SYMPOSIUM TITLE	PRIMARY ORGANIZERS	INSTITUTIONS	ABSTRACT DESCRIPTION	AUDIENCE
Improving the learning of chemistry through sharing best practices of the western states chemistry education group	Thomas James Greenbowe | Richard L Nafshun	1. Department of Chemistry & Biochemistry, University of Oregon, Eugene, OR, United States. 2. Chemistry and Biochemistry, University of Oregon, Eugene, OR, United States. 3. Oregon State University , Corvallis, OR, United States.	Symposium Description: Science education studies have shown the use of active learning pedagogies in the classroom result in positive student learning outcomes. These outcomes include higher test scores and grades, improved conceptual understanding of chemistry, lower withdrawal rates and improved attitudes toward science. Members of the Western States Chemistry Education Group will share their activities and techniques that have proven to be effective. This symposium will focus on instructional implementation of active learning strategies in the classroom and in the chemistry laboratory.	College, High School
General Papers	William Joseph Donovan	1. University of Akron, Akron, OH, United States.	Symposium Description: Submissions to this symposium are encouraged from presenters that feel that their work does not fit into any of the predefined symposia. The organizer will build sessions of similarly-themed presentations.	College, High School, Middle School, General Audience
Teach me something I don't know	Allison Strange Soult	1. Dept of Chemistry, University of Kentucky, Lexington, KY, United States.	Symposium Description: As chemists, we tend to find concepts fascinating and interesting on their own. However, our students often wonder why they need to understand a particular topic. Most general and organic chemistry classes are filled with engineering, pre-health profession (medical, dental, nursing, pharmacy, veterinarian), and biology majors. Share your favorite application (or two) outside of chemistry to help students relate to the topic. You don't need to be an expert in the other field, but you do need to provide enough information about the context of the application so that educators can adapt and use in their own classroom.	College, High School
Organic laboratory as an extension of the classroom	Kevin Stewart	1. Chemistry and Biochemistry, Harding University, Searcy, AR, United States.	Symposium Description: As chemical educators, we face many challenges in the modern teaching laboratory: the rising costs of chemicals, books, and supplies, assessment of learning, integrating green chemistry principles, development of a culture of safety in the laboratory, etc.. These pressures have in many ways changed the organic laboratory to the point it is often unrecognizable compared to those even 20 years ago. In this symposium, presenters will share experiments and pedagogical ideas they have developed that allow the laboratory to be an extension of the classroom.	College
Teaching ethics in undergraduate chemistry courses	Kathryn Louise Haas	1. Chemistry, Saint Marys College, South Bend, IN, United States.	Symposium Description: What is ethics, anyway? And how do you build ethics learning outcomes into content-heavy undergraduate courses? This session will include examples of how faculty are incorporating ethics training into undergraduate coursework, and how ethics learning outcomes can be assessed.	College

Understanding and engaging the underserved learner	Cathrine Reck	1. Chemistry, Indiana University, Bloomington, IN, United States.	Symposium Description: Reaching and engaging underserved populations in STEM fields has become a heightened focus for most educational institutions recently. The definition of “unserved populations” has recently expanded to include rural students, low income, first-generation, students who identify as LGBTQ+, as well as traditional minority populations. Driven by this sense of urgency, stakeholders are still struggling with developing best practices to address unmet needs for several marginalized populations. This symposium will be a combination of talks that provide intervention strategies (e.g., boot camps, peer-mentoring, networked communities, first-year experiences, summer academies, individualized course sections, flexible and inclusive learning spaces, innovative and accessible measures of learning, and societal and/or cultural activities that promote diversity and opportunity in STEM disciplines). Speakers will be asked to address their successes as well as their challenges.	College, High School
Identifying and addressing inequity	Vanessa Rosa Ralph	1. Chemistry, University of South Florida, Riverview, FL, United States. 2. Chemistry, Box 7486, Wake Forest University, Winston Salem, NC, United States. 3. Chemistry, University of Michigan, Ann Arbor, MI, United States.	Symposium Description: Inequities in the academic outcomes of chemistry students provide opportunities for a review and critique of teaching and assessment practices. This symposium invites speakers to share works elucidating contributors to inequity and discuss advancements toward promoting equitable learning and assessment in chemistry.	College
Advances in online chemistry education	Matt Earle Morgan	1. Teachers College, Secondary Education, Western Governors University, Salt Lake City, UT, United States.	Symposium Description: Delivery of chemistry education online continues to develop and reach a wider audience. Also, the differences between chemistry concepts delivered online and in traditional classrooms decrease as asynchronous teaching tools improve. Presenters in this symposium will share online teaching tools and best practices, both for online lecture and laboratory curricula.	College, High School
Chemistry education research: Graduate student research symposium	Olivia Marie Crandell	1. Michigan State University, Haslett, MI, United States. 2. Grand Valley State University, Allendale, MI, United States.	Symposium Description: This symposium has a long history of being a great platform for graduate students to present their work in a constructive environment. In this symposium, graduate students will present their work on any topic involving chemistry education research. The goal of this particular forum is for the audience to provide feedback in a way that does not intimidate or overly-challenge the presenter, but professionally advises the student in a way that helps the student grow into a better presenter and researcher. This symposium is hosted by the Younger Chemistry Education Scholars committee of DivCHED, which seeks to foster such growth in the future generation of chemical education researchers.	General Audience

Innovative and creative approaches used in the teaching of chemistry courses via an online or hybrid platform	Kishore Bagga	1. Drexel University College of Medicine, Philadelphia, PA, United States.	Symposium Description: This symposium allows for sharing of approaches used by instructors at the college level in order to engage and motivate their students through the online or hybrid platform. The approaches can include pedagiogical developments, use of instructional technology, hands-on approaches using technology, discussion board, ApreNet, team-based learning tools which have been developed to name a few examples. The symposium shall allow for educators to share what has worked for them in the teaching of chemistry via the online or hybrid platform. This symposium shall also therefore allow for attendees to take away after the presentations ideas which they can then apply into their own courses to provide an engaging and enriched atmosphere for student-centered learning.	College, High School
Engaging students in physical chemistry	Craig M. Teague	1. Department of Chemistry, Cornell College, Mount Vernon, IA, United States. 2. Lander Univ, Greenwood, SC, United States.	Symposium Description: Presentations in this symposium may include new laboratory or classroom exercises, new approaches to the structure of the physical chemistry curriculum, active learning pedagogies, the inclusion of contemporary research topics in the curriculum, and the interface of physical chemistry with other disciplines. Discussions will include issues in the physical chemistry curriculum and strategies to improve student engagement.	College
Food chemistry	Keith Dolman Symcox	1. Chemistry, University of Tulsa, Bristow, OK, United States.	Symposium Description: This symposium will focus on the creative use of food and drink to teach chemical concepts at the high school and college level.	College, High School, General Audience
ALEKS in the classroom: Implementing adaptive learning in the chemistry curriculum	Jason S Overby	1. Chemistry and Biochemistry, College of Charleston, Charleston, SC, United States.	Symposium Description: ALEKS (Assessment and Learning in Knowledge Spaces) is an adaptive learning tool for students in chemistry. As with all technology, implementation is vital to success and ALEKS Is not alone. The range and utility of ALEKS allow it to be utilized in essentially any classroom, ranging from an intimate community college level classroom to the lecture hall at large universities. Further, the depth and breadth of ALEKS make it a truly useful tool for preparation and review of material for incoming students as well. This symposium will explore the many facets of implementing ALEKS in a variety of modes and a variety of classroom settings.	College, High School

Teaching programming in the chemistry curriculum: Approaches, challenges, and best practices	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.	Symposium Description: Programming and computational science is an increasingly important part of chemistry. This symposium, organized by the Molecular Sciences Software Institute (MolSSI), focuses on how programming is taught within the chemistry curriculum at all levels of higher education. Different institutions and departments may include computer programming as part of the chemistry curriculum in many different ways. Some curricula may require a stand-alone programming course, taught by a computer science or computer engineering department, while others may not include any computer programming instruction at all. This symposium focuses on a middle ground: when computer programming is taught by chemists within the existing chemistry curriculum. The symposium will bring together chemical educators from all levels of higher education to discuss how and when they incorporate programming into their curriculum, what challenges they faced in implementing their programming curriculum, how the programming learning objectives are integrated with chemistry learning objectives, and the best practices they have discovered for teaching programming to chemists. A speaker from the Molecular Sciences Software Institute will describe programming and resources for faculty offered by MolSSI and introduce MolSSI's best practices in software engineering for computational molecular science. We welcome submissions that describe a particular activity that is used to teach programming to your students or those that describe larger curricular innovations at the department or institutional level. Submissions should focus on teaching programming rather than using computational tools in the chemistry curriculum.	College
Molecular modelling in biochemistry to enhance visual literacy	Shane Austin	1. Department of Biology, University of Alabama at Birmingham, Birmingham, AL, United States. 2. Department of Biological and Chemical Sciences, University of the West Indies, Bridgetown, Barbados.	Symposium Description: Biochemistry similar to several other chemical disciplines relies on visual content from which students must obtain meaning. Practically, however, biochemistry textbooks can be as much as 50% images in page volume. In spite of this, students have difficulty understanding some of these images and the processes that are being explained by them. As active learning techniques become more widespread at both small and large institutions, more instructors appear to be using various types of models, both commercially available and self-made. Models are valuable tools in simplifying content in difficult to comprehend diagrams, as well as effectively illustrating complicated subject matter to students. Therefore this symposium endeavours to allow biochemical educators to present relevant and novel modelling strategies they have used in their classrooms. Abstracts submitted should make clear the benefits to students and a discussion as to any limitations or special considerations that should be made for use. Specifically, the symposium aims to address the topics of protein-protein interaction, DNA-protein, RNA-protein and protein structure-function models. Instructors who use other models that similarly tackle issues of visual literacy are also encouraged to submit abstracts.	College

Biochemistry education: Discussions of the laboratory environment	Franziska K. Lang | Sara L. Johnson	1. Chemistry/Center for Instructional Excellence, Purdue University, West Lafayette, IN, United States. 2. Chemistry and Industrial Hygiene, University of North Alabama, Florence, AL, United States.	Symposium Description: Biochemistry education is unique in that students must synthesize learning from many courses (e.g., chemistry and biology) and attain a high-level of representational competence to be successful. Additionally, biochemistry education is unique in that the host department for undergraduate biochemistry courses can be found in many disciplines such as chemistry, biochemistry, microbiology, and medicine. Thus, research studies and discussions of practice within the laboratory can be found in many journals and spanning a number of disciplines. The purpose of this symposium is to provide a forum for biochemistry education researchers and practitioners to present their work in the biochemistry teaching laboratory.	College
Laboratory practical examination tasks	Stephanie Ann Myers	1. Dept of Chemistry & Physics, Augusta University, Augusta, GA, United States.	Symposium Description: While common in biology, using a laboratory practical to evaluate student laboratory skills is less common in chemistry. However, many schools do use them. This symposia will showcase various types of practicals and provide advice on design and implemenatation of laboratory practical exams in chemistry.	College
Trends in general, organic and biochemistry (GOB) chemistry course	Corina E Brown | Laura D Frost | Lafayette Eaton	1. Chemistry and Biochemistry, Univ. of Northern CO, Greeley, CO, United States. 2. Whitaker Center for STEM Education, Florida Gulf Coast University, Fort Myers, FL, United States. 3. Biology, North Seattle College, Seattle, WA, United States. 4. Chemistry, NSC, Lake Forest Park, WA, United States. 5. Chemistry, St John Fisher College, East Rochester, NY, United States.	Symposium Description: One of the requirements in many health professions programs is one or two semesters of chemistry as a General, Organic, and Biological (GOB) Chemistry course. Teaching the GOB chemistry course has its own set of challenges for students and instructors. However, these challenges are often turned into opportunities for novel ideas to be implemented and tested. This symposium will explore the development of the GOB curriculum, examine innovations in the curriculum, and explore multidisciplinary approaches that can be demonstrated to be successful. Presenters are encouraged to share their research, experiences, strategies, and successes with the course. This session will conclude with a discussion among the audience and the presenters to identify successful trends in teaching the GOB course.	College

