – all levels, including Community College, PUI's and Universities
How to extract essential oils from plants in a common classroom with extensions to enable student projects	David Hackleman	1. OilExTech, LLC, Oregon, United States 2. Portland Public Schools, Oregon, United States	Essential oils from plants have been utilized by human civilizations for millennia, by plants since the beginnings of life, and still there exists intrigue, educational opportunity and room for creativity in their study. This workshop will ask the attendees to extract some essential oils from plants both common to the local area and available world-wide using a very simple and rapid technique, that of solvent free microwave extraction using a common home microwave oven. After doing the extractions, attendees will be in small teams to craft a specific learning experience based on either the essential oils or the processes utilized. Focused fields for these experiences are chemistry, other physical sciences, life sciences, mathematics, engineering and social sciences. Each team will then be offered the opportunity to share their developed concept with the workshop attendees.	College, High School
Hydrogen-powered soda bottle rockets	Steve G Sogo	1. Science, Laguna Beach High School, Laguna Hills, CA, United States.	Participants will have a BLAST creating rockets from 2-liter soda bottles by applying reaction stoichiometry, gas laws, and thermodynamics. The bottles will be safely launched using home-made electronic igniters made from aluminum foil and index cards. This is an exciting lab activity that will ignite your students' passion for science.	College, High School
Illustrating the particulate nature of matter	Alice Putti	1. Jenison High School, Jenison, MI, United States.	Are you interested in using particulate level representations in your chemistry class but not sure how to start? This workshop will focus on how to implement particulate representations throughout the school year. The instructor will be share particulate activities and example problems used in her class. Participants will learn how to convert typical end of chapter problems into particulate level questions and have an opportunity to create their own. All questions will be shared at the end of the workshop. This session will not focus on software programs that can be used to create particulate drawings.	College, High School

Implementing a next generation digital learning environment for chemistry: iPads, digital labs, and digital lectures	Jonathan C Rienstra-Kiracofe	1. Department of Chemistry, Purdue University, West Lafayette, IN, United States. 2. Chemistry and Biochemistry, North Park University, Chicago, IL, United States.	In this workshop particpants will learn how the cloud-enabled, Next Generation Digital Learning Environment for Chemistry (NGDLEC) works at Purdue University and North Park University. This includes the principles behind NGDLEC implementation and a hands-on, in-depth overview of various interconnected technologies used in the NGDLEC. Participants will gain first-hand experience with: 1) Using an instructor iPad or stylus-enabled computer and Microsfot OneNote to give interactive, digital lectures, 2) Using Microsoft OneNote as a digital lab manual; wireless lab data collection with Vernier probeware direct to student iPads or student-owned devices; electronic laboratory notebooks; and managing iPads or similar technologies in the lab, 3) Teaching with technology. Best practices for using your iPad or pen-enabled device to grade electronically and how to use Apple School Manager to transform laboratory instruction into a collaborative, interactive teaching environment, and 4) Methods and strategies for implementation at their institution.	College, High School
Improving problem-solving skills in freshman chemistry through IT.A.L.I.C.: An ITerative Approach to Learning In Chemistry	Bhavani Balasubramanian	1. Chemistry and Environmental science, New Jersey Institute of Technology, Newark, NJ, United States.	In this workshop, the participants will be introduced to the Iterative Approach to problem-solving and learn how this approach engages students in critical thinking. This approach has been shown to reduce failure rates and improve standardized ACS exam scores. The workshop will consist of three activities: 1) Identifying clear outcomes for a given topic 2) Designing an effective worksheet to test the outcomes 3) Learning to create an atmosphere that promotes active student-instructor interaction. At the end of the workshop, each educator will be prepared to implement the iterative approach in their course to improve student engagement and learning. To get the most out of this workshop, participants are requested to bring some questions and or topics for practice.	College
Improving students' mathematical reasoning with Modeling Instruction	Brenda Royce	1. STEMteachersMassBay, Sharon, MA, United States. 2. University High School, Fresno, CA, United States.	In chemistry, mathematical tools are used to create quantitative models of the behavior and structure of matter. Chemists view these relationships as information about a phenomenon. Yet, students in our classes tend to view these mathematical expressions simply as a computational means for "getting answers". One of the challenges of teaching chemistry is simultaneously developing the proportional reasoning of our students as they tackle new ideas about matter. So, how do we get students to authentically reason about the quantitative relationships in matter that we'd like them to understand? In this workshop we will look at ways we can help students develop a conceptual framework for proportional reasoning, and tie this framework to the various representations (graphical, diagrammatic, verbal, mathematical) used to express models of chemical phenomena.	College, High School, Middle School, General Audience

Improving visual literacy using PyMOL, augmented reality, and LEGO® bricks	Shane Austin	1. University of the West Indies, Bridgetown, Barbados. 2. Biology Department, University of Mary Washington, Fredericksburg, VA, United States. 3. Division of Biosciences, University of Georgia, Athens, GA, United States.	Students pursuing biochemistry and cell biology courses encounter several representations of proteins and nucleic acids in classes. Each image encodes lots of information and relies on several discipline-specific norms; including, use of color, shapes, patterns and illustrations that the students have only previously seen as drawings. This makes obtaining information from these illustrations difficult for some students. We have developed a series of active learning strategies to enhance visual literacy of our students. Replacing traditional lecture-based instruction with hands-on engaged learning has significantly improved student perception of the complex 3-dimensional architecture of proteins and Nucleic acids and their interactions. During this workshop, participants will take part in two guided activities based on themes in glycolysis and Krebs cycle and learn how to incorporate active learning strategies using protein databank (PDB), the molecular visualization tool PyMOL and Augmented reality. Participants will learn how to use PyMOL in classes to teach key concepts in macromolecule structure and function. Using LEGO® bricks as metaphors, instructors will build models to explain this, and also learn how to guide students to generate suitable models that represent the various facets of proteins' functions and processes. At the end of the workshop, attendees will be able to implement any or all of these interventions in their classroom. Finally, the presenters will also share classroom assessment tools that they have used to assess the effectiveness of this novel instructional method.	College

Increasing student engagement in first-year courses using the Chem101 active learning platform	Justin Blake Weinberg	1. Co-founder & CEO, 101 Edu, Inc., New York, NY, United States.	Chem101 is a next-generation student engagement platform built specifically for first-year courses such as General Chemistry, Introductory Chemistry, and GOB Chemistry. The platform helps instructors easily incorporate active learning into their classrooms and keeps students engaged after lecture with homework and practice activities that they can access anytime on their phones and personal devices. In this workshop, you will receive a guided and hands-on experience with the Chem101 platform from both an instructor and student perspective. In the first part of the workshop, you will be provided with a personal device and work with Chem101's scaffolded modules that help students understand dimensional analysis, Lewis structures, nomenclature, chemical equations, equilibrium/ICE table problems, and more. The second part will focus on best practices for active learning in the classroom where we will guide you on how to use Chem101 to support Think-Pair-Share activities, flipped classrooms, and incorporate active learning into previously traditional lectures. In the third and final part, we will focus on engagement outside of the classroom with homework assignments and extra practice activities. Here, we will guide you through creating problem sets, incorporating OER into your assignments, and managing student performance. At the end of the workshop, you will take home your own instructor account with assignment templates to explore in the weeks and months to follow. High school instructors who teach AP Chemistry or Honors Chemistry are also welcomed to participate in the workshop.	College, High School
Interactive experience with microwave technology in teaching and research Labs	Gabrielle Dusharm	1. CEM Corporation, Charlotte, NC, United States.	Microwave technology has become a common tool for chemical synthesis with many academic institutions incorporations microwave-assisted experiments into their teaching and research labs. Early introduction to innovative instrumentation, such as microwave reactors, teaches students to embrace ideas on the cutting edge of chemistry, better preparing them for technologies they will encounter in their careers. This workshop will include a review of microwave theory, provide a pedagogical comparison of both single and multi-mode technologies available for the teaching lab, and highlight several examples of experiments that have been adapted for microwave technology with an emphasis on green chemistry principles. Participants will receive hands-on training to understand how microwave-assisted chemistry can fit into any teaching lab.	College

Introducing GOB students to the molecular world with physical models of proteins and other macromolecules	Tim Herman	1. BioMolecular Modeling, MSOE, Wauwatosa, WI, United States.	The MSOE Center for BioMolecular Modeling (CBM) is an instructional materials design laboratory focused on the invisible molecular biosciences. The CBM uses 3D printing technology to create physical models of proteins and other molecular structures. In addition to 3D printed models, we have worked with educators over the past 15 years to create a wide range of student-centered manipulative teaching tools designed to engage students in thinking about this invisible molecular world. In this workshop, we will (i) introduce educators to a wide range of instructional materials that will make the molecular world real for your GOB students, and (ii) introduce educators to teaching with models as we tell two different molecular stories of current research. Instructional materials presented in this workshop will include: The Water Kit … modeling four basic principles of chemistry. The Protein Folding Kit … applying basic principles of chemistry to protein folding The Dynamic DNA Discovery Kit … from complementary base pairs to epigenetic markers. Flow of Genetic Information Kit … three examples of templated enzymology. The two molecular stories that will be presenting in this workshop will focus on: Fragile X Syndrome . . . using CRISPR to modify DNA methylation patterns, and The Beery Family Story…. connecting whole genome sequencing to neurotransmitter biosynthesis. All materials used in this workshop can be borrowed from the MSOE Model Lending Library (http://cbm.msoe.edu/lendingLibrary/index.php) ….at no charge other than the cost of return postage.	College, High School
Introduction to green chemistry for high school parts one and two	Janie Butler	Beyond Benign, 100 Research Drive, Wilmington, MA 01887	Green chemistry captivates and engages students by focusing on the solutions to environmental challenges. Highlighting industrial examples of sustainable design is one way to engage students and provide an opportunity to demonstrate how chemistry connects to our world and why the knowledge is important for scientists, consumers and citizens alike. Additionally, in this session you will learn about replacement labs that use inexpensive materials that are safer to handle, store, and dispose and that teach students about the principles of green chemistry. Types of reactions, rates of reactions, LeChatelier's principle, and flame tests can all be demonstrated using safer chemicals or household products. Participants will have hands-on time with these labs and will have the opportunity to collaborate and learn how to "green" lab experiments in their classroom from experienced green chemistry educators.	High School Science Educators

Introduction to IONiC/VIPEr: Using and sharing inorganic chemistry education resources	Anne K Bentley	1. Dept of Chem, Lewis Clark College, Portland, OR, United States. 2. Chemistry, University of Wisconsin-Whitewater, Whitewater, WI, United States. 3. Department of Chemistry, Southeast Missouri State University, Cape Girardeau, MO, United States. 4. Department of Chemistry, Lewis University, Romeoville, IL, United States. 5. Chemistry Biochem, Ohio Northern University, Ada, OH, United States.	Inorganic chemistry finds its way into the curriculum at a variety of levels from general chemistry to upper division undergraduate courses. VIPEr (the Virtual Inorganic Pedagogical Electronic Resource) is a website (www.ionicviper.org) that provides a platform to share content and materials for teaching inorganic chemistry while building a community of inorganic faculty known as IONiC (Interactive Online Network of Inorganic Chemists). Workshop participants will be introduced to the IONiC community and will 1) learn how to find and adapt "learning objects" (in-class activity, literature discussion, laboratory, etc) on VIPEr for teaching general chemistry and inorganic chemistry, 2) learn how to use the social networking features of VIPEr to give and receive support in teaching and research, and 3) learn how to design and upload a learning object to the site. Participants will be encouraged to bring a learning object and publish it on VIPEr by the end of the workshop. Both experienced and new users of the site are welcome.	College
Introduction to open educational resources (OER) for chemistry: How to find, adapt, and publish an OER	Rayne Michele Vieger	1. University of Oregon Libraries, University of Oregon , Eugene, OR, United States.	In this interactive workshop, participants will learn about the basics of OER: the value of using them, how to find them, licensing considerations, and how to make OER accessible to all learners. Participants are strongly encouraged to bring their own devices to practice editing an existing OER to add their own unique content to it.	College, High School, Middle School, General Audience
It's all fun and games in high school chemistry	Elaine Kollar	1. Science Department, New Trier High School, Winnetka, IL, United States.	Most concepts in high school chemistry focus on the invisible world of the atom, making the learning of chemistry quite a challenge. The vocabulary of chemistry is a language of its own, and forming connections between these abstract ideas can be difficult. If incorporated into the curriculum correctly, games can provide high schoolers with an experience that allows them to gain a better understanding of such concepts. Further, device-free games allow students to engage with both the content and their classmates. Our comprehensive review games for each unit are designed to provide an opportunity for students to collaborate, problem solve and think critically while working together as a team in a growth-mindset environment. Our experience supports the research that low-achieving students and students receiving special education services find classroom games most beneficial. This workshop will provide teachers an opportunity to play games covering the following topics: electron configuration, bonding (ionic, covalent, intermolecular), nomenclature, balancing equations, molar mass, stoichiometry, heating & cooling curves, solutions and equilibrium. Teachers will take home the games that are played and resources for making class sets of each.	High School

Life cycle projects and the science classroom	Julian R. Silverman	1. Chemistry and Biochemistry, Manhattan College, New York, NY, United States. 2. College of the Atlantic, Bar Harbor, ME, United States.	Life Cycle thinking is a method analagous to the scientific method and can be used to assess the sustainability and viability of in class experimental methods and global processes alike. Connecting science to economic, environmental, and social considerations, Life Cycle Assessments (LCAs) use flexible metrics to quantitatively address topics including toxicity, captical costs, and human impacts. These methods lend themselves to broadening the impacts of science instruction, building on basic chemistry principles to tackle real world problems. While most evaluation methods using life cycle thinking may leverage propriataty softwares and length analyses, these methods may be easily adapted for high school and college classrooms using open-access softwares (such as excel) and freely available information (from the internet and chemical literature). This workshop will be broken into two parts: first is a Life Cycle 101 session where the basics of the assessment are explored and case studies given for example grade 9 - 16 courses and undergraduate research. The second part will focus on helping educators connect course learning objectives to life cycle projects and explore online resources for their use with students or for personal research.	College, High School, General Audience
Making the most of mentoring relationships: A guide to mentoring undergraduate researchers	Cheri A Barta	1. Chemistry, UW-Madison, Madison, WI, United States.	Researchers often are not trained for the crucial role they play in mentoring the next generation of scientists. Based on the training program adopted by the National Research Mentoring Network, this workshop will detail how to become an effective mentor to undergraduate researchers. Through case studies, activities and group discussions, participants will leave this workshop with strategies for building effective mentoring relationships. The workshop will be offered in two sessions; participants may sign-up for both sessions or choose to attend just one. Articulating expectations for mentoring relationships, effectively communicating with trainees, and promoting professional development will be discussed during the first session. The second session will focus on strategies to build inclusive mentoring relationships, assess trainee understanding, and foster independence.	College