Closing the concept chasm between general and organic chemistry	Mitzy A Erdmann | Jacqueline Amine Nikles	1. Chemistry, University of Alabama at Birmingham, Tuscaloosa, AL, United States.	Symposium Description: Organic Chemistry has earned the reputation as the "gatekeeper" course for undergraduate STEM majors. Why? What makes this course such an ordeal for students who managed to succeed in general chemistry? What barriers make organic chemistry "harder" than general chemistry for these students? One obstacle may be that organic chemistry may be the first course which tests a student's ability to think critically. Another is that success in an organic class requires the student to think in 3-dimensions like few others due – they must master the ability to visualize molecular shape and electron movement. If students struggle during the first several weeks of the first semester, it can snowball and cause students to wither give up or do poorly. This symposium will highlight proven strategies and provide discussions for new ones that aim to help students rise to the challenge of organic chemistry. Interventions that help to bridge the gap between the first and second year sequences are of particular interest.	College
Advancing teaching in inorganic chemistry	Rebecca M Jones	1. Chemistry and Biochemistry, George Mason University, Fairfax, VA, United States.	Symposium Description: This symposium will enable practicing inorganic faculty to share their innovative approaches to teaching. Inorganic topics are covered in introductory and advanced courses and we welcome submissions related to teaching innovations at the undergraduate and/or graduate level. Faculty who have developed new laboratory experiences or lecture activities are welcome to submit. Presenters may elect to share fully developed or pilot exercises. Inquiry and/or research-based activities are particularly welcome. This symposium will share examples of how faculty can be creative in their teaching as well as in their research.	College
Writing to promote learning and disciplinary thinking in chemistry	Solaire A Finkenstaedt-Quinn	1. Chemistry, University of Michigan , Ann Arbor, MI, United States.	Symposium Description: The National Research Council recently called for increased incorporation of writing in STEM classrooms because of its ability to support conceptual learning and student development of disciplinary practices. Current writing pedagogies utilized in chemistry courses range from tasks focused on conceptual learning and critical thinking to genre assignments that support discipline-specific writing skills and practices. Additionally, there are moves to incorporate instructional scaffolds that support both the efficacy of writing assignments and their instructional use. The purpose of this symposium is to bring together instructors that use writing and researchers that study writing in chemistry classrooms at the college and/or high school level. Both instructors and researchers are encouraged to submit abstracts related to the implementation of or research on writing of any form (long-from, short-form, disciplinary genres, writing-to-learn, etc.) in chemistry classrooms. Abstracts should clearly indicate a research or practice focus.	General Audience

Exploring strategies for decreasing DFW rates in general and organic chemistry courses	Amanda Leigh Waters | Eric S. Eitrheim	1. Chemistry, The University of Central Oklahoma, Edmond, OK, United States. 2. Chemistry, University of Central Oklahoma, Oklahoma City, OK, United States.	Symposium Description: A simple metric for measuring student success is the course's DFW rate (D,F, Withdrawal). The purpose of this symposium is to introduce and explore strategies implemented in general and organic chemistry courses that aim to increase overall student success, notably for students who are at risk of not passing. Attendees and presenters can get ideas from others regarding strategies for decreasing DFW rates amongst their students. This can include institutions and classes of various sizes utilizing multiple teaching styles. Either qualitative or quantitative analyses of these strategies is acceptable.	College
What is TDS? Good and Bad TDS in Drinking Water.	Vikki Choudhry	1. BSS Materiel , New Delhi, Delhi, India.	Symposium Description: Drinking water purification	General Audience
Course-Based Undergraduate Research Experiences (CUREs) in Chemistry	Laura C Brown	1. Chemistry, Indiana University, Bloomington, IN, United States. 2. Indiana University, Bloomington, IN, United States.	Symposium Description: Undergraduate research experiences can be transformative for budding scientists, however many do not find their way into traditional research labs. Course-Based Undergraduate Research Experiences (CUREs) are an alternative that can serve all students, including those who are not savvy enough to find themselves a position, or who have jobs or financial constraints that prohibit them from devoting a significant amount of time to research. In this symposium, we want to hear from faculty who have developed and/or implemented CUREs in chemistry. Faculty in the early stages of developing a CURE are welcome to present course design and plans for implementation. Faculty who have already run the CURE are invited to share all aspects of the course, including what worked well, and obstacles (both expected and unexpected) that arose.	College
Interconnecting disciplines: Design and delivery of integrated laboratory or classroom exercises	Kristopher V Waynant	1. Chemistry, University of Idaho, Moscow, ID, United States.	Symposium Description: Chemistry is regarded as the central science interconnecting the biological processes and physical theories of a multitude of scientific observations and experiments. No matter the discipline of choice for a budding scientist or engineer, chemistry is a core subject in her/his curriculum. Laboratory and/or classroom exercises can provide key overlaps to a variety of disciplines and connect students to chemistry and/or from chemistry through more relatable context including biology, physics/engineering, agriculture, natural resources, social sciences, art, history, and even business. This symposia will support contributions that highlight integrated or multi-disciplinary laboratory or classroom topics, exercises, and ideas, including vertical integration of courses across one subject, or horizontal integration of courses across many disciplines. We ask presenters to discuss how and where integrations are added into current curriculum, as well as assessment strategies for evaluating how the addition of integrated material accomplished learning outcomes, rigor, or value to the course.	College, General Audience

Eye tracking in chemistry education	Katherine Havanki	1. The Catholic University of America, Washington, DC, United States. 2. Columbia Univ Chemistry Dept, New York, NY, United States. 3. Department of Chemistry, Grand Valley State University, Wyoming, MI, United States.	Symposium Description: This symposium will bring together CER researchers who incorporate eye-tracking methodologies into their work. Eye tracking as a technique allows for the capture of eye movement behavior that gives us insight into not only the usability of educational materials but also into deeper cognitive processes. This symposium invites submissions that explore the role of eye tracking in chemistry education research, particularly discussions of the ways in which eye tracking can be used as both a teaching and research tool.	General Audience
Chemistry in health science career	Roshinee costa	1. Chemistry, Kent State University/ Tuscarawas, New Philadelphia, OH, United States.	Symposium Description: Most of the time Health Science related chemistry classes offer as introductory courses; which is designed mostly for nursing majors. Material cover in this section is general chemistry, organic chemistry, and biochemistry and how they related to medical profession. Sometime these sections cover through three, two or one semester. Teaching these three sections with in one semester course is always challenging. In this symposium I would like to see how to overcome the challenges when you are teaching these sections, and how to improve learning using different effective teaching methods.	College, High School, General Audience
Electrochemical biosensor based on aptamer of nucleic acid	Jiao Chen	1. Qingdao University of Science and Technology, Qingdao, China.	Symposium Description: The aptamers are DNA or RNA oligonucleotides selected in vitro that can bind their targets with high affinity and high specificity. As a kind of new and special recognition molecules , the aptamers present notable advantages over conventional recognition molecules , such as antibody , thus they have received great attention and been widely utilized in various fields involving molecular recognition and relevant applications , especially in biosensing. Electrochemical DNA sensors typically consist of an electrode that holds a DNA fragment and an electroactive hybridization indicator for detection. Under appropriate conditions, using a specific interaction between two complementary DNA single strands, a DNA fragment (DNA probe) of a known sequence on the surface of the electrode is hybridized with the DNA of the sequence to be tested (target sequence) in solution. The target sequence is determined by measuring the change in the electrochemical response of the electroactive indicator before and after hybridization; or by hybridizing the target sequence on the surface of the electrode to the DNA probe of the labeled electrochemically active substance in solution. After the formation of the DNA double helix on the surface of the electrode, the sensor can also be used to detect electroactive small molecules with specific affinities for DNA duplexes. As a new type of biosensor, electrochemical DNA sensor not only has the high specificity and reversibility of DNA hybridization reaction, but also has the traditional characteristics of easy miniaturization of electrochemical sensors. It has become a hot topic in biosensor research.It is an important tool for DNA analysis.	College

Authentic learning experiences in lecture and laboratory	Sarah S Pierce	1. Cumberland University, Lebanon, TN, United States.	Symposium Description: “When are we going to use this in the real world?” is a common question students ask in the classroom. Authentic learning experiences bring “real world” applications into the classroom, and provide students context for chemical concepts. Authentic learning experiences are activities where students produce knowledge through self-directed projects, construct meaning using open-ended inquiry, and work towards a product or solve a problem that has value beyond the classroom. This symposium welcomes presentations on authentic, “real world” learning experiences that have been used in lecture classes and laboratory experiments.	College, High School, General Audience
Empowering students to succeed after graduation: Introducing professionalism and soft skills in the development of undergraduates	Cheryl Baldwin Frech	1. Dept of Chem, Univ of Central Oklahoma, Edmond, OK, United States. 2. Chemistry, University of Central Oklahoma, Stillwater, OK, United States.	Symposium Description: How do we prepare our students for their next steps after they receive an undergraduate degree in chemistry? Content knowledge and undergraduate research experiences are important, but so are numerous other skills that we assume that our students will learn or pick up without necessarily being taught: ethics, safety, networking, scientific communication, poster preparation, professional behavior, and what to include on a resumé, cover letter, or professional social media site. We invite faculty to share courses, electronic portfolios, transformative learning experiences, club activities, and other waysthat allow students to demonstrate and departments to assess students’ progress as they move from their undergraduate coursework to the workplace or graduate or professional program.	College, General Audience
Current research investigating the effectiveness of instruction in the undergraduate chemistry laboratory course	Nikita Burrows	1. Chemistry and Physics, Monmouth University, Long Branch, NJ, United States. 2. Chemistry and Biochemistry, Florida International University, Miami, FL, United States.	Symposium Description: Chemistry faculty generally agree that the laboratory is an important component of the chemistry curriculum. However, there may be less agreement among faculty about the goals and learning objectives for the laboratory and how laboratories should be designed and assessed. This symposium will focus on current qualitative and quantitative research related to the undergraduate chemistry laboratory curriculum. Contributed papers should address research related to any aspect of the undergraduate laboratory. This includes, but is not limited to, general chemistry, organic chemistry, biochemistry, instructors, students, laboratory curriculum, pre-laboratory assignments, laboratory assessments, cognitive, affective or psychomotor factors, etc. Related research on laboratory design for exploring student’s engagement in chemistry laboratory may also be addressed.	College
Chemical Education Xchange: Engaging with contributors	Jon L Holmes	1. Chemical Education Xchange, Madison, WI, United States.	Symposium Description: The Chemical Education Xchange (ChemEd X, www.chemedx.org) is a virtual home for high school and higher education chemistry instructors. ChemEd X is designed to be a collaborative space to share resources, ideas, and expertise. ChemEd X contributors will engage with you by highlighting and expanding upon ideas and activities they have shared at ChemEd X. Attendees are encouraged to register for a free account at www.ChemEdX.org and bring their preferred device to access the website during the symposium. Find out more about the resources available at ChemEd X and how you might engage with and contribute to this growing, vital community.	College, High School

Discourse frameworks in active learning chemistry classrooms	Lisa Shah	1. Chemistry, Stony Brook University , Stony Brook, NY, United States. 2. Chemistry, University of Nebraska-Lincoln, Lincoln, NE, United States.	Symposium Description: Recent investigations of discourse patterns in active learning chemistry courses have provided novel insights into how students think and learn. Findings from these studies have informed instructional and curricular adaptations aimed at improving the quality of student discourse and conceptual understanding in these settings. This symposium will highlight the application of specific discourse frameworks for investigating unique research questions and contexts across K12 and higher education.	College, High School
Embedding transferable skills into the chemistry curriculum	Samantha Louise Pugh	1. Faculty of Engineering and Physical Sciences, University of Leeds, Leeds, West Yorkshire, United Kingdom.	Symposium Description: A chemistry program consists of the learning of core chemistry knowledge and the development of a wide range of transferable skills. Research suggests that the development of these transferable skills is much more effective when embedded into the delivery and assessment of the core curriculum. This symposium will showcase the varied ways in which transferable skills are embedded and developed in the chemistry curriculum, with a focus on how students recognise and are able to articulate such skills.	College, High School, General Audience
Designing and evaluating curricula to incorporate scientific research skills	Stefan Mark Irby | Kathleen A. Jeffery | Christopher Bauer	1. Chemistry, University of Central Florida, Orlando, FL, United States. 2. Chemistry, University of Central Florida, Orlando, FL, United States 3. Chemistry, University of of New Hampshire, Durham, NH, United States.	Symposium Description: Inclusion and development of scientific research skills in the classroom has been a major focus of K-16 curriculum development in recent years. This has been pursued through the adoption of teaching strategies, such as inquiry-oriented laboratories or pedagogical techniques (e.g. POGIL), and the re-design of lab curricula around authentic research (e.g. CUREs). Scientific literature and authentic data have also been incorporated into classroom science to develop support the development of scientific research skills like data analysis, experimental design, etc. However, the learning goals associated with these skills are often too generic to adequately assess. This is likely due in part to the distinct lack of data-driven research specifically focused on the process of designing and evaluating curricula that support the development and assessment of specific scientific skills. This symposium is open to researchers and practitioners who are interested in the use of student data to inform the design and evaluation of curriculum to develop scientific research skills. Abstracts submitted to this symposia should focus on either the design and implementation of these teaching formats, evaluation of these types of teaching formats, or assessment of student learning within these teaching formats. Presentations should include how literature or data was used to inform design, evaluation, and/or assessment decisions.	College, High School, Middle School, General Audience

Improving implementation of innovative laboratory models	Dawn I Del Carlo	1. University of Northern Iowa, Cedar Falls, IA, United States. 2. Chemistry, Saint Vincent College, Latrobe, PA, United States.	Symposium Description: Over the last few decades, several innovative laboratory approaches (such as ADI, CUREs, PBL, POGIL, SWH, among others) have been utilized in a variety of chemistry laboratories. As the needs of individual classrooms and institutions vary, it is reasonable to expect that specific components of these laboratory models must be adjusted to meet those needs. This symposium invites speakers to share their experiences on the implementation and modification (when needed) of any of these laboratory models. Both research and practitioner-based talks relevant to all levels of instruction are welcome and should address how the changes met their specific needs.	College, High School, Middle School, General Audience
Views from the classrooms presented by chemistry teachers who earned teaching awards	Deanna Cullen	1. Chemical Education Xchange, Montague, MI, United States.	Symposium Description: Many excellent chemistry teachers have been recognized for their work by receiving a variety of awards, including the James Bryant Conant, ACS Regional Awards, the Beaumier award in Canada and other science teacher awards. These teachers have much to share with other educators about best practices in the classroom. Award recipients typically have an opportunity to present an award address but, how many of us get to hear their actual award presentations and learn from their experience? This symposium will give attendees a chance to meet and benefit from these award-winning teachers, as well as find out more about how to nominate a teacher for one of these awards and how each award selection process works.	High School
Strategies for student success: Lessons from minority serving institutions.	Erik J Menke	1. School of Natural Sciences, UC Merced, Merced, CA, United States. 2. Chemistry, University of California, Merced, Merced, CA, United States.	Symposium Description: Historically, minority serving institutions (MSIs) were developed to provide access to education, but more recently MSIs have focused on student success. To this end faculty at MSIs have developed numerous strategies for improving student success, both broadly and focused in chemistry. Most, if not all, of these strategies are also effective for students, whether historically underrepresented or not, at non-MSIs. This symposium provides an opportunity to share these success strategies with a broader audience.	College
Implementing Course Based Undergraduate Research Experiences (CUREs): Challenges & Successes	Kristina Roth Stefaniak	1. Chemistry, Radford University, Radford, VA, United States. 2. Chemistry, CSU Fresno, Fresno, CA, United States.	Symposium Description: A course based undergraduate research experience (CURE) is a popular, high-impact pedagogical approach in laboratory courses for numerous reasons. First, students gain authentic experiences in designing a research question where the outcome is unknown to both the student and instructor and requires the student to work collaboratively. Second, CUREs increase student interest in science and self-efficacy, as well as retain students in the sciences. Finally, CUREs facilitate the ability to think critically, a skillset which is often difficult to develop in traditional laboratory experiences. The objective of our symposium is to provide a platform for educators to share and discuss the challenges and successes of previously implemented CUREs at all levels of the undergraduate chemistry curriculum.	College

Fun-tastic games and how to make and use them	Theresa D Gaines	1. Math and Sciences, Delta State University, Cleveland, MS, United States. 2. Chemistry, University of California, Irvine, Irvine, CA, United States. 3. Chemistry, UC Davis, Davis, CA, United States. 4. Education, Brown University, Providence, RI, United States.	Symposium Description: Looking for creative ways to make your chemistry classroom or lesson more engaging? Content-based games provide an alternative to traditional forms of learning and promote active learning through student-student and student-content interactions. This session will explore game-related questions, such as the following: How do you make educational games?; When and how should games be used in the classroom?; or How do you adapt games to your own classroom setting? This symposium will provide a space for presenters to share their games and their experiences implementing games in the classroom. All types of games are welcome, and presenters are encouraged to use part of their presentation time to engage the audience in a demo of their game.	College, High School, Middle School, General Audience
Communicating chemistry: Improving oral and written communication skills to foster academic and career success	Bozena Widanski	1. Science & Health, University of Cincinnati Clermont, Batavia, OH, United States. 2. English, Languages, and Fine Art, University of Cincinnati Clermont, Batavia, OH, United States.	Symposium Description: The need for chemistry students to be able to clearly and accurately communicate what they have learned both orally and in writing has been identified as an important pedagogical issue by educators and employers alike. Our symposium will address this issue by soliciting submissions that provide examples of best practices, tips for success, and suggestions for averting problems while improving students' oral and written communication skills. The symposium will encourage presentations from faculty teaching chemistry majors and general education chemistry courses, those incorporating oral and written communication pedagogy into their chemistry courses, and those team teaching across disciplines.	College
Non-traditional' qualitative research frameworks in chemistry education research	Christopher Randles	1. University of Central Florida, Orlando, FL, United States. 2. Chemistry, Florida International University, Miami, FL, United States.	Symposium Description: As the chemistry education field continues to grow, novel qualitative frameworks emerge and are adopted by the field. The purpose of this symposium is to introduce to our community how novel non-traditional qualitative frameworks are being applied to chemical education research. Frameworks can be conceptual, theoretical or analytical in nature. Speakers will be expected to shift the focus of their presentation from the results of a study towards how a framework informed the development and design of their project. Speakers should also be prepared to discuss the impact the framework has had on the analysis of their results and the way the results are presented. You should be prepared to explain your framework explicitly to an audience that may not be familiar with its perspective and/or implementation.	College

Considering the chemistry learning environment	Julie Donnelly	1. University of Central Florida, Edgewater, FL, United States. 2. Chemistry, University of Florida, Orlando, FL, United States.	Symposium Description: Active Learning Classrooms (ALCs) are a quickly growing educational "technology" in higher education. However, research on learning environments in general that can support effective pedagogical use of learning spaces, including ALCs, is sparse, especially in chemistry. This symposium will provide an opportunity for researchers and practitioners to discuss what research says about chemistry learning spaces and how various spaces are currently being used in chemistry courses. We are especially interested in studies of specific pedagogies used in ALCs, studies comparing courses in different types of learning spaces, and professional development concerning the learning environment. We invite both researchers and practitioners in order to bring both groups together to discuss what research is ongoing, what is happening in the classroom, and how we can make a connection between the two.	College
High impact teaching beyond chemistry	Supaporn Hartwell	1. Xavier University, Cincinnati, OH, United States.	Symposium Description: This symposium focuses on chemistry teaching practices that intend to expand student learning outcomes beyond the subject content and aim to prepare students for an effective and responsible workforce. These include teaching practices that introduce students to community service, civic duties, moral obligation, team work, global knowledge, and culturally inclusive working experiences. Incorporating these extra learning outcomes in STEM classrooms can be challenging, but they are very important in preparing students for their future working environments. Examples of teaching practices include but are not limited to service learning, case studies, interdisciplinary projects, team based learning, green chemistry applications, and international collaborative learning. Please come share your teaching practices, class management, successes and challenges.	College, High School, General Audience
Engaging students in optional Out-Of-Class instruction	Daniel Albert	1. Chemistry, Millersville University, Landisville, PA, United States.	Symposium Description: Student success in college chemistry courses requires significant engagement with course materials outside of class. Support resources including faculty office hours, tutoring, peer learning, etc. exist to support student engagement and achievement outside of the classroom. Oftentimes students see these support resources as remedial which brings with it a negative connotation. Avoiding or delaying participation in supportive out-of-class instruction for some students can lead to unsatisfactory achievement in courses. This symposium will include projects that examine how to increase participation in optional out-of-class instruction and how to utilize effective practices that encourage students to continue participating in optional out-of-class instruction. How do we engage students most in need of additional instruction? What initiatives have been successful in building comprehensive structures for engaging students in out-of-class instruction? What roles do peers, instructors, and tutors play in fostering out-of-class engagement? What are the barriers for engaging students in out-of-class instruction? What are effective practices for student recruitment and engagement in out-of-class instruction?	College

Supporting the growth and impact of the chemistry education research community	Deborah G Herrington	1. Dept of Chem, Grand Valley State University, Allendale, MI, United States. 2. Lyman Briggs College, Michigan State University, Ann Arbor, MI, United States. 3. Michigan State University, Haslett, MI, United States.	Symposium Description: Chemistry Education Research (CER) is a growing field with dedicated journals and conferences, an increasing number of CER graduate programs, and a developing community of CER scholars worldwide. Over the past several decades we have learned a great deal about effective methods for teaching and assessment of chemistry learning. Yet, there are still many questions we need to answer and decisions we need to make as a community if we are to increase the acceptance and impact of our work and more broadly influence the practice of chemistry education. This symposium aims to expand on a 2018 BCCE symposium and subsequent commentary in the Journal of Chemical Education that focused on supporting the growth of the CER community. Based on prior feedback from the CER community, this symposium will focus on ways in which we can better define our community identity and work together to use CER and data to more broadly influence the teaching and learning of chemistry. Topics will include creating standards for effective practice, research, and dissemination supported by the CER community, drawing from the practices of other disciplines, and building bridges to other communities. Additionally, during the symposium discussions we will be eliciting feedback from the CER community to build towards the ideas presented by the speakers.	College, General Audience
Three-dimensional printing in chemical education: Engaging students and creating tools for active learning	Lon A Porter	1. Wabash College, Crawfordsville, IN, United States.	Symposium Description: The recent and accelerating advances in computer-aided design (CAD) and 3D printing methods capture the imagination as this exciting technology finds new applications in chemical education. This symposium will highlight innovative work toward creating 3D printable resources and fabrication activities that enhance active classroom and laboratory learning. The focus will encompass computer-aided design (CAD) and 3D printing methods to produce designs that span pedagogical applications from visualizing complex molecular structures and energy surfaces to the production of innovative new analytical tools and equipment for student use in laboratory learning. Classroom implementation strategies, student engagement, and assessment will also be highlighted. Plenty of time will be provided for your questions during the panel discussion concluding this symposium.	College, High School, Middle School, General Audience

Using technology to engage students and promote learning	Brandi Lee Baldock | Brooke Taylor	1. Chemistry & Biochemistry, Merrimack College, North Andover, MA, United States. 2. Science, Lane Community College, Eugene, OR, United States.	Symposium Description: The students now enrolled in our chemistry courses are digital natives that prize individual learning and achievement and value flexible learning environments. The use of learning management systems, in-class polling systems and online homework programs in early college chemistry courses is now widespread, and instructors are increasingly incorporating iPad and SmartPhone apps, supplemental instruction videos, virtual labs and simulations, and online discussion forums into their courses. The ever-expanding nature of the education technology toolbox makes it a daunting challenge for any one instructor to test-drive each new pedagogical tool and assess its potential effectiveness in their course. The goal of this symposium is to provide a forum for instructors to share how they use technology to engage students in their courses, and discuss the challenges they've encountered and lessons learned.	College
Graduate teaching assistants' role in undergraduate education	V. M. Berns	1. Chemistry, Northwestern University, Evanston, IL, United States.	Symposium Description: Graduate Teaching Assistants (GTAs) are an integral part to instruction in most large university settings. The pedagogical training and utilization of this workforce is managed differently at different institutions and changes over time. At Northwestern, we are striving to leverage graduate students' experience in the classroom to maximize the benefit to both their careers and our undergraduate instruction. Devoting effort to high-quality training of GTAs and subsequent opportunities for using that training is a benefit to the department as well as to the graduate student population. Others have made great strides toward this effort, and it is our hope to highlight the unique contributions of many individuals across a broad scope of institutional contexts. We have identified several key aspects of the role of GTAs in undergraduate instruction and the contributions that can potentially be shared by several key individuals, highlighted below. TA Training Methods and Programs Perhaps the most universal experience among institutions that utilize GTAs is the challenge of providing sufficient pedagogical instruction. Many institutions have developed training programs that span from a few days to a course that lasts a full semester. The GRAD-TA PREP Workshop has done an excellent job at bringing representation from physics and chemistry departments together to brainstorm about this subject, but the results inspired by the three-day conference are worthy of the larger venue of BCCE. Further, there are programs that we are aware have well-developed programs that would be ideal to highlight. At Purdue, Jon Reinstra-Kiracofe and Franziska Lang have developed a program with a full course that would serve as a great example. Similarly, Maria Gallardo-Williams' semester-long course entitled "How to be a Grad Student" at North Carolina State encompasses a lot of the pedagogical training that is often incorporated into GTA training, and goes beyond that to enhance graduate student preparation in many arenas. Vera Dragisich at University of Chicago has also recently published a new TA training program that may be highlighted. Impact of Teaching and Mentorship on Graduate Student Development Another interesting aspect of the GTA experience is the impact that the act of teaching has on graduate students as they develop as scientific trainees. A large body of research has been done to discredit the common misconception that teaching has a negative impacts research progress and negatively impacts graduate students' career trajectories. A recent article by Erin Shortlidge (Biology, Portland State University) and Sarah Eddy (Biology, Florida International) delves into dispelling these myths. While not in chemistry specifically, the perspectives from biology are largely relevant in this context. Within chemistry, work from Melanie Cooper (MSU), Santiago Sandi-Urena (University of South Florida), and Todd Gatlin (Greenhill Schools) highlights the impact of facilitating a cooperative problem-based chemistry lab on GTA metacognitive development. TAs Mentoring Undergrads in Research Often at large research institutions, graduate students serve as mentors for undergraduates in research labs. Providing appropriate training for this position and finding ways to leverage it as professional development can benefit both graduate students and undergraduates. The University of Wisconsin (through the Delta Program and WISCIENCE) provides a Research Mentor Training program that aims to instruct graduate students and post-docs about productive mentorship in a research lab setting. Amber Smith (the Associate Director of WISCIENCE and Director of the RMT program) would be an excellent person to speak on behalf of this training. Often, this population is more effective at instructing new undergraduate researchers than a research adviser, due to more seamless communication ("peer" to "peer") and more recent experience with being a novice. While this is a common practice, explicit mentoring programs to facilitate this mutually-beneficial relationship are being established. Cornell has established a campus-wide initiative: Graduate Students Mentoring Undergraduates (GSMU). Effective Feedback for TAs on Teaching Practice One of the great challenges of maintaining the integrity of teaching within a curriculum that incorporates GTAs is ensuring that the quality of teaching among the TAs is consistent and at an appropriate level. Because only a few individuals are usually involved in managing the TA workforce, other types of tools must be implemented to provide feedback about TA performance. Daniel Collins at Texas A&M has developed a program utilizing video recording to provide structured feedback to a large cohort of GTAs about their teaching progress. Further, the Real-time Instructor Observing Tool (RIOT), developed by Cassandra Paul at San Jose State and Emily West in Humboldt, CA, has enabled highly-specific, constructive feedback to instructors in physics through a web-based application. This type of tool can easily be imagined for chemistry, and adapting tools between disciplines is a good way to avoid reinventing the wheel.	College