Mapping the undergraduate curriculum and item alignment in the ACS Biochemistry Examination	Olga Michels	1. Chemistry, Luther College, Decorah, IA, United States. 2. Chemistry and Biochemistry, University of Wisconsin-Milwaukee, Milwaukee, WI, United States. 3. Chemistry, University of South Florida, Tampa, FL, United States. 4. #27, Bemidji State University, Bemidji, MN, United States. 5. Chemistry Department, Grand Valley State University, Allendale, MI, United States.	At ACS Exams, we have been working on constructing Anchoring Concept Content Maps (ACCM). These maps provide a content framework for the entire undergraduate chemistry curriculum using a four-tiered structure. The first two tiers are broad and subdiscipline independent. The third and fourth tiers get progressively more detailed and are subdiscipline specific. We have published four ACCM (general, organic, physical and inorganic) only through the contributions from faculty and instructors through many focus groups and workshops. The map for analytical chemistry has also been completed and is in the process of being published. The final map for biochemistry is nearing completion. For this workshop, we are working on the final revision of the level three and four details for the content map in biochemistry. In addition to this, we will conduct an item alignment of ACS Exams Biochemistry items to the content map. Reflecting on the feedback from the other subdiscipline maps often provides participants with a unique insight about the courses taught and how the concepts taught in these courses contribute to the overall undergraduate chemistry curriculum. In addition, the alignment process can be applied to other classroom and programmatic assessment endeavors.	College, High School, General Audience
Matter, heat, and energy in the Earth system: Understanding convection currents and plate tectonics through chemistry	Caroline Hsia Tsuyuki	1. Curriculum and Professional Development, PASCO Scientific, Roseville, CA, United States.	In studying the nature of matter, students focus on its properties, the physical and chemical changes it undergoes and the thermodynamic principles that govern those changes. In this workshop, participants will: 1) investigate two intrinsic properties of matter: density and specific heat, using a PASCO density set and wireless temperature and pH sensors; 2) model convection and conduction of heat in laboratory systems in an Energy Transfer Lab; 3) apply the principle that "heat moves matter" to understand the processes that operate at the scale of the Earth system with convection currents and plate tectonics.	High School
Modeling matter: An experience as a student and teacher	Karrie L Heinze	1. West Bend East High School, West Bend, WI, United States. 2. North Boone High School, Poplar Grove, IL, United States. 3. Sevastopol High School, Sevastopol, WI, United States.	Modeling instruction was developed to create a student-centered experience which engages them in constructing and using scientific models. Instruction is organized into modeling cycles which move students through all phases of model development. This workshop will provide an experience with the modeling cycle for the Unit 1 material from the Chemistry Modeling Curriculum from AMT on Matter. Participants will begin as “students” by participating in a paradigm demonstraiton laboratory and successive whiteboard meetings as well as deployment labs. The focus will be on how to build the beginning mental models of matter (particulate representations) which progresses to deployment of a laboratory on density. The second part of the workshop has the participants transitioning from student to teacher with strategies on how to unpack the modeling cycle when teaching it.	College, High School, Middle School

National Science Foundation programs that support undergraduate chemistry education	Dawn Rickey	1. Division of Undergraduate Education, National Science Foundation, Alexandria, VA, United States.	In this workshop, National Science Foundation (NSF) program directors from the Division of Undergraduate Education (DUE) will provide an overview of programs designed to enhance undergraduate STEM education, with a focus on chemistry education. DUE's programs provide opportunities to secure funding for research, the application of evidence-based strategies, and scholarships to improve chemistry learning and engagement for undergraduate students. These programs also prioritize generating new knowledge about what works for chemistry learning and learning environments, broadening participation, and workforce development. The two NSF merit review criteria--intellectual merit and broader impacts--will be discussed as well other aspects of meritorious proposals. The workshop will also include multiple breakout sessions, with opportunities for participants to select topics of interest. During these sessions, program directors will facilitate deeper discussions of topics such as NSF DUE programs that provide for student scholarships; programs that support chemistry education research and action research to adapt proven strategies in new environments; project evaluation; resources and tips for those new to writing proposals for NSF DUE programs; and guidance for revising declined proposals for resubmission. The $10 fee for this workshop is an OSU/BCCE fee. No portion of this fee will be directed toward the NSF or NSF personnel. The cost of all handouts and other workshop materials are paid for by NSF.	College, General Audience
No hassle messy science with a wow: Chemical reactions and inquiry for K-8 classrooms	Alexe Mastanduno	1. Chemistry, Oregon Museum of Science and Industry, Portland, OR, United States.	Let's get messy! In this program developed by the Oregon Museum of Science and Industry, participants will get hands-on with a variety of teacher-tested chemistry activities appropriate for K-8 classrooms. We'll explore a variety of chemical reactions using color-changing vegetable juice, dissolving packaging products, and disappearing drinks, all using everyday materials. Participants will feel confident when they walk away with a handful of activities and access to dozens more, each of which has detailed explanations and strategies for explaining the content to students of all ages; demonstrations to engage students in the science topic, to extend learning to new areas, or to reinforce understanding; extensions useful for furthering whole-class inquiry or as independent projects for individual students; cross-curricular integrations with other areas such as social studies, language arts, or mathematics; and student procedure sheets in English and Spanish.	Middle School, General Audience

No hassle messy science with a wow: Nature of matter for K-8 classrooms	Alexe Mastanduno	1. Chemistry, Oregon Museum of Science and Industry, Portland, OR, United States.	Let's get messy! In this program developed by the Oregon Museum of Science and Industry, participants will get hands-on with a variety of teacher tested chemistry appropriate for K-8 classrooms. We'll explore the size and properties of atoms and molecules through scented balloons, surprising temperature changes in a bag, and stacking liquids, all using everyday materials. Participants will feel confident when they walk away with a handful of activities and access to dozens more, each with detailed explanations and strategies for explaining the content to students of all ages; demonstrations to engage students in the science topic, to extend learning or to reinforce understanding; extensions useful for furthering whole-class inquiry or as independent projects for individual students; cross curricular integrations with subjects such as social studies, language arts, or mathematics. Student procedure sheets in English and Spanish.	Middle School, General Audience
Nuclear science for chemistry educators	George E Miller	1. Chemistry, University of California Irvine, Irvine, CA, United States.	Nuclear properties underpin atomic behavior in chemistry. In addition many applications in physical, biological and medical sciences require an understanding of nuclear relationships. Important comparisons of future power sources in a world subject to climate change also demand a fuller understanding of nuclear energies and transformations. This workshop presents simple introductory experiments and materials that can be adapted for use from middle school through college courses. Participants will explore properties of radiation using materials derived from nature, thereby gaining understanding of radioactive decay, nuclear fission, nuclear fusion, nuclear power reactors, and natural and anthropomorphic radiation in the environment. Participants will also explore on-line resources including those made available by the American Nuclear Society in its Navigating Nuclear Science program.	College, High School, Middle School, General Audience
Nuts and bolts of chemical education research (CER): How to get started in CER	Diane M Bunce	1. Chemistry, The Catholic University of America, Annapolis, MD, United States. 2. Chemistry, US Naval Academy, Annapolis, MD, United States. 3. Chemistry & Biochemistry , San Diego State University, San Diego, CA, United States.	Are you interested in learning how to turn your research idea of effective teaching and learning into a research project? Then this workshop is a great place to get started. Working in teams and individually, experienced chemical education researchers will help you turn your question into a researchable hypothesis and get you started determining a meaningful theoretical framework in cognitive psychology, learning theory or visualization. Discussion will then turn to what methodology will help you investigate your question including both qualitative and quantitative approaches. Although we can't accomplish everything in one workshop, we can help you get your thinking started, engage in beginning conversations on how to create a meaningful investigation and provide you with a list of resources to help you proceed. Participation is limited so that we can better address your needs. All you need to participate is a question that you would like to investigate. Beginners and advanced beginners welcome!	College