ACS Guidelines: Standards for the professional training of the next generation of chemists	Michelle Brooks	1. Education, American Chemical Society, Washington, DC, United States. 2. Chemistry, Marquette University, Milwaukee, WI, United States.	Symposium Description: The professional landscape for chemists is changing rapidly. To stay current, most domestic institutions offering bachelor degrees in chemistry use the American Chemical Society (ACS) Guidelines to inform their program standards. The Committee on Professional Training (CPT) of the ACS has begun reviewing these guidelines, last updated in 2015, for revision. This symposium aims to engage the community in defining the major initiatives being considered/adopted for the next revision. Relevant topics will include the teaching and assessing of professional skill development, undergraduate chemistry curricula, assessing workloads and contact hours for faculty and instructional staff, and incorporating criteria valuing diversity, equity and inclusivity as part of the institutional climate.	College
Beyond Boyle and Lavoisier: Creating equity, inclusion, and social justice in the chemistry classroom	Ariel N Serkin	1. STEMteachersMassBay, Sharon, MA, United States. 2. International Community School, Kirkland, WA, United States.	Symposium Description: Do your class demographics match the faces in your chemistry curriculum? How do we encourage, support, and model for non-dominant demographics? Presenters will explore how to make class spaces inclusive, equitable, and offer strategies on how to start to deconstruct traditional chemistry pedagogy.	College, High School, Middle School, General Audience
Revising chemical education for the twenty-first century students	Michael James Castaldi	1. C2 Education, Blue Bell, PA, United States.	Symposium Description: The education of the next generation of chemist is an important concern for the chemistry profession. We are all aware of the problems of stem education's inability to attract and keep students. Looking for inactivation in both delivery and content is often something that is not always easily. The saying that this is the way we did it in the past does not resonate with our current students New ways of delivering instruction, instrumentation and soft skills are important aspects that need to be included in our rethinking of the\chemistry curriculum. For good or bad chemistry is often the gate keeper for all of STEM sciences. Creating an interesting, dynamic and relevant courses in General, Organic and Biochemistry are important especially at the introductory level.	College, High School, General Audience
Process Oriented Guided Inquiry Learning (POGIL) in the classroom and laboratory	Gail Hartmann Webster	1. Guilford College , Greensboro, NC, United States.	Symposium Description: Process Oriented Guided Inquiry Learning (POGIL) is a student-centered, team learning pedagogy based on research on how students learn. In a POGIL learning environment, students work in self-managed teams using specially designed activities that guide them to construct key concepts while developing important process skills such as problem solving, critical thinking, communication, and teamwork. The purpose of this symposium is to bring together practitioners of POGIL pedagogy from seconday school through university level. Presentations focusing on implementation, process skills, curricular development, and assessment are welcome.	College, High School, Middle School

Connecting models in chemistry through cross-cutting concepts	Teresa Marx	1. Needham High School, Needham, MA, United States. 2. University High School, Fresno, CA, United States.	Symposium Description: In the NGSS, crosscutting concepts (CCCs) are said to "provide students with an organizational framework for connecting knowledge from the various disciplines into a coherent and scientifically based view of the world." These are essential to the approach employed by Modeling Instruction in High School Chemistry. Each presenter in this symposium will explore the role played by of one of these 7 crosscutting concepts across various models of chemistry, helping teachers reinforce these important universal patterns in nature with their students.	College, High School, Middle School
Have we done this before? Student learning and retention of acid-base chemistry	Sarah K St Angelo	1. Chemistry Dep, Dickinson College, Carlisle, PA, United States.	Symposium Description: Acid-base chemistry permeates the chemistry curriculum, and yet it presents challenging concepts that are often not well retained. Starting in general chemistry and continuing throughout their chemistry courses, students encounter acid-base concepts in a wide range of situations. Activities, projects, demonstrations, laboratory exercises, computer modules, online learning, etc. that effectively introduce, review, or deepen learning of acid-base chemistry are welcome. Particularly of interest are strategies that encourage retention of acid-base chemistry starting in general chemistry.	College, High School
Linus Pauling Collection and Life	Richard L Nafshun	1. Oregon State University , Corvallis, OR, United States.	Symposium Description: Several speakers familiar with Linus Pauling and the collection of Linus Pauling will present.	College, High School, Middle School, General Audience
The equity gap in STEM education	John L Grutsch	1. Chemistry, University of Wisconsin - Whitewater, Whitewater, WI, United States.	Symposium Description: College attendance has grown dramatically since the year 2000 increasing by approximately five million students to a total enrollment of approximately 20 million. Most of the increase in attendance is from the enrollment of minority and low-income students, often the first in their families to attend college. However, the academic success rate between students from different socioeconomic classes in post-secondary education has also increased with minority and low-income students 20 percent less likely to graduate than their middle and upper class peers. Enrollment of students in STEM majors has also increased, however there continues to be concern over the widening retention and success gap of minority and low-income students in those majors. The purpose of this symposium is to provide a platform to present and discuss current research with respect to the widening academic success rates for minority and low-income students in STEM disciples.	College, High School, Middle School, General Audience
Manipulatives for the high school chemistry class	Kristen Drury	1. William Floyd High School, Bellport, NY, United States.	Symposium Description: Learning chemistry often requires students to imagine and visualize structures and reactions on particulate and sub-particulate levels. This can be difficult for many students, particularly those who learn best in a visual or tactile way. Chemistry manipulatives can be a great solution for students to study chemistry concepts that require them to "see" the structure or process to fully understand it. In this session participants will interact with manipulatives that could be used or modified for any level of high school or introductory chemistry.	High School

Increasing teachers' chemistry content knowledge	Kristen Drury	1. William Floyd High School, Bellport, NY, United States.	Symposium Description: Teachers need to have a firm understanding of chemistry at a level higher than what they teach in their classrooms in order to answer extended student questions and challenge the highly motivated student. In this symposium, experts in specific chemistry content areas will share their knowledge to help elevate our understanding of chemistry.	High School
New products To enhance instruction in the chemistry classroom and laboratory	Caroline Hsia Tsuyuki	1. Curriculum and Professional Development, PASCO Scientific, Roseville, CA, United States.	Symposium Description: This symposium provides a venue for companies to present two or three of their products in the context of supporting Chemistry educators and enhancing active learning in the classroom and laboratory. Each presenter must be able to demonstrate the utility of their products in facilitating the collection and/or analysis of data. In cases where this is not possible. sample data generated from actual experiments is allowed. Each presenter is allocated 15 minutes to complete their demonstration plus an additional 4 minutes to answer questions. Presentations may include tolerances and specifications of the products but may not include direct comparison to similar products from other companies.	College, High School, Middle School, General Audience
Biochemistry education: Discussions of the lecture learning environment	Rodney Austin	1. Chemsitry, Geneva College, Beaver Falls, PA, United States. 2. Chemistry and Biochemistry, University of California, San Diego, San Diego, CA, United States.	Symposium Description: This symposium will focus on teaching innovations and educational research related to the biochemistry lecture learning environment. The biochemistry classroom can provide students with the opportunity to grow and develop their understanding of the molecular life science concepts and practices. However, as many biochemistry educators can attest, this potential for student learning is not often fully realized. We invite those teaching lecture courses in all areas of biochemistry to share their work with a specific interest in active learning pedagogies. We encourage all symposium speakers to include some form of assessment, such as results from surveys, exam questions, student interviews, or formal assessment instruments in their presentation.	College
Research in chemistry education	Thomas C Pentecost	1. Chemistry Department, Grand Valley State University, Allendale, MI, United States. 2. Natural Sciences, Oregon Institute of Technology, Klamath Falls, OR, United States.	Symposium Description: This symposium provides a broad forum for chemistry education research (CER) including but not limited to quantitative, qualitative, mixed methods, and action research studies. A submitted abstract and presentation should be aligned with the criteria for CER published in the Journal of Chemical Educationand address (1) the motivation or purpose for the research and type of problem investigated, (2) the research question(s), (3) the conceptual and methodological frameworks chosen to guide the study, and (4) the findings and implications of the study. Presentations should focus primarily on the findings and interpretation of data. This symposium is sponsored by the ACS DivCHED Committee on Chemistry Education Research.	College, High School, Middle School

Quick and meaningful laboratories for AP Chemistry and general chemistry	Linda Cummings	1. Chemistry and Biochemistry, University of Colorado, Colorado Springs, Colorado Springs, CO, United States.	Symposium Description: Laboraotry work is essential to chemical education, but students are often so focused on rushing through and getting all the steps right that they cannot think about what is actually happening during the lab. In this symposium, presenters will describe quick laboratory activities that really work, along with some tips on how to enable students to think about what is happening during the laboratory, supporting conceptual learning. These laboratory experiments should take 50 minutes or less, and be appropriate for AP Chemistry, IB Chemistry, and general chemistry classes at a college or university.	College, High School
Active Learning in organic chemistry	Alexey Leontyev	1. Chemistry and Biochemistry, North Dakota State University, Fargo, ND, United States. 2. Chemistry, Dartmouth College, Norwich, VT, United States. 3. Chemical Sciences, University of California, Riverside, Riverside, CA, United States. 4. Purdue Univ at Ft Wayne, Fort Wayne, IN, United States. 5. Chemistry Dept, Centre College, Danville, KY, United States. 6. LR Box 7474, Lenoir-Rhyne University, Hickory, NC, United States. 7. Spelman College, Atlanta, GA, United States.	Symposium Description: Multiple studies have shown that the use of active learning pedagogies in the classroom result in positive student learning outcomes in science courses. These improved outcomes include higher test scores and final grades, improved understanding of content, lower withdrawal rates, and more positive attitudes toward science. There are many techniques that can be implemented to introduce more active learning into any environment, including those that can be incorporated into traditional lectures, used to flip the classroom, promote collaborative learning, or scaffold construction of knowledge. This symposium includes presentations of organic chemistry faculty who have implemented active learning, broadly defined, in their organic courses.	College, High School, General Audience
Laboratory assessments	Alice Putti	1. Jenison High School, Jenison, MI, United States.	Symposium Description: The laboratory experience can enhance student understanding of chemistry concepts and develop scientific reasoning. Student learning can be assessed through lab reports, post-lab quizzes, or presentations. This symposia will focus on different types of assessment pertaining to laboratory investigations.	College, High School