Online chemistry courses: Bringing the laboratory to online courses with at-home laboratory kits	Elizabeth Pearsall	1. York Technical College, Rock Hill, SC, United States.	At the college level, hybrid and online courses continue to increase in popularity with an ever-changing student population. Creating an engaging online classroom is paramount to student success in an online learning environment. While many institutions utilize simulations for the laboratory component of distance education courses, these do not allow students to fully experience a hands-on laboratory environment. The ability to offer a chemistry laboratory course online is challenging, as students must provide evidence of proficiency of laboratory skills. The use of home laboratory kits for exploratory chemistry and general chemistry courses provides an opportunity for offering these courses online while maintaining the integrity of a hands-on laboratory environment. Participants will have the opportunity to evaluate chemistry lab kits and conduct sample experiments from an at-home chemistry lab kit. This workshop is sponsored by eScience Labs.	College
OpenOChem: An LMS-agnostic chemistry quizzing platform	Ehren C Bucholtz	1. Basic Sciences, St. Louis College of Pharmacy, St. Louis, MO, United States. 2. Chemistry Dept, Centre College, Danville, KY, United States. 3. Chemistry, Indiana Univeristy of Pennsylvania, Indiana, PA, United States.	Key components to student success in organic chemistry are the practice of visualizing and drawing chemical structures as well as mastering the vast quantity of reactions in a two semester organic chemistry course sequence. Structure drawing is not trivial as novices often do not recognize the difference between implicit and explicit information necessary and how to apply the rules required to convert structural information in different formats. Reactions are also challenging as students often resort to memorizing reactions as specific instances because they are not presented with enough varied examples to become adept at recognizing trends. Adequate feedback is necessary to help students recognize trends, predict outcomes, and ensure that their practice time is used effectively. To meet the needs of students we developed OpenOChem, an online homework system. This system uses LTI, so that students and faculty members access it through their learning management systems (e.g., Moodle and Canvas). Please visit https://openochem.org/ooc/ for more information on how to become involved in the project. There are over 1700 user submitted questions that range from drawing partial and complete mechanisms, drawing reaction products and reactants, identifying most acidic proton in a molecule to name a few. The goal is to create a system where faculty create a moderated question bank where users share questions that have been developed and peer reviewed. In this workshop we will describe the system, provide examples of question types available, and how to incorporate it into your learning management system.	College
Photographic chemistry	Rebecca M Jones	1. Chemistry and Biochemistry, George Mason University, Fairfax, VA, United States.	Analog photography is an excellent vehicle for teaching chemical concepts and engaging students. In this workshop, participants will learn about the chemistry of black and white photography, cyanotypes and silver-salted prints. Participants will create their own photographs using readily available supplies and learn how to integrate these experiments into their laboratory courses. These topics can also be used for inquiry and research based labs and the instructor will present options that have been successful in the past.	College, High School

Proteopedia: A three-dimensional (3D) web-based encyclopedia for researching and teaching protein structure and function	Jason R. Telford	1. College of Arts and Sciences, Maryville University, Chesterfield, MO, United States. 2. Department of Biological Services, Weizmann Institute of Science, Rehovot, Israel. 3. Department of Stuctural Biology, Weizmann Institute of Science, Rehovot, Israel.	Proteopedia an open, interactive resource that facilitates understanding protein structure-function relationships. Proteopedia is widely used in scientific research, in the preparation of papers for publication and teaching from secondary level to post-graduate. Workshop participants, including researchers, teachers and students, will be able to use the more than 150,000 pages in Proteopedia, e.g. as a pedagogical tool to teach protein structure and function, information literacy and communicate science to the public. Examples of Proteopedia pages are easily found on the internet. At the end of this hands-on workshop, participants will have made a Proteopedia page, including adding 3D interactive scenes via a user-friendly GUI for Jmol/JSmol, adding text to Proteopedia pages with hyperlinks to the interactive scenes, and ending with developing guidelines and scoring rubrics for student-generated pages.	College, High School, Middle School
Real-world examples of transcription, calculation, rounding, statistical, logic, and other errors in global public health policy	Seth Frisbie	1. Chemistry and Biochemistry, Norwich University, Northfield, VT, United States.	Students are often taught how to avoid making transcription, calculation, rounding, statistical, logic, and other errors in high school and college chemistry courses. However, many instructors and textbooks do not use real-world examples that might improve learning by showing students the importance of this topic. The proposed workshop is a review of the current World Health Organization (WHO) drinking-water guidelines for copper, boron, uranium, cyanide ion, nickel, and manganese that gives real-world examples of these types of errors. Teaching with these real-world examples has increased student engagement and learning in my classroom. For example, the current WHO drinking-water guideline for Cu has a transcription error and a calculation error. In the transcription or copying error, the actual no-observed-adverse-effect level (NOAEL) is 15 mg of copper gluconate /(kg of body weight×day); however, the WHO incorrectly used 5 mg/(kg of body weight×day). That is, a “15” was published, but a “5” was transcribed. In the calculation error, mg of copper gluconate was not converted to mg of Cu. As a result of these errors, the WHO set a 2 mg of Cu/L of drinking water guideline; however, the WHO should have set a more protective 0.6 mg of Cu/L of drinking water guideline. These errors were identified by the California Environmental Protection Agency in 2008. A copy of the finished activity for this proposed workshop is available upon request from sfrisbie@norwich.edu	College, High School, General Audience
Relative strengths of bases: Revisiting the Brønsted-Lowry model	Larry Dukerich	1. American Modeling Teachers Association, Phoenix, AZ, United States.	In the standard treatment of the Bronsted-Lowry model of acid-base behavior, acids are described as “proton donors” with an acid’s strength as a measure of its tendency to transfer protons to another species. However, it is counterintuitive, at the particle level, to discuss the relative tendency of an acid to "give up" a proton, when, as students well know, "energy is required" to separate bound particles. In this workshop, acid-base equilibria are viewed in terms of the competition between bases for the acidic proton. Participants will use conductivity data to determine the equilibrium position in a series of acid-base reactions and thus rank order the strengths of the bases involved.	College, High School

Removing barriers to flipped classrooms using technology	Matthew D Casselman	1. Chemical Sciences, University of California, Riverside, Riverside, CA, United States. 2. Chemical Sciences, University of California, Riverside, CA, United States.	Flipped and blended approaches to teaching are finding increased use in the chemistry classroom. Facilitating active learning in the classroom can be challenging for a number of factors, including class size, classroom constraints, etc. In this workshop, attendees will learn about various technologies and methods that address these challenges in active learning. Methods include pre-class videos and assignments, in-class student response systems and post-class grading systems.	College, High School
Rubric development for the assessment of mechanism examination questions in the second-year organic chemistry course sequence	Michael T Wentzel	1. Chemistry, Augsburg University, Roseville, MN, United States. 2. Department of Chemistry, Central College, Pella, IA, United States. 3. Department of Chemistry and Biochemistry, Georgia Southern University, Savannah, GA, United States.	This workshop will address the question of how to effectively write and assess organic chemistry mechanism questions. There are a wide variety of approaches and no standardized way to assign credit for incorrect or partially correct answers. Participants will score example questions and discuss why and how they assigned the grade. As a group, the participants will develop a rubric that can be applied to all mechanism questions. Participants will be asked to use this rubric in scoring questions in their courses and report back on its use. A subsequent advanced workshop will also be offered at this BCCE for these and previous participants if parties are interested.	College
Science tidbits	Tameka Clemons	1. Chemistry & Biochemistry, Spelman College, Atlanta, GA, United States.	This workshop will provide instructors with a fun way of engaging students with science information. Although biochemistry context will be the focus of the workshop, the strategy can be used in all science classes. Science tidbits provide students with the work they will be engaged in before class and allow time during class for students to discuss what they were able to discover from the questions provided. A few cool features of this strategy include: 1) past scientists are honored for their work in the field as students learn how various scientists' work propelled the field forward 2) students are able to work independently on science questions that are contextual and helpful to the objectives of the course 3) students are able to engage in an intellectual conversation during class as the instructor facilitates important concepts critical for the student to understand 4) the material is presented in "tidbits" so that the information is not overwhelming.	College, High School

Skipping the Bohr Model: a modern, mathematics-free quantum mechanics approach to teaching atomic structure	Binyomin Abrams	1. Chemistry, Boston University, Brighton, MA, United States.	The Bohr atomic model is not only factually wrong (even Bohr admitted this in his first US talks), but recent studies indicate that focusing on teaching atomic theory from that perspective leads to persistent misconceptions about the nature of electrons in atoms and molecules. The traditional challenge, however, has been that the "right" answer (quantum mechanics) traditionally requires a level of math that is beyond high school and introductory college students. Not anymore! In this workshop we will guide teachers through a new approach that covers all of the material that students are expected to learn about atoms and molecules (i.e., for standardized tests and subsequent courses), and is also true to the quantum nature of electrons. The approach begins with students discovering light-matter interactions (which can also be used to teach about climate change) and then moving through electron nature, atomic structure, and finally how molecules form from electron cloud overlap. The workshop will include a series of guided inquiry exercises (that can be brought back and used in the classrooms), online simulations of atomic structure, and a discussion of how these materials can be used in teaching at the college and high-school levels. Participants will receive classroom notes, handouts, textbook supplement, and assessment questions.	College, High School
Spectrometry, colorimetry, and reaction kinetics for AP Chemistry and college chemistry	Caroline Hsia Tsuyuki	1. Curriculum and Professional Development, PASCO Scientific, Roseville, CA, United States.	Spectrometry is an analytical tool that utilizes electromagnetic radiation to study how light interacts with matter. It can be used to yield qualitative information about the nature of a compound in solution or quantitative data to indicate the amount of a compound in a solution. In this hands-on workshop with the wireless spectrometer and wireless colorimeter, you will be able to enhance student understanding of atomic structure, emission spectra, solution color analysis, applications of Beer's law and reaction kinetics.	College, High School
Statistics in chemical education research (CER)	Clarissa Sorensen-Unruh	1. School of MSE, CNM Community College, Albuquerque, NM, United States. 2. Center for Teaching and Learning, University of Missouri at St. Louis, St. Louis, MO, United States. 3. Organization, Information, and Learning Sciences, University of New Mexico, Albuquerque, NM, United States.	Statistics is essential for quantitative educational research. And yet, statistics in human subjects educational research is difficult and muddy. Statistical research with published open data sets allows for replication of studies, which in current educational research comprise 0.13% of education articles published in the field's top 100 journals. This workshop will explore current statistical methodologies employed regularly in educational research with a focus on current research literature and participant research studies in progress. We will try to bring these methods into focus, as well as our own bias, by framing and reframing the data seen in the literature and in our own research. Please join us in this emergent active learning environment as we explore statistics in chemical education research.	College, High School, General Audience
STEM education and social justice: Exploring systemic racism and sexism in the chemistry classroom	Dana K. Hsi	1. International Community School, Kirkland, WA, United States.	Science was written down by people who were (un)consciously influenced by societal norms. How can we incorporate social justice lessons into STEM classes? Bring your laptops and explore the Underrepresentation Curriculum Project (URC), a framework with which to examine ourselves and our biases in our chemistry classes.	College, High School

Stoichiometry: Tools and strategies to make it easier to teach	Caroline Hsia Tsuyuki	1. Curriculum and Professional Development, PASCO Scientific, Roseville, CA, United States.	How can you tell when a reaction is complete? How much product can be made from a reaction? This hands-on workshop will enhance your understanding of chemical quantities with specific concentration on mole ratios, stoichiometry and limiting reactants. Using wireless pressure sensors, molecular model kits and household chemicals, you will engage in exercises that support your teaching of reaction stoichiometry by connecting macroscopic observations to molecular phenomena. Find out how you can relate these lessons to the carbon cycle and how human impact may affect the delicate balance of carbon in the environment.	High School
Strategies and resources for chemistry teaching assistant (TA) professional development	Stacey Brydges	1. Chemistry and Biochemistry, University of California, San Diego, La Jolla, CA, United States.	Graduate students require adequate preparation and ongoing support to fulfill their roles as teaching assistants (TAs) who share responsibility for the delivery of high-quality undergraduate chemistry education. This workshop is intended to support chemistry faculty and others in the (re)design of discipline-specific, research-informed TA professional development that is tailored to their departmental needs and institutional context. Participants will explore – via case studies, small group discussions and other activities – interactive strategies and teaching and learning resources that they might incorporate as part of TA orientations, meetings, workshops, or courses of varying lengths. These strategies and resources aim to promote TA's adoption of evidence-based, inclusive teaching practices for chemistry lecture and laboratory, creation of a strong, supportive professional network, and cultivation of transferrable career skills. The workshop facilitators (a faculty member, postdoctoral researcher, and two senior graduate TAs) will draw on examples from their own work as a teaching team in the design and delivery of a graduate level course on teaching in the chemical sciences, as well as ongoing research on graduate TA professional development.	College
Student-centered chemical demonstrations to promote active learning	Deborah Wiegand	1. Chemistry, University of Washington, Seattle, WA, United States.	Are you thinking about incorporating demonstrations to create a more student-centered learning experience? This workshop will provide you with an overview of active-learning demonstrations and how they can enhance student learning. You will have an opportunity to design your own demonstration and learn about resources to help you create a more engaged classroom environment. Worried about limited funding or if your class is too large? We can help you find a way to make it work. All institution types and class sizes are welcome.	College, High School