Incorporating environmental chemistry into the undergraduate chemistry curriculum	Krista A Barzen-Hanson	1. Department of Chemistry, Elmira College, Elmira, NY, United States. 2. Dept. of Chemistry, Elmira College, Elmira, NY, United States.	Symposium Description: The increasing popularity of green chemistry practices in education and research echoes the heightened importance to protect our environment. Developing solutions to many of the world's environmental problems requires a multi-disciplinary approach. In addition to environmental scientists and engineers typically addressing climate change and contamination, among other problems, chemists' understanding of natural phenomena at the micro- or nanoscale may prove beneficial in bringing solutions to impacted communities. Therefore, exposure to environmental chemistry, beginning as freshman undergraduate chemistry students is of utmost importance. In this session, we invite abstracts that include current teaching practices and novel approaches for introducing environmental chemistry throughout the undergraduate chemistry curriculum. Overall, the goal of the session is to highlight best practices, innovative strategies, available resources, and implementation challenges for teaching environmental chemistry that capture undergraduate student attention and interest.	College, General Audience
Integration of plant medicinal chemistry into the undergraduate chemistry laboratory curriculum	Corey E Stilts	1. Dept. of Chemistry, Elmira College, Elmira, NY, United States.	Symposium Description: The use of CBD supplements as well as other products related to hemp and cannabis has been on the rise. The legalization and/or decriminalization of marijuana in many states has led to a growth of research and development in this area. The need for quality control as well as the determination of active ingredients in these products will play a role in the future of product development. This area of chemistry along with all other fields related to plant medicinal chemistry such as viticulture, lead development, and extraction are all important techniques in any undergraduate chemistry program. In this session, we invite abstracts related to the field of plant medicinal chemistry that could be used in an undergraduate laboratory curriculum. This could include experiments or techniques that might be found in any undergraduate chemistry lab such as general chemistry, organic chemistry, analytical chemistry, biochemistry, etc	College, General Audience
Connecting the visible with the invisible	Pamela Auburn	1. Chemistry , Lone Star College, Houston, TX, United States.	Symposium Description: Chemistry is all about molecules in motion. This presents two challenges to learning. First students must be able to connect what is seen on a marcroscopic level with what is going on unseen at the molecular level. Further since since molecules are three dimensional they must be able to visualize this 3D world that is presented in a 2D format. When students arrive in a chemistry class it is often the first time that they have been faced with the need for these visualization skills. Numerous studies have shown that this is challenging and a significant barrier. Without the ability to connect the macroscoscopic with the microscopic in a 3D context, they may be able to know but not understand chemistry. This symposium will focus on ways instructors have supported students in making these connections.	College, High School, Middle School, General Audience

Critical thinking in organic chemistry laboratory classes	Klaus Bernhard Himmeldirk	1. Dept. of Chemistry Biochem., Ohio University, Athens, OH, United States.	Symposium Description: The teaching of critical thinking (CT) skills is one of the most important goals in laboratory education. The ability to define a problem, to make conclusions based on evidence, to rationalize a hypothesis, or to develop and use models to explain data are some aspects of CT and central to the scientific process in chemistry. The symposium seeks to explore and define practical ways to teach important aspects of CT in organic chemistry laboratory classes. Presenters are invited to share their experience with experiments that have a focus on the teaching of critical thinking. Emphasis should be placed on areas of CT that are especially amenable to instruction in laboratory classes and cannot be taught easily in lecture classes.	College
Extended reality in chemistry education	Lyniesha Wright	1. Chemistry, North Carolina State University, Raleigh, NC, United States.	Symposium Description: The usage of technology in instruction promotes different ways for students to interact with the educational material at hand. Virtual tools can be interactive and responsive in real-time which adds a new layer of feedback to the user. Extended reality (XR) tools encompass augmented reality (AR), virtual reality (VR) and mixed reality (MR). They provide an interactive nature and a three-dimensional immersive environment, non-attainable by traditional means. This symposium is for practitioners and researchers at all levels who have used XR to complement instruction, training, or as a means of assessment to address challenges when teaching chemistry. Presenters will discuss advantages and limitations of using XR in the classroom or laboratory, and-or results from studies using XR materials.	College, High School, Middle School, General Audience
Teaching nuggets for AP Chemistry and general chemistry	Paul David Price	1. Trinity Valley School, Fort Worth, TX, United States.	Symposium Description: Veteran teachers of AP and general chemistry know to prepare themselves for the multitude of questions and misunderstandings students will exhibit over a variety of topics. In the course of trying new approaches to present material, we may be lucky and hit upon an original approach, enlightening demonstration, or clarifying problem that significantly aids student understanding. Join educators on both sides of the high school- college interface as they present some of their favorite teaching nuggets to help all students improve their comprehension.	College, High School
Scaling up TA preparation for lab courses with 75+ students	Renee D Link	1. Chemistry, University of California Irvine, Irvine, CA, United States. 2. Chemistry, Rutgers-Newark, Springfield, NJ, United States.	Symposium Description: Lab courses enrolling more than 75 students require a “scaling up” of time and resources for materials, grading, and teaching assistant training. Successful running of these large lab courses relies heavily on graduate student teaching assistants, many of whom are inexperienced instructors or are new to the level of responsibility required. Therefore, training and support of new graduate students, both initially and ongoing, is key to course success. Speakers are welcome to share training practices for TA training days/weeks as well as well as “on the job” training if no formal training period exists.	College

Systems thinking in chemistry education: what it is and why we should do it	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. University of Nevada, Las Vegas, Las Vegas, NV, United States.	Symposium Description: Systems thinking is an approach for examining and addressing complex behaviors and phenomena from a holistic perspective. This approach can be used to not only increase understanding of various natural and artificial systems, but to prepare citizens to address global world challenges—such as sustainability, pollution, climate change, and poverty—and to participate knowledgeably and democratically in science-related policy decisions. While the idea of systems thinking has infiltrated many areas of STEM education, including biology and engineering, it has yet to become an integral part of the chemistry curriculum. Over that past several years, an international coalition of chemists, educators, and chemistry education researchers has been considering how some of the potential advantages of systems thinking might be achieved in the chemistry education context. The IUPAC Systems Thinking in Chemistry Education (STICE) Working Group has worked to define systems thinking for chemistry education and is beginning to develop systems thinking learning objectives and assessment models for general chemistry. In this session, speakers from the STICE project—and others--will describe systems thinking, the skills and competencies of a systems thinker, and how it can serve chemistry teaching, chemistry learning, and earth and societal systems.	College
Creating a strong foundation in polarity: Effective methods in teaching polarity in lecture and lab.	Graeme R. A. Wyllie	1. Concordia College, Moorhead, MN, United States.	Symposium Description: Polarity, both bond and molecular, is a key topic in chemistry and a solid understanding of this is essential in many aspects of chemistry and biology. The purpose of this symposium session is to provide an opportunity to share and discuss the various methods (both lecture and laboratory based) that presenters use to enhamce student understanding of polarity.. Presenters who have developed activities or related materials particularly targeted for introductory courses such as high school, first year general chemistry or first semester organic chemistry are strongly encouraged to consider applying since building a strong foundational knowledge of polarity is critical for sucess in many upper level classes.	College, High School
Transforming chemistry laboratory courses to teach transferable skills and develop young scientists	Binyomin Abrams	1. Chemistry, Boston University, Brighton, MA, United States.	Symposium Description: The ACS Guidelines for Bachelor's degree programs place a substantial emphasis on preparing students to enter the workforce or postgraduate education (section 7). While lecture courses may be the primary vehicle of content-based instruction, it is primarily the laboratory experiences that prepare our majors for the work that they will do upon graduation. In this symposium, talks will focus on novel approaches being designed to improve, supplement, or replace the traditional laboratory education that our students receive. Particular emphasis will be on approaches to laboratory instruction that seeks to bridge the "skills gap" in the areas of problem solving, chemical literature and information use, lab safety, communication, teamwork and collaboration, and ethics.	College

Collaborating outside the sciences	Susan Plummer Oxley	1. Chemistry and Biochemistry, St. Mary's University, San Antonio, TX, United States.	Symposium Description: Chemists often work with other scientists in the natural and physical sciences. This symposium focuses on collaborations with faculty and students outside the sciences, such as humanities, business or law. These relationships provide a pathway for faculty growth and development, along with opportunities for enhancing student learning and engagement. Presentations in this session may include course-based collaborations and activities taking place outside of the classroom. Presenters are encouraged to discuss best practices, pitfalls to avoid, and the benefits of collaborative work.	College, High School
Metacognitive strategies and resources for learning outside and inside the chemistry classroom.	Ted M Clark	1. Chemistry and Biochemistry, The Ohio State University, Columbus, OH, United States.	Symposium Description: A great deal of student learning takes place outside of the classroom and students need appropriate metacognitive strategies for learning both outside and inside the chemistry classroom. Resources like homework, the textbook, practice tests, computer simulations, and online videos are all frequently used outside of the classroom. These resources may be linked to in-class learning activities, or they may be stand alone. This symposium examines student learning outside of the classroom and will consider the design and implementation of resources, strategies for learning from these resources, and how instructors can connect learning outside and inside their classrooms. Both chemical education research projects and insights from instructors as practitioners are welcome.	College
Supporting three-dimensional learning by building chemistry learning environments around core ideas	Ryan Stowe	1. Chemistry, University of Wisconsin - Madison, Madison, WI, United States. 2. Engineering Academy at Olathe Northwest High School, Olathe, KS, United States. 3. Wyoming High School, Wyoming, MI, United States. 4. Kinsley High School, Kingsley, MI, United States.	Symposium Description: Widespread adoption of the Next Generation Science Standards (NGSS) has created a need to carefully consider how chemistry curricula should support students in understanding the world in terms of atomic/molecular behavior. We argue that Standards-aligned coursework should be “core-ideas centered” due to evidence that curricula embedded in scaffolded progressions of core ideas can help students develop, organize, and use their knowledge to make molecular-level sense of phenomena. This symposium will describe an effort to adapt the core idea sequence underpinning the evidence-based undergraduate general chemistry curriculum Chemistry, Life, the Universe, and Everything (or CLUE) for use in high school. Adaptation was accomplished by a team of high school chemistry teachers and researchers, many of whom will be symposium speakers. Audience members will have the chance to hear the theory behind development of High School CLUE (HS-CLUE), learn from detailed accounts of enacting the curriculum, and ask questions of the researcher-practitioner team.	High School
Nanotechnology in undergraduate education	David S. Heroux	1. Department of Chemistry, St. Michaels College, Colchester, VT, United States.	Symposium Description: The subject of this symposium is the implementation of nanomaterials in undergraduate education in the classroom and teaching laboratory. Speakers will describe their efforts and findings related to broadening the undergraduate chemistry curriculum through the introduction of nanomaterials and technology. Presentations that give insight into the successful integration of nanotechnology and the Chemistry Curriculum or provide adaptable examples of nanotechnology courses for non-science majors are encouraged.	College

Strategies for introductory chemistry student success	Aimee L Miller	1. Chemistry, Millersville University, Millersville, PA, United States. 2. Chemistry, Montgomery College, Rockville, MD, United States.	Symposium Description: Introductory chemistry is a gateway course in most science programs and sometimes serves as an unintentional barrier to student completion of STEM degrees. This symposium will explore classroom or institutional strategies that provide learning opportunities aimed at enhancing student success in introductory chemistry courses. Have you or your institution tried something new to promote success for introductory chemistry students? How are best practices from individual classrooms transferred more broadly within a department or school? What learning tools or initiatives have you found to be most valuable for students? What design features have helped motivate students to engage actively in their own learning? All are invited to share innovations for instructional strategies in classrooms or programs that increase student success in introductory chemistry and keep STEM programs accessible to all students.	College
Promoting a positive safety culture in chemical education	David Carl Finster	1. Chemistry, Wittenberg University (retired), Springfield, OH, United States. 2. Chemistry, University of Cincinnati , Cincinnati, OH, United States. 3. Chem Tech Dept, Texas State Tech College, Waco, TX, United States.	Symposium Description: This symposium seeks to bring together many voices and perspectives regarding efforts to support a positive safety culture in education settings including K-12 and college. Topics can include local strategies to enhance safety instruction, the use of RAMP in designing labs and fostering student use of RAMP, connections between safety and green chemistry, student assessment of safety instruction, efforts that illustrate the ACS safety initiatives, and future directions of safety in the classroom and lab.	College, High School, Middle School
Effective graduate education for masters and doctoral chemistry students	Jordan Harshman	1. Chemistry and Biochemistry, Auburn University, Auburn, AL, United States. 2. Department of Chemistry, University of Michigan, Ann Arbor, MI, United States.	Symposium Description: Graduate education in chemistry has received a great deal of attention from national organizations such as the American Chemical Society, National Academies, Council of Graduate Schools, and others for several decades. While primarily thought of as a model for the world to look up to, the culture and outcomes of U.S. graduate education has faced intense scrutiny and many calls for drastic reform. Additionally, the advent of chemistry education research as an area of chemistry has lead to the formation of many new programs that rely on courses and experiences not traditionally observed in the other areas. This symposium is dedicated to disseminating fundamental research and/or innovations that exist in chemistry graduate education. Two different areas are targeted: (1) Research on the effectiveness of current elements of graduate education (courses, seminars, research groups, mentoring, etc.) and data from implementation of reformed practice in the traditional areas of chemistry (biochemistry, organic, inorganic, physical, and analytical) are welcomed. (2) Innovations and approaches to the effective training of graduate students specifically in chemistry education research are also welcomed. Presentations in these two areas should help shed light on best practices in graduate education in the ongoing effort to produce highly trained chemists.	College, General Audience

Engaging students in organic chemistry: A Symposium to Honor Barbara Murray	Patricia J F Kreke	1. Science Department, Mount St Mary's University, Frederick, MD, United States. 2. Univ of Redlands, Redlands, CA, United States.	Symposium Description: Organic Chemistry's role in providing foundational material for upper level science courses requires that the instructor engage students in learning the fundamental concepts in organic chemistry not only to appreciate the content but also to help students identify its applications to other areas. In this symposium, a variety of methods for engaging students in organic chemistry will be presented ranging from individual creative activities to yearlong methods of teaching using new pedagogies.	College
ACS and AACT K-12 teaching resources	Kimberly Duncan	1. Education Division, American Chemical Society, Washington, DC, United States.	Symposium Description: Description: The American Chemical Society (ACS) Education Division offers a range of resources for K-12 teachers of chemistry. In this symposia, you will walk away with tools to use in your lessons, but you'll also learn about programs and grants that ACS offers to enhance your teaching. You'll learn how to address difficult concepts using modeling from the resources ChemCom, AACT, and the Journal of Education. The ACS Hach and ChemClubs offices have grants for teachers available, and you'll learn important strategies to apply for them. The Science Coaches project manager will outline the benefits of the One-on-One program, which pairs teachers and chemists for a school year. Learn how to start ChemClub and walk away with resources that you can use to celebrate National Chemistry Week in 2020: Sticking from Chemistry.	High School, Middle School
Empowering student learning in the flipped classroom: How to encourage students to do what you want them to do	Lisa Hibbard	1. Chemistry & Biochemistry, Spelman College, Atlanta, GA, United States.	Symposium Description: Recent chemical education research has shown that implementation of a flipped (or blended) learning pedagogical approach in the introductory chemistry classroom can lead to deeper learning and improved student performance. One critical aspect of this approach is that it places the onus of learning on the students, which may be a new concept for both the student and the instructor. This symposium will present ways in which instructors can structure the flipped classroom to encourage individual student active learning and foster team engagement. Assessment strategies that promote student persistence in improving their own learning process and the impact on overall course performance will be described.	College, High School
Atoms first: Assessment, challenges and successes	Debra Kay Dillner	1. Chemistry, US Naval Academy, Annapolis, MD, United States. 2. Chemistry, Tennessee Technological University, Cookeville, TN, United States. 3. Chemistry and Biochemistry, Abilene Christian University, Abilene, TX, United States.	Symposium Description: Description: Atoms First General Chemistry is an approach where atomic theory is taught early and the particulate nature of matter is emphasized. Multiple institutions have adopted this approach and some publishers have text books that support it. In this symposium, those who have moved to an Atoms First approach will share their experiences, including challenges related to curriculum topic order and content, successes and opportunities for improvement. Particular focus will be on planning coordinated laboratory curriculum and assessment of the teaching and learning environment. The symposium will be of interest to those who are considering or are in the process of adopting an Atoms First curriculum. There will be an education research component based on assessment being undertaken.	College

Current and future status of teaching and learning materials to support the chemistry curriculum	Jason S Overby	1. Chemistry and Biochemistry, College of Charleston, Charleston, SC, United States. 2. McGraw-Hill Education, New York, NY, United States.	Symposium Description: The world of publishing chemistry teaching materials as we know it is changing rapidly. This symposium will provide a venue for companies, projects, or individuals to present the current and future capabilities of their chemistry textbooks, adaptive learning courseware, on-line homework systems, and interactive textbooks in the context of supporting chemistry instruction. Each presenter is allocated 15 minutes with an additional 4 minutes for questions at the end of the presentation. Presentations may not include a direct comparison to other products from other companies.	College, High School, Middle School, General Audience
CURES in the chemistry and biochemistry teaching laboratory.	Michael Pikaart	1. Hope College, Holland, MI, United States. 2. California Polytechnic State University, San Luis Obispo, CA, United States.	Symposium Description: Research experience at the undergraduate level is a proven asset in training novice scientists. In the physical and life sciences, this has traditionally taken place in apprenticeship based, PI-directed laboratory settings. However, this model incurs time, cost, and space limitations. To make undergraduate research more accessible, recent years have seen an increase in course-based undergradute research experiences, or CUREs. In a CURE, students work on authentic research questions by searching literature, proposing hypotheses, designing and carrying out experiments, and interpreting data, in a directed manner guided by an expert investigator as occurs in a traditional research lab setting. A CURE seeks to do this in a traditional semester/academic year timeframe, with group sizes ranging from dozens to hundreds of students. This approach requires pursuing research questions that (a) can be adressed in meaningful depth in a time of months rather than years, (b) can be carried out in parallel fashion by multiple students at a time, and (c) fulfil requisite learning content within an academic program. In this symposium, presentations will be welcomed from CURE practitioners teaching chemistry and biochemistry laboratory courses at introductory and upper levels to share effective practices in CURE development, implementation, and assessment.	College
Teaching in the chemistry laboratory: Beyond confirmatory experiences	David J Styers-Barnett	1. Chemistry, University of Indianapolis, Indianapolis, IN, United States.	Symposium Description: This symposium looks at innovative and effective experiments conducted at all levels of the college chemistry curriculum. Presentations will describe labs, projects, or curricular structures that seek to give students appropriate experiences in the practice of chemistry.	College

Incorporating the maker movement into chemical education	Robert J LeSuer	1. Chemistry, The College at Brockport, SUNY, Brockport, NY, United States.	Symposium Description: The Maker Movement is a term typically used for do-it-yourself (DIY) or do-it-with-others (DIWO) technology enthusiasts who develop unique products and solutions often with inexpensive or re-used materials and limited or constrained resources. In addition to fulfilling a number of Next Generation Science Standard criteria, Maker Movement projects can lead to unique and innovative scientific instrumentation and educational opportunities. A number of projects, such as spectrometers, optical benches and fluid delivery systems, are already available in the chemical education literature. Projects often involve knowledge from various content areas such as digital fabrication (e.g. 3D printing), electronics, and programming, which can make integration of the Maker Movement into the classroom challenging for the uninitiated. This symposium will focus on projects and ideas that newcomers to the Maker Movement can incorporate into the Chemistry classroom. Topics will include project ideas, lessons learned and guidance on how to leverage the vast wealth of information already available to instructors.	College, High School
Integrating green chemistry and sustainability into chemistry education	Loyd Bastin	1. Widener University, Chester, PA, United States. 2. Chemistry, University of Toronto, Toronto, ON, Canada. 3. Green Mountain College, Poultney, VT, United States.	Symposium Description: This symposium will highlight the incorporation of green chemistry and sustainability principles throughout the chemistry curriculum as well as through co-curricular activities such as clubs, organizations and service-learning opportunities. The focus will be on green chemistry and sustainability materials and models rooted in the Twelve Principles of Green Chemistry that are designed to educate high school, community college, four year college and graduate students. These materials will include classroom teaching modules/courses, learning methods, educational research, laboratory experiments and experiences, and the integration of toxicology into the chemistry curriculum.	College, High School
When curricular change and transformed teaching do not go according to plan	Julia Chamberlain	1. Chemistry, University of California Davis, Davis, CA, United States.	Symposium Description: Transforming teaching practices and shifting institutional norms takes time and energy. While models for successful change exist, there is also much to be learned from instances where efforts have not gone according to plan. In this symposium, college and university faculty are invited to share what worked, what failed, and most importantly, lessons learned for future implementations of large-scale teaching transformation and curricular change projects.	College
Learning through peer review: Using evaluation practices to foster deep understanding and professional skills	Breeyawn Lybbert	1. Chemistry, University of Wisconsin, Green Bay - Manitowoc Campus, Manitowoc, WI, United States. 2. Chemistry and Biochemistry, UCLA, Los Angeles, CA, United States.	Symposium Description: Peer review is a powerful tool that can be used in the chemistry classroom (at all levels) to foster students' deep understanding of chemistry content. In the process, peer review also develops the critical thinking skills and analysis of writing expected in an ACS-approved BS degree and practicing chemistry professionals. This symposium is designed to allow educators the opportunity to share how they use peer review as a learning tool for chemistry content and for the professional development of their students.	College, High School

Preparing students for success in organic chemistry	Joseph Houck	1. Department of Chemistry, Penn State University, State College, PA, United States. 2. Chemistry Department, York College of Pennsylvania, York, PA, United States.	Symposium Description: Organic chemistry can be a challenging subject for college sophomores to master, particularly those who anticipate pursuing a career in medicine--and may not necessarily be excited about chemistry! Given the diversity of students engaging with the organic chemistry curriculum and the range of learning goals faculty establish for students, this session will highlight effective techniques used to improve student success in organic chemistry. These applications may exist in a variety of settings, including but not limited to course preparation (i.e. Gen Chem II scaffolding, pre-course assignments, etc.) and course enhancements (active learning, peer instruction, specialized tutoring, etc.).	College, High School
Innovations, challenges, and practices in large-enrollment laboratory courses	Katie A. M. Gesmundo	1. Chemistry, Northwestern University, Evanston, IL, United States.	Symposium Description: Large-enrollment laboratory courses face unique challenges in administration, pedagogy, and assessment. As the number of students approaches or exceeds 100 people, the faculty and staff administrating these labs face similar challenges. This symposium aims to provide a space for the directors of large laboratory courses to share their creative approaches to laboratory curriculum, structure, instruction, and execution of their courses. Discussions of the successful implementation of new ideas, as well as lessons learned from not-so-successful ones, are welcome.	College
Putting CER into practice: Using chemistry education research to improve student learning experiences	Jessica R Vandenplas	1. Department of Chemistry, Grand Valley State University, Wyoming, MI, United States. 2. Western Washington University, Bellingham, WA, United States.	Symposium Description: The results of chemistry education research provide a significant resource to inform teaching strategies and the design of instructional materials at both the high school and undergraduate levels. The goal of this symposium is to provide a forum for instructors wishing to learn about, adapt, and incorporate evidence-based materials and teaching strategies into their courses, with the goal of creating more effective learning environments. Presentations are expected to demonstrate intersections between chemical education research and instructional practices. We encourage a wide range of presentations from describing how the results of a chemical education research project have informed instructional practices, to challenges in implementing a research-based strategy or curriculum, to collaborations between researchers and instructors. Paired submissions are welcome in this symposium. Linked talks by different presenters may include one talk presenting the design and results of a chemistry education research project, while the second talk describes how the research informed changes to classroom practice. Please indicate paired talks in the notes to organizers. This symposium is sponsored by the DivChed Chemistry Education Research Committee.	College, High School, Middle School

Using manipulatives, modeling and movement to help students visual particulate behavior	Anne Schmidt	1. Science , Bay Port High School, Green Bay, WI, United States.	Symposium Description: This symposium will focus on using hands-on manipulatives, digital modeling, or the use of student physical movement to make connections between macroscopic observations of chemical or physical phenomena and what is happening at the particulate/molecular scale of that phenomena. Each presentation will focus on using particulate representations (with manipulatives, modeling or movement) to help students in visualizing “microscopically” those chemical or physical changes that they are seeing on the macroscopic scale. This visualization should correlate to students developing a better understanding of chemistry and the ability to craft well written or spoken explanations of the chemical or physical properties and principles that they are learning about in the classroom or laboratory.	High School, Middle School
Scientific graphs and figures: A component of the "symbolic" corner of Johnstone's triangle	Arlene Ann Russell	1. Chemistry and Biochemistry, UCLA, Los Angeles, CA, United States.	Symposium Description: Edward Tufte's 1983 book The Visual Display of Quantitative Information eloquently articulated both the power and potential abuse of depicting numerical data in a different format. Graphing data and interpreting graphs have long been a mainstay of chemistry lab and lecture courses. Given the importance of graphical representations in science, it is critical that students possess the ability to construct appropriate graphs as well as the knowledge to interpret graphical data. As digital tools have evolved, the graphing process has become more automated, allowing for the increased use of visual representations of data sets. It seems timely, therefore, to consider how students and instructors are using graphs in the modern classroom. This symposium will explore current strategies used to teach students how to accurately prepare informative graphs as well as how students integrate graphical invormation into their understanding of the macroscopic, microscopic, and symbolic.	College, High School
Encoiling research and practice to understand and improve inorganic chemistry education	Justin M Pratt	1. Chemistry, University of South Florida, Tampa, FL, United States. 2. Dept of Chem, Hope College, Holland, MI, United States.	Symposium Description: The diversity of undergraduate inorganic chemistry courses in the U.S. is a reflection of the breadth of the inorganic field, the relative autonomy of inorganic instructors, and the many ways that courses emerged and were integrated into chemistry curricula at different institutions. This diversity and autonomy can open doors to pedagogical innovation, yet present challenges to studying teaching and learning in these many contexts and disseminating findings outside individual institutions. The goals of this symposium are (1) to provide a forum for inorganic chemistry educators to share their efforts to develop, adapt, and/or adopt evidence-based materials and teaching strategies in undergraduate inorganic chemistry courses, and (2) for education researchers to describe what has been learned from studying inorganic chemistry teaching and learning. Submitted talks should express how educational research has informed classroom practice or how classroom practice has informed education research. This symposium is organized and supported by the Interactive Online Network of Inorganic Chemists (IONiC).	College