Supporting molecular-level understanding under the Next Generation Science Standards (NGSS)	Ryan Stowe	1. Chemistry, University of Wisconsin - Madison, Madison, WI, United States. 2. Science, Kingsley High School, Traverse City, MI, United States. 3. Chemistry, KIPP Columbus, Columbus, OH, United States. 4. Neshaminy High School, Langehorn, PA, United States.	Chemistry, under the Next Generation Science Standards (NGSS), should focus on helping students make sense of the world at a molecular level. This presents significant challenges as atoms and molecules are far removed from experience and behave in ways that cannot be intuited from macroscopic experience alone. In this workshop, we will consider how students should be supported in developing the resources necessary to predict, explain, and model phenomena at the molecular level. Four questions will guide our discussion: 1. What do we want students to know and be able to do as they progress through a course in chemistry?, 2. How will we know students have developed a robust and useful understanding of chemistry?, 3. How should concepts be scaffolded and interconnected to promote molecular-level understanding?, 4. What role should curricular materials play in an NGSS-aligned chemistry course? Evidence from analysis of our NSF funded learning environment design project (DRL 1906293) will be used to guide our discussion. Workshop participants will focus on answering our four focal questions for their own institutional settings. In addition, they will have the opportunity to work with the materials developed for a transformed chemistry curriculum including formative and summative assessments.	High School, General Audience
Teaching effectively with three-dimensional (3D) visualization at the molecular level	Jurgen Schnitker	Wavefunction, Inc. 18401 Von Karman #370 Irvine, CA, United States	How can we best help students make the right connections between the macroscopic, symbolic, and molecular levels of chemistry? Attend this workshop and learn how to work with SPARTAN Student Edition and ODYSSEY Molecular Explorer--two highly interactive programs that bring the power of Computational Chemistry to classrooms everywhere. A number of examples from the standard course sequence for General and Organic Chemistry will be explored in hands-on activities (also applicable to High School Chemistry). Find out how abstract concepts can come to life and how students can develop an intuitive feel for the molecular world. Attendees are strongly encouraged to bring a laptop (Windows or Macintosh) and to come a few minutes early to install the programs. Some loaner laptops will be available for those who are unable to bring a computer.	College and High School

Teaching entropy with fun	Regina Rüffler	1. Institute of Physical Chemistry, Job Foundation, University of Hamburg, Hamburg, Germany.	The benefit of chemical thermodynamics is beyond question but the field is reputed to be difficult to learn. Students often regard it as very abstract and remote from everyday life. In this context, the quantity entropy seems to be especially difficult to grasp. Therefore, we propose to introduce this quantity directly by a phenomenological description (a kind of “wanted poster”) complemented by a direct measuring procedure. This approach is consequently linked to everyday experience; especially, the motivating power of fascinating but nevertheless easily and safely realizable demonstration experiments is used. The workshop will start with a short theoretical introduction into the topic. Afterwards, the attendees will have the opportunity to perform experiments that are particularly suitable to illustrate different aspects of entropy at various stations according to the rotation model. One of the experiments involves the popular toy “pop-pop boat” that represents a simple heat engine. But it is also very interesting to know how, for example, a fire piston or a simple rubber band can equip students with more knowledge about entropy.	College, High School
Teaching Python scripting for computational molecular sciences	Ashley Ringer McDonald	1. Department of Chemistry and Biochemistry, California Polytechnic State University, San Luis Obispo, CA, United States. 2. Molecular Sciences Software Institute, Blacksburg, VA, United States.	The Molecular Sciences Software Institute (MolSSI) is an NSF-funded institute whose goals are to improve software, education, and training in the computational molecular sciences. MolSSI has developed a Python scripting and data analysis workshop (see https://molssi-education.github.io/python_scripting_cms/) aimed at undergraduate students participating in, or planning to start, undergraduate research, particularly in the computational molecular sciences. This workshop will train instructors to teach the Python Data and Scripting workshop. The workshop covers topics such as: a) Reading and writing files, b) File manipulation and parsing, c) Analyzing and graphing data, d) Creating command line programs from Python script, e) Basic troubleshooting, f) Version control with git, and g) Sharing code on GitHub. MolSSI is developing a nationwide network of instructors who can teach this workshop to undergraduate students through conferences, REU programs, university workshops, and other events. This workshop will introduce instructors to the workshop curriculum, discuss best practices in programming instruction, and offer participants the chance to workshop the “live coding” style of teaching used in the curriculum. All curriculum will be made available to workshop participants through GitHub so they can easily offer a workshop at their own university or in their region. The curriculum focuses on data parsing and scripting in computational molecular science using Python. Participants with prior Python programming experienced are welcome, but prior programming experience is not required. Participants are asked to bring their own laptop to use during the workshop.	College

Teaching toxicology for chemists: Designing safer alternatives	Amy S Cannon	1. Beyond Benign, Wilmington, MA, United States. 2. Grand Valley State Univ, Allendale, MI, United States. 3. HWTR, Washington State Department of Ecology, Tacoma, WA, United States.	A key sustainability challenge for chemistry professionals today remains the lack of training for addressing hazards at the very beginning of the design stage of a product lifecycle. Chemists are not trained in basic toxicology concepts and in understanding of what makes a molecule hazardous to human health and the environment. This knowledge gap may continue to result in chemical products that have unintended consequences. Beyond Benign has launched a new project, in partnership with a network of chemists and toxicologists from industry, academia and government, to create open-access toxicology curriculum and resources for use within higher education classrooms and laboratories. These resources will allow current and future chemists to better understand the language of toxicology and molecular hazards, with the goal of equipping chemists with the tools to design chemical products and processes with reduced hazards. This workshop, as part of the roll-out of these resources, will provide participants with a brief overview of the project, and a snap shot of several toxicology topics by using activities, lesson plans and supporting lecture materials developed in the project. The workshop will be a mixture of lectures, case studies, and hands-on activities. Toxicology topics will include: introduction and history of toxicology, understanding hazard, risk and alternatives assessment, and toxicokinetics and toxicodynamics. Participants will leave with a better understanding of how to introduce toxicology topics within their chemistry courses, along with a set of resources to use within the chemistry classroom. By providing much needed toxicology resources for chemists, this will enable chemists to better design and prepare safer alternatives for solving sustainability challenges.	College
Team-based learning 101	Amina K El-Ashmawy	1. Collin College, McKinney, TX, United States. 2. Dept of Chem, Univ of Central Oklahoma, Edmond, OK, United States.	Have you thought about using an engaging pedagogy in your classes? Want to learn how Team Based Learning (TBL) works? Wondered how to get started using it in your classes? To get answers to these questions and more, join us for this introductory workshop on Team-Based Learning™ (TBL). The workshop will be conducted in the TBL format. Participants will be given a preparatory assignment, divided into teams, given individual and team readiness assurance tests with immediate feedback, and achieve consensus with their team on a set of increasingly challenging application-based questions.	College, High School, General Audience