Digital laboratory platforms: Pragmatic benefits and drawbacks	Eric Malina	1. Chemistry, University of Nebraska-Lincoln, Lincoln, NE, United States.	Symposium Description: The educational environment is rapidly moving into digital platforms: homework, textbooks, course management systems. The development of digital platforms for use in the teaching lab setting is relatively new compared to these other platforms. This symposium will provide an opportunity to share experiences with digital lab platforms including what was worked well and what has not worked well (a lot can be learned from what has not worked well). Digital lab platforms can cover all aspects of the teaching lab including, but not limited to, prelab assignments, lab instructions, data collection, data analysis, report writing, and/or TA management.	College
Closing the assessment loop with part-time faculty	Kathleen Kolbet	1. Truckee Meadows Comm College, Reno, NV, United States.	Symposium Description: We have all been collecting assessment data and adjusting our teaching based on that data for our own courses. However, with many campuses employing larger numbers of part-time or adjunct faculty, how do we encourage those faculty to not only take assessment seriously but also apply the results to their own courses? Presenters are invited to share their experiences not only as full-time faculty organizing such efforts within their own departments but also as part-time/adjunct faculty who have participated in closing the loop.	College, General Audience
Making the connection is paramount: Two-year to four-year transfer initiatives	Laura J Anna	1. Department of Chemistry, Montgomery College, Rockville, MD, United States. 2. Chemistry, Metropolitan State University of Denver, Denver, CO, United States. 3. Chemistry, Northeastern Illinois University, Chicago, IL, United States.	Symposium Description: Nearly half of all undergraduate students enroll in a two-year college at some point in their educational career and many STEM students start their degree by completing introductory chemistry courses at a two-year college. The educational pathway of these students is often complex and non-linear towards transfer to and completion of a four-year degree program. These non-traditional pathways present unique opportunities and challenges in and out of the classroom for the educators that serve this important and diverse group of students. This symposium will explore how two-year and four-year institutions are partnering to serve students starting chemistry studies at two-year colleges. Chemical educators and administrators from two and four-year institutions are invited to share initiatives at two-year colleges and collaborations or partnerships between two-year and four-year institutions that promote successful transfer and/or degree completion for chemistry students in two-year college programs.	College

Reimagining chemistry education: Integrating systems thinking into green and sustainable chemistry education	Natalie O'Neil	1. Department of Chemistry, University of York, Heslington, York, United Kingdom. 2. Beyond Benign, Wilmington, MA, United States.	Symposium Description: While there have been multiple calls to integrate systems thinking into chemistry education, less attention has been paid to the practical implementation of systems thinking into chemistry courses and classrooms. This symposium will outline new approaches for the implementation of teaching and learning curricular materials to facilitate systems thinking within the context of green and sustainable chemistry education. Particular attention will be focused on using the former to address emerging global challenges such as those outlined via the United Nations Sustainable Development Goals and Planetary Boundary Framework. Approaches will be presented for implementation at the pre-university-level, university-level and beyond to include examples from activities, demonstrations and laboratory experiments to whole program-level and cross-institutional/international partnerships. While integration within chemistry programs will form the emphasis of the symposium, application in related disciplines such as biochemistry, pharmacy and others will be outlined.	College, High School, Middle School, General Audience
Best practices for teaching chemical nomenclature, terminology, and symbols	Timothy M. Trygstad	1. Chemistry, The College of Saint Scholastica, Duluth, MN, United States. 2. Science, Rye High School, Rye, NY, United States.	Symposium Description: Would you like to gain insight into how other chemistry teachers approach the challenge of teaching 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 symposium will focus on best practices for teaching chemical nomenclature, terminology, and symbols and is a compliment to both the workshop on Best Practices for Teaching Chemical Nomenclature, Terminology, and Symbols: Organic Chemistry and the workshop on Best Practices for Teaching Chemical Nomenclature, Terminology, and Symbols: Inorganic Chemistry. This symposium is supported and organized in part by the American Chemical Society's Committee on Nomenclature, Terminology, & Symbols.	College, High School, General Audience
Exploring implementation of Peer-Led Team Learning and its outcomes	Kathleen Jeffery | Christopher Bauer | Scott E. Lewi	1. Chemistry Dept., University of South Florida, Tampa, FL, United States. 2. Chemistry Dept, University of New Hampshire, Durham, NH, United States. 3. Chemistry Dept., University of South Florida, Tampa, FL, United States.	Symposium Description: Peer-Led Team Learning (PLTL) is a national initiative to promote active learning in STEM classes through the use of peer leaders, which are students who have successfully completed a course that return to lead students in small groups. This symposium aims to highlight diverse outcomes that result from enacting PLTL or other forms of peer-supported instruction, and how these outcomes support the continued development of such programs. Additionally, this symposium explores efforts to initiate or sustain PLTL in the chemistry curriculum. Given the potential for PLTL to have a substantive impact on the experiences of students, peer leaders, and/or faculty members, the symposium welcomes presentations that employ any methodological approach. The symposium will include a discussion dedicated to initiating, developing, and sustaining Peer-Led Team Learning.	College

Linking lecture and lab: Helping students make explicit connections between the classroom and the laboratory	Kathryn D Kloepper	1. Chemistry, Mercer University, Macon, GA, United States.	Symposium Description: Undergraduate chemistry courses may be entirely lecture based or may be entirely laboratory based, but many courses, especially those at the introductory level, exist on the spectrum between these two extremes, including both traditional classroom time and an exploratory laboratory experience. Since many programs lack the physical space to teach these courses as a studio experience, we often must present material separately in both a traditional classroom and in a teaching laboratory, creating two distinct experiences for our students. This may be compounded further at institutions where the laboratory and lecture may be distinct courses taught by different instructors with little enrollment overlap between sections. How can we help students integrate their laboratory experiences with material presented in lecture? Does the separation of these experiences lead students to approach them differently? Do they change their study skills in ways that limit their overall learning of the material? This symposium seeks to identify effective teaching strategies and best practices for the integration of student experiences in the laboratory and in the classroom. Both formal and informal methods of promoting integration are of interest. Submissions from all levels and topics of chemistry courses, including non-majors and high school courses, are encouraged.	College, High School, General Audience
Oral communication in the chemistry curriculum	Garland Crawford	1. Chemistry, Mercer University, Macon, GA, United States.	Symposium Description: This symposium is a follow up to a session from 2018, and we hope to further explore approaches for integrating oral communication in chemistry courses as a way to enhance technical expertise and to teach a professional competency. The goal of this symposium is to discuss best practices for the development of oral communication skills in chemistry. Both formal and informal methods of promoting student oral communication are of interest. What are the best ways to help our students develop this important transferable skill? How does one give constructive feedback? How do oral communication experiences help with student learning, engagement, and metacognition? What role can the chemistry lab, both instructional and research, play in helping students improve as oral communicators? How can these skills be used to promote student-student interactions? What other benefits (and pitfalls) result from getting students talking? Speakers are encouraged to address how they answer some of these questions but may also explore additional areas. Submissions from all levels of chemistry courses, including non-majors and high school courses, are encouraged.	College, High School, General Audience

Technology Integration in Chemistry Education & Research (TICER)	Tanya Gupta	1. Chemistry & Biochemistry, South Dakota State University, Brookings, SD, United States.	Symposium Description: TICER symposium invites papers from instructors, curriculum developers, chemical education researchers and other contributors who have a keen interest in integrating technology in classroom and laboratory teaching, and for chemistry education research. The symposium will focus on applications of technology for teaching and learning, the impact of technology on student learning, laboratory practices, advancing student skills, and student retention. The symposium also seeks presentations that focus on recommendations for implementing various technologies in classroom (standalone or simultaneously with other teaching approaches) and for research purposes. The papers will involve a range of presentations that include but are not limited to Simulations, Visualizations, Games-Based Learning, Assessments, YouTube videos, Handheld and mobile devices, Augmented and Virtual Reality applications, Interactive Whiteboard, Student Response Systems, Student created media (podcasts, videos), Collaborative Tools (Wikis, Google Docs etc), Social media (Facebook, Twitter etc), databases, smart devices, and online Open Education Resources (OERs).	College, High School, Middle School, General Audience
Course-embedded research experiences in the first and second year curriculum	Nichole L Powell	1. Chemistry Department, Oxford College of Emory University, Oxford, GA, United States.	Symposium Description: Research experiences allow students to practice being scientists; to be exposed to the way chemists approach problems, how knowledge is acquired, and the use of evidence to support that knowledge. The ability to embrace uncertainty, not knowing the “right” answer, is an integral aspect of this experience, but it is often a difficult process for freshmen and sophomores. This symposium invites discussion on the use of research projects in the first and second year laboratory curriculum. Presentations should include important aspects of the successful incorporation of research projects into the curriculum as well as the challenges faced in the development of the program. The inclusion of tools used in the assessment of student gains related to the development of scientific inquiry skills is also encouraged.	College

Evidence-based Instructional practices: Flipped classrooms and inquiry-based teaching strategies	MaryKay Orgill	1. Chemistry Department, Mail Stop 4003, University of Nevada, Las Vegas, Las Vegas, NV, United States. 2. Chemistry, Portland Community College, Vancouver, WA, United States. 3. Department of Chemistry, University of New Hampshire, Durham, NH, United States. 4. Chemistry, East Carolina University, Greenville, NC, United States. 5. AACT, Washington, D.C., DC, United States.	Symposium Description: There are multiple types and communities of chemistry educators. Some of us are excellent teachers. Some of us are excellent educational researchers. Some of us are excellent providers of public outreach. Some of us teach in high schools, some in community colleges, some at universities (at both the undergraduate and graduate levels), and some in more informal venues like homes and museums. Each of us brings value to our understanding of how chemistry is taught and learned, and we can ALL learn from each other. This symposium is jointly sponsored by the Two-Year College Chemistry Consortium (2YC3), the American Association for Chemistry Teachers (AACT), the Chemistry Education Research Committee from the ACS Division of Chemical Education, and the American Chemical Society Committee on Education communities as an attempt to allow chemistry educators at all levels to learn from each other. There are many different instructional practices we can use to help our students learn chemistry. The most effective of these practices are supported by classroom- and/or research-based evidence. This symposium is meant to be a place for sharing those evidence-based practices: both the research that explains why they work and how to implement them in our classrooms. Presenters from high schools, community colleges, and universities will discuss, for example, how they use these techniques in their classrooms, ways to modify the techniques to meet the needs of learners from diverse backgrounds and with diverse abilities, ways to assess the impact of these techniques on student learning, or educational research supporting the use of the techniques. The inaugural sessions of this symposium will focus on two specific evidence-based instructional practices that allow students to engage directly in constructing their understanding of chemistry content: flipped classrooms and inquiry-based teaching strategies.	College, High School, Middle School, General Audience
Big 10 general chemistrylaboratories: Advances, innovations, and challenges	Eric Malina	1. Chemistry, University of Nebraska-Lincoln, Lincoln, NE, United States. 2. Chemistry, Penn State University, State College, PA, United States.	Symposium Description: This symposium will provide a forum for discussing the current state of the general chemistry labs at universities in the Big 10 Conference. Topics of discussion, while aimed at large, research-oriented chemistry departments, will be relevant to most any other size chemistry department. This symposium invites presentations that outline any innovative approach to teaching general chemistry labs (curriculum, new/novel laboratory activities, TA training or mentoring, facility management, etc.), whether successful or not. The organizers believe that a lot can be learned from innovations that work and those that don’t work as expected.	College