The POGIL Project Workshop: An introduction to writing POGIL activities	Laura Trout	1. Science, Lancaster Country Day School, Lancaster, PA, United States. 2. Chemistry, Virginia Wesleyan University, Virginia Beach, VA, United States.	This session is an introduction to the essential characteristics and structure of high-quality POGIL activities. Participants will also examine the value of developing content and process objectives for POGIL activities, and create a draft or outline of an activity based on these learning objectives. After attending this session, participants will be able to: (1) identify the basic components of a POGIL activity, such as a model and critical thinking questions, (2) classify questions in an activity according to the following types: directed, convergent, or divergent, (3) classify questions in a learning cycle activity according to the following types: exploration, concept invention/term introduction, or application, (4) use both the Learning Cycle and question types to critically analyze activity structure and guide construction of quality POGIL activities, and (5) write, or begin to write, a POGIL activity focused on specific learning objectives.	College, High School, Middle School, General Audience
The POGIL Project Workshop: Classroom facilitation	Rodney Austin	1. Chemsitry, Geneva College, Beaver Falls, PA, United States. 2. Chemistry, University of Washington-Bothell, Bothell, WA, United States.	There is no single way to implement POGIL -- each time there are unique characteristics that can influence how particular goals are achieved. Facilitating a POGIL classroom effectively involves more than student groups and collaborative activities; it requires careful planning and effective classroom management through reflective facilitation techniques. This workshop is designed to provide participants with an introduction to facilitating POGIL activities. Through this experience, participants will reflect on how facilitation can enhance or interfere with student learning, as well as how facilitation strategies can be critical in the development of student process skills. After attending this session, participants will be able to: (1) name different components of classroom facilitation, (2) explain how the actions of the instructor can promote or inhibit development of student process skills, and (3) propose facilitation strategies for classroom use.	College, High School, Middle School, General Audience
The POGIL Project Workshop: Climate change concepts in general chemistry	Daniel B King	1. Drexel Univ, Philadelphia, PA, United States. 2. Guilford College , Greensboro, NC, United States.	Process Oriented Guided Inquiry Learning (POGIL) activities have been used in a large number of general and introductory chemistry courses. While the activities themselves are designed to engage students in the learning process, sometimes the activity content does not engage the students. We have written a set of classroom POGIL activities that use climate change concepts to teach fundamental chemistry content. Another unique aspect of these activities is the incorporation of socioscientific models and questions, which are designed to encourage data-driven discussions of non-scientific content. Participants in this workshop will have the opportunity to work through a sample activity. Time will be spent highlighting the range of chemistry content covered in this set of activities and discussing how these activities might be incorporated into a general chemistry curriculum.	College, High School

The POGIL Project Workshop: Development and implementation of guided inquiry experiments for physical chemistry	Robert Michael Whitnell	1. Guilford Coll, Greensboro, NC, United States. 2. Natural and Health Sciences, Seton Hill University, Greensburg, PA, United States.	The NSF-funded POGIL-PCL project implements the principles of Process Oriented Guided Inquiry Learning (POGIL) in order to improve student learning in the physical chemistry laboratory (PCL) course. Tested POGIL principles are being used to develop inquiry-based physical chemistry experiments that emphasize macroscopic and molecular models of chemical phenomena. The goal of the POGIL-PCL project is to make available a wide range of physical chemistry experiments with training materials and practitioner support so that instructors may assess their needs and resources and choose from a variety of turn-key experiments that best enhance their students' learning. This workshop will introduce the structure of a POGIL physical chemistry experiment through a classroom-tested, hands-on example, providing participants with both the POGIL-PCL experience from the student perspective and an illustration of what makes an effective guided inquiry experiment. Workshop participants will have the opportunity to discuss how to use the POGIL-PCL principles to write new experiments, how to convert existing physical chemistry experiments, and how to participate further in the POGIL- PCL project.	College
The POGIL Project Workshop: Introduction to POGIL laboratories: Strengthening process, inquiry, reflection, and application in the laboratory	Michael P. Garoutte	1. Chemical and Physical Sciences, Missouri Southern State University, Joplin, MO, United States. 2. Department of Chemistry, Cornell College, Mount Vernon, IA, United States.	This session will introduce the basic concepts and principles of the POGIL laboratory. Participants will experience a simulated POGIL laboratory experience and examine its components and structure. The criteria for a POGIL laboratory experiment will be introduced and applied to the written description of an experiment. After attending this session, participants will be able to: (1) articulate the components of a POGIL laboratory experiment and correlate them with the components of the Learning Cycle, (2) describe several differences between a POGIL laboratory experiment and a traditional laboratory experiment, and (3) determine the extent to which an experiment meets the POGIL laboratory criteria.	College, High School
The POGIL Project Workshop: Introduction to POGIL: The fundamentals	Martin D Perry	1. Science, Mount St. Mary Academy, Little Rock, AR, United States. 2. UW-Rock County, Janesville, WI, United States. 3. Beloit College, Beloit, WI, United States.	This session is designed for those with limited or no previous exposure to POGIL. Participants will have the opportunity to engage in POGIL activities, observe facilitation strategies firsthand, learn about POGIL classroom implementation, and discuss common barriers to implementation. After attending this session, participants will be able to: (1) name essential elements of POGIL pedagogy and philosophy, (2) list student learning outcomes supported in a POGIL classroom, and (3) create plans to begin implementation of POGIL in their own classrooms.	College, High School, Middle School, General Audience
The POGIL Project Workshop: Introduction to POGIL: The fundamentals	Joseph D Brown	1. Science, United States Coast Guard Academy, New London, CT, United States. 2. Chemistry , William Rainey Harper College, Crystal Lake, IL, United States.	This session is designed for those with limited or no previous exposure to POGIL. Participants will have the opportunity to engage in POGIL activities, observe facilitation strategies firsthand, learn about POGIL classroom implementation, and discuss common barriers to implementation. After attending this session, participants will be able to: (1) name essential elements of POGIL pedagogy and philosophy, (2) list student learning outcomes supported in a POGIL classroom, and (3) create plans to begin implementation of POGIL in their own classrooms.	College, High School, Middle School, General Audience

The POGIL Project Workshop: POGIL in high school chemistry courses	Laura Trout	1. Science, Capital Senior High School, Boise, ID, United States. 2. Science, Lancaster Country Day School, Lancaster, PA, United States. 3. Science, North Carolina School for Science and Mathematics, Durham, NC, United States.	This session is designed for high school teachers with limited or no previous exposure to POGIL. With a focus on high school classrooms, participants will have the opportunity to engage in POGIL activities, observe facilitation strategies firsthand, learn about POGIL classroom implementation, and discuss common barriers to implementation. After attending this session, participants will be able to: (1) name essential elements of POGIL pedagogy and philosophy, (2) list student learning outcomes supported in a POGIL classroom, and (3) create plans to begin implementation of POGIL in their own classrooms.	High School, Middle School
The POGIL Project Workshop: Student-centered learning in the laboratory: The Science Writing Heuristic (SWH) approach	Steve Gravelle	1. Chemistry, University of Wisconsin Richland, Richland Center, WI, United States. 2. Chemistry, St. Vincent College, Latrobe, PA, United States.	In this session, participants will explore an active learning strategy known as the Science Writing Heuristic (SWH). Features of SWH including beginning questions, procedures and results, and claims and evidence will be demonstrated through a lab simulation experience. After attending this session, participants will be able to: (1) articulate the components of an SWH laboratory experiment, (2) describe methods for soliciting and facilitating the generation of beginning questions, (3) show students how to derive evidence-based claims that are drawn from the actual data collected in lab, (4) articulate the structure of the SWH laboratory experience and contrast it with the laboratory report format.	College, High School
The POGIL Project Workshop: Using an observation tool for observing a POGIL (or team-based) classroom	Regina Frey	1. Chemistry, Washington University in St. Louis, St. Louis, MO, United States. 2. Education, University of Wyoming, Laramie, WY, United States.	This session will focus on the basics of using the OPTIC (Observation Protocol for Teaching in Interactive Classrooms) tool, which is a whole classroom observation instrument, developed for use in an interactive team-based classroom such as a POGIL classroom. OPTIC can be used for: 1) coaching and mentoring practitioners, 2) giving feedback to experienced practitioners on their facilitating, 3) assisting administrators in the evaluation of faculty who participate in POGIL teaching styles, and 4) documenting collaborative learning in a POGIL (or team-based) classroom. By the end of this session, participants will be able to i) distinguish between different OPTIC Codes, ii) examine and interpret the meanings of the OPTIC Facilitator Actions Codes and the Interaction Codes, iii) use the OPTIC tool while watching videos of POGIL classrooms, and iv) use a pre/post observation discussion handout.	College, High School, Middle School, General Audience
Undergraduate laboratory access for students with visual impairments with Vernier Sci-Voice Talking LabQuest	Ashley Elizabeth Neybert	1. Independence Science, West Lafayette, IN, United States.	This hands-on workshop will demonstrate how to use the Vernier Sci-Voice Talking LabQuest, a version of the traditional Vernier LabQuest modified for those with visual impairments sold by Independence Science, in a chemistry laboratory context. Aspects of capabilities and limitations of this technology will be discussed as part of this training session as well as laboratory safety for those with visual impairments. Multi-sensory science learning experiences such as this can foster a more inclusive science learning experience for all learners including those with special needs.	College

Using an online learning platform to improve student data collection and laboratory report submission, grading, feedback, and learning analytics	James Caras	1. Catalyst Education, Austin, TX, United States.	Chemistry laboratory courses can be very challenging to deliver. Students struggle with data collection errors and lab report writing and submission, and when surveyed complain about the fairness of grading and timeliness of feedback. It is often difficult for laboratory Instructors and teaching assistants (TAs) to achieve consistent scoring across all sections of a lab course. Laboratory Directors and Coordinators are all too often disconnected from the data collection, grading, and commenting on lab reports, making coaching of instructional staff and TAs difficult, and timely interventions problematic, all of which result in lower course evaluation scores. Labflow is an online learning software platform designed specifically to improve lab courses. It includes activities and assessments to train the TAs and prepare students for success in labs each week. Online submission, hosting, and grading of lab reports cuts down on grading time while providing feedback to students that is more timely and or higher quality, as well as improves grading consistency across TAs and sections. Mobile student engagement and learning analytics promote better TA-student interactions and provide opportunities for Coordinators to mentor TAs and improve their teaching. This workshop will focus on the lab data collection and lab report submission, grading and commenting features of Labflow, including hands-on use of the software.	College
Using classroom assessment techniques to improve students' learning in chemistry	Yunteng He	1. Central Community College, Kearney, NE, United States.	Classroom Assessment Techniques (CATs) are generally simple activities designed to give both instructor and students useful feedback on the teaching-learning process. With the appropriate implementation of CATs, it could: (1) provide just-in-time feedback about the teaching-learning process, (2) provide information about student learning with less work than traditional assignments (tests, papers, etc.), (3) encourage the view that teaching is an ongoing process of inquiry, experimentation, and reflection, (4) help students become better monitors of their own learning, and (5) provide concrete evidence that the instructor cares about learning. Although there are many published CATs, educators who use them generally invent more as they become comfortable incorporating them into their teaching. In my chemistry classes, I have been developing CATs to improve students' learning, such as traffic light card (*College Teaching* , 2019) and constructive error climate (*Journal of College Science Teaching* , accepted). In this workshop, I will work with the audience in solving Rubik's cube, by implementing multiple CATs, to improve their learning.	College

Using role-playing and active learning to prepare teaching assistants (TAs) to teach chemistry	Christina Sue Bagwill	1. Chemistry, Saint Louis University, Saint Louis, MO, United States.	The goal of this workshop is to share effective methods for improving the professional attitude and the public face of chemistry teaching assistants (TAs). This workshop will teach the methods of role-playing activities and discussion groups which have been developed as part of at Saint Louis University's Chemistry Training Program. The workshop will be structured as an active learning environment. Facilitators will moderate discussions, allowing participants to view our approach to training and instruction from the TA's point of view. Role-playing scenarios will illustrate how second-year and third-year teaching assistants can help to train new TAs. Participants will leave the workshop with a list of possible lab "performance" scenarios and have a chance to brainstorm the development of new scenarios applicable to their institution. The focus of this workshop is training of laboratory TAs although there are some educational topics and best practices that can be applied to learning assistants or lecture TAs.	College
Using the learning cycle in POGIL activities to support students' ideas about models and modeling	Nicole M Becker	1. Chemistry, University of Iowa, Iowa City, IA, United States. 2. Chemistry, University of Iowa, Iowa City, IA, United States.	In this workshop, participants will be introduced to a series of general chemistry activities designed using the POGIL learning cycle to engage students in the process of constructing and using graphical and mathematical models. Example contexts for the activities include the Ideal Gas Law, rate laws, and equilibrium. We will focus on how these activities may be used to support students' understanding of the nature and purpose of models in chemistry, that is their metamodeling knowledge. Workshop attendees will have an opportunity to participate in a "fishbowl" activity, either by working through activities as students or as observers/reflectors. We will provide examples of the ways in which students' metamodeling ideas may be scaffolded through activity design and instructor facilitation.	College, High School
Visualization and docking of protein-ligand interactions to discover the function of unknown proteins for the biochemistry teaching laboratory	Michael Pikaart	1. Hope College, Holland, MI, United States.	Biochemistry laboratory courses often focus on protein biochemistry, with an emphasis on purification, concentration measurement, electrophoresis, and kinetics. Along with these in vitro techniques, visualization of a protein's structure can add excitement as well as deepen understanding of the relationship between a proteins structure and its function. This workshop will use approaches developed as part of the BASIL curriculum (Biochemistry Authentic Science Inquiry Laboratory; https://basilbiochem.github.io/basil/) to combine discovery of functions of unknown proteins within the teaching laboratory. Participants will use online and local software to predict an active site within and protein structure, propose molecules which represent ligands or substrates for these proteins, and use docking software to predict binding site and affinity between one or more small molecules and their protein. While designed for junior and senior level undergraduates, these techniques are readily adaptable to introductory level chemistry and biology courses as well as at the high school level. They are based on free open source software packages and web tools and require no specialized equipment beyond a standard computer setup.	College, High School

What happens after a test: How to provide students feedback on their examination performance to promote learning	Cynthia J. Luxford	1. Department of Chemistry and Biochemistry, Texas State University, San Marcos, TX, United States. 2. Chemistry, University of Wisconsin River Falls, River Falls, WI, United States. 3. Chemistry, US Naval Academy, Annapolis, MD, United States.	Summative assessments such as exams or tests are often used by general chemistry instructors. We typically give some feedback to students as an indicator of their course performance and amount of content knowledge demonstrated. The level of feedback might range from a single score to handing back the exam to using immediate feedback techniques. While studies exploring students' perceptions and use of test feedback are being conducted, it is also valuable to determine common classroom practices and perceived limitations and/or barriers to testing feedback. Participants will be asked to discuss and reflect on their current teaching practices regarding testing feedback and compare their practices to national survey data collected from general chemistry faculty. Participants will also have the opportunity to see and discuss student data gathered through a series of classroom studies regarding the use of feedback after testing.	College
Writing competitive research proposals that win funding	Nancy Jensen	1. ACS Office of Research Grants, American Chemical Society, Washington, DC, United States.	The workshop will cover the basics of the process of writing research grant applications. These will include, selecting a funding agency, interacting with agency grants officers, the process of writing a proposal, funding agencies and decision makers expectations and common errors to avoid. The workshop will include some interactive exercises in how to present information in a proposal. The workshop will also include a segment in which the ACS Petroleum Research fund is used as a specific example of a funding agency's scope, expectations and operation.	College, General Audience