Communicating chemistry via social media	Clarissa Sorensen-Unruh	1. School of MSE, CNM Community College, Albuquerque, NM, United States. 2. University of York, York, United Kingdom.	Symposium Description: As of 2019, the number of daily active users on Facebook exceeded 1.59 billion and the number of monthly active users on Facebook exceeded 2.41 billion. On any given day, over half of its users log-on to the social networking site. The average user is connected to 80 community pages, groups and events, and posts about 90 pieces of content each month1. Approximately 72% of high school and 78% of college students spend time on Facebook, Twitter, Instagram, and other social media platforms each day2. Twitter's 326 million registered users will produce 500 million tweets per day3. Social media usage has not been widely adopted in scientific disciplines but is gaining traction as a means to communicate with peers and the public. Leading scientific societies are advocating for increased science communication by the science community as evidenced by recent articles in Science and Nature among others. With such ubiquitous use of social media platforms amongst students and the general public, utilization of these platforms by instructors in order to effectively communicate chemistry is becoming increasingly popular and important. In fact, recent studies and classroom implementations have shown that social media can be used as a feedback mechanism to empower students to create and share new knowledge with instructors, their peers, and the world. The exciting possibilities surrounding the use of social media to facilitate international chemistry education has prompted the collaboration of the Biennial Conference Committee, DivCHED in the USA with the RSC Tertiary Education Group in the UK. This interactive symposium will feature contributions from practitioners who are utilizing social media platforms to engage and educate students, scientific professionals, and the general public about chemistry. 1Facebook: https://newsroom.fb.com/company-info/; Van Eperen, L. and Marincola, F.M. (2011) How scientists use social media to communicate their research. Journal of Translational Medicine 9, 199. 2http://www.technicianonline.com/opinion/article_d1142b70-5a92-11e5-86b4-cb7c98a6e45f.html 3https://www.omnicoreagency.com/twitter-statistics/	General Audience
Persistence in STEM: What can we do to support students?	Sachel Villafane-Garcia	1. Chemistry and Biochemistry, California State University, Fullerton, Fullerton, CA, United States.	Symposium Description: Students' persistence in STEM is of great concern for educators and researchers. In this symposium, we are going to explore different activities educators and researchers are pursing in classrooms and colleges to support students' persistence in STEM. These activities include, but not are limited to research studies of factors that affect students' persistence and results from programs implemented at the university or college level to support students. We invite researchers and practitioners to share their findings with the community.	College, High School, Middle School, General Audience

Technology Enhanced Learning (TEL) in college chemistry courses	Mark Blaser	1. Chemistry, Shasta College, Redding, CA, United States.	Symposium Description: In a rapidly changing and increasingly technological world, instructional approaches and methods are being transformed alongside other aspects of modern life. Technology Enhanced Learning (TEL) offers many ways to improve student engagement and increase student learning. These include use of computer-based educational technology, learning with technology using cognitive tools, technology-enhanced classrooms, data collection technologies, and much more. Technology can be used to: facilitate innovate teaching methods; provide an integrated, interactive learning environment; and leverage data to improve teaching. By combining a teacher's practical experience, an understanding of learning science, and the appropriate use of technological tools, student learning outcomes and experiences can be improved. This symposium will feature presentations on technology-enhanced learning approaches that instructors have found to offer instructional and/or learning benefits in their college chemistry courses.	College
Community-based learning in chemistry: implementation, best practices, and evaluation	Yi Jin Kim Gorske	1. Sciences, Saint Joseph's College, Standish, ME, United States.	Symposium Description: Evidence indicates that community-based learning (CBL), or service-learning (SL), not only enhances feelings of engagement in the community, but also increases confidence and competence in the sciences. However, the logistics of implementing CBL can be imposing, and there is no one-size-fits-all set of best practices for the design, scaffolding, and evaluation of CBL activities. This symposium seeks to convene current and aspiring practitioners of CBL in chemistry to share ideas on all aspects of CBL, such as initiating and sustaining partnerships with community organizations, designing activities (from ideation to supporting and assessing students), and evaluating the impact on students and partners.	College, High School, Middle School, General Audience
Incorporating the human element into a chemistry course	Kathleen Hess	1. Chemistry, College of DuPage, Glen Ellyn, IL, United States.	Symposium Description: How can we introduce students to the scientists that discovered important molecules or chemical concepts that we teach in our chemistry courses? Giving students the opportunity to learn about the lives of scientists is a way to humanize and bring social awareness to a chemistry course. Choosing scientists from historically underrepresented groups (HUGs) or female scientists can provide role models for students. This symposium welcomes presentations that focus on creative ways to introduce the lives of scientists who discovered a specific molecule or an important chemical concept into a chemistry course. The presentation can detail efforts within a traditional chemistry course or the creation of a completely new course.	College, High School

Writing peer review in the general chemistry laboratories	Graeme R. A. Wyllie	1. Chemistry, Concordia College, Moorhead, MN, United States.	Symposium Description: The peer review process is a critcial step in scientific publishing and should be viewed not simply as a hurdle to overcome but rather an opportunity to gather feedback from a like-minded audience and through the process, create a better paper or similar work. Writing experimental reports is a traditional part of many general chemistry laboratory programs and we hope that through the process, our students gain relevant skills that will aid them in later classes. Feedback is commonly provided by instructors or teaching assistants though this cannot technically count as peer review. This symposium is designed to provide an opportunity for sharing strategies, methods, rubrics and any other relevant work on implementing peer review in the general chemistry laboratories. Reports of what works, what maybe does not work, how such peer review is assessed in terms of graded assignments or benefit to students, the hope is the symposium will provide many opportunities to share our experiences in this topic.	College, High School
Faculty experience in developing a course-based undergraduate research experience (CURE)	Kuang-Chiu Joseph Ho	1. Chemistry & Chemical Biology, Univ of New Mexico MSC 03-2060, Albuquerque, NM, United States. 2. Division of Math, Engineering, and Science, University of New Mexico - Valencia Campus, Albuquerque, NM, United States.	Symposium Description: Undergraduate research (UR) has been recognized as a high impact practice to improve student content mastery, retention, and graduation rates in STEM fields. Compared to an independent, mentored research experience, a course-based undergraduate research experience (CURE) can serve a larger population of students without requiring an extensive additional time commitment from students outside the classroom or lab. CUREs in the general education courses also open up the diversity of students served by introducing involvement in research earlier in their careers. We invite presentations that discuss important aspects of the development, assessment, and/or benefits of CUREs on student learning, as well as the challenges faculty face in teaching and developing these courses. Presentations are not limited to CUREs that provide full or authentic research experiences, but can also include CUREs that prepare students for a full research experience (pre-CURE) and only provide particular elements of a full research experience. Discussion of CUREs for lecture courses are particularly encouraged.	College, High School, General Audience
The affective domain in chemistry education: How research on affective and cognitive factors has evolved and shaped student learning	Shalini Srinivasan	1. Chemistry and Biochemistry, California State University, Fullerton, Fullerton, CA, United States. 2. Chemistry and Biochemistry, Metropolitan State University of Denver, Denver, CO, United States.	Symposium Description: Pedagogical practices, focused on active learning, have evolved to facilitate greater student engagement in classrooms, better performance and retention in chemistry courses. However, as qualitative and quantitative results have demonstrated, regardless of ability, students' interests, motivations, and beliefs about themselves have a far-reaching impact on their performance and persistence in chemistry courses and in their intended majors. This symposium, targeted at the college level, will highlight the influence of affective factors on cognitive outcomes and retention. Researchers and practitioners using techniques to assess and evaluate affective dimensions in the undergraduate chemistry classroom are welcome to contribute to this symposium.	College, General Audience

Differentiation strategies in the high school chemistry classroom	Johanna Rae Brown	1. Science, Pullman High School, West Lafayette, ID, United States.	Symposium Description: The purpose of this symposium is to showcase multiple strategies of differentiation and universal design in chemistry classrooms.	High School
Addressing underrepresented groups in STEM	Daniel Cruz-Ramirez de Arellano	1. Chemistry, University of South Florida, Tampa, FL, United States. 2. Chemistry, Purdue University, Lafayette, IN, United States.	Symposium Description: Addressing the underrepresentation of many populations in Science, Technology, Engineering, and Mathematics (STEM) academic majors and careers is one of the great challenges of being a 21st century science educator. There are many components of an individual's identity that could make them a part of one of these underrepresented groups. These components of personal and social identity include (but are not limited to): gender identity and expression, racial and ethnic identity, sexual orientation, being an individual with a disability, and others. The issues faced by these underrepresented groups in academic environments are often multi-faceted and interface with educational systems that sometimes operate to perpetuate inequality along the lines of these identities. This symposium, open to researchers and practitioners, aims to address these issues with paper submissions that characterize the experiences of these populations, describe curricular interventions that help increase representation, share successful programs and best practices that target these populations, share interventions for social justice, and any other research or educational endeavor that somehow addresses underrepresented groups in STEM.	College, High School, Middle School, General Audience
Engaging students in analytical chemistry	Lynetta Mier	1. Chemistry, Regis University, Denver, CO, United States. 2. Biological and Physical Sciences, Montana State University Billings, Billings, MT, United States.	Symposium Description: This symposium welcomes presentations covering curriculum and laboratory advancements in analytical chemistry, instrumental analysis, and quantitative analysis. All types of courses, universities, and programs are invited to present.	College
Diversity, equity, and inclusion initiatives in STEM - Programming to ensure equal access to careers in the sciences	April Marchetti	1. Randolph Macon Colg, Ashland, VA, United States.	Symposium Description: This symposium highlights innovative programming designed to provide equal access to STEM education to underrepresented groups, with particular emphasis on community and academic partnerships, initiatives to increase recruitment and retention of diverse STEM populations, programs designed to enhance culturally-sensitive STEM instruction, and endeavors to preserve the STEM pipeline for underrepresented groups.	College, High School, Middle School

Chemistry Education in the Emerging World of IOT, Raspberry Pis, Arduinos and Maker Space Labs	Robert E Belford	1. Univ of Arkansas at Little Rck, Little Rock, AR, United States. 2. Basic Sciences, St. Louis College of Pharmacy, St. Louis, MO, United States.	Symposium Description: The Internet of Things (IoT) is the largest and fastest growing segment of the Internet with over 22 billion devices in 2018. Inexpensive single board microprocessors and microcontrollers like the Raspberry Pi and Arduino have opened-up a wide range of opportunities for chemical educators to bring into the curriculum emerging interdisciplinary skills and knowledge that will be of great value to tomorrow's chemist, who will work in future labs that will be full of smart devices. Our goal with this symposium is to bring together pioneers, innovators and early adopters in IoT technologies to share in their experiences and learn from each other. We are looking for contributions across the spectrum of applications. These could be laboratory activities like the building of a spectrometer or automated titration devices, or pedagogic activities teaching problem solving skills as students trouble shoot code and sensor circuits. Presentations on high school robotics clubs, IoT enabled citizen science projects and innovative applications like vertical farming are encouraged. How these devices can be used to bring programming and big data analytics like machine learning into the chemistry curriculum are also desired, as well as novel applications like offline access to online content through Internet-in-a-Box devices. This symposium is sponsored by the CHED Committee on Computers in Chemical Education (CCCE) and will include an open panel discussion on how the CCCE can support K12 through university faculty who wish to use these technologies in their classrooms, especially faculty with no programming experience.	College, High School, Middle School, General Audience
Teaching students in large enrollment chemistry classes	Alicia Paterno	1. Chemistry & Biochemistry, Duquesne University, Sarver, PA, United States.	Symposium Description: This symposium will discuss successes, trials, and tribulations in the large chemistry classroom. Topics may include course management strategies, technology, mentoring teaching assistants, and other topics that pertain to teaching large classes. A desired result of this symposium is the formation of a support network of faculty who teach large classes at different colleges and universities.	College
Present and future directions in organic chemistry laboratory courses	Noel M Paul | Christopher S Callam	1. The Ohio State University, Columbus, OH, United States.	Symposium Description: This symposium seeks to foster a discussion of innovations in course content and delivery by bringing together chemical educators who instruct undergraduate organic chemistry laboratories. Presenters are invited to offer their perspectives on the development of new experiments or teaching modules, the utilization of digital resources for visualization, problem solving, or scientific recordkeeping, or strategies to streamline the learning experience. Advancements in the realization of large enrollment laboratory courses are of special interest, as are advancements that may be scalable to that environment.	College
Engaging the future: Teaching teacher candidates	Lori Bolyard	1. University of Indianapolis, Indianapolis, IN, United States.	Symposium Description: This symposium will focus on courses, laboratories, class activities and other resources utilized to teach science to future high school, middle school, elementary and/or preschool teachers.	College, High School, Middle School

Authentic practices and experiences in the chemistry curriculum	Anthony Chase | Pratibha Varma-Nelson	1. Occupational Therapy, IUPUI, Whitestown, IN, United States. 2. Chemistry and Chemical Biology, IUPUI, Indianapolis, IN, United States.	Symposium Description: This symposium presents an opportunity to expand a large and still growing field of CER research in authentic instructional methods. Course-based Undergraduate Research Experiences, Undergraduate Research Experiences, internships, and leadership programs and other methods have highlighted the usefulness of instruction focused on authentic methodologies. Students receiving authentic practice within their academic careers proves as invaluable to their professional preparedness. This symposium will focus specifically on the authentic experiences within chemistry courses, programs, and activities. Presentations in this symposium will focus on the impact of instructional methods that include authentic strategies such as those mentioned above and their subsequent impacts on students and their professional preparedness. This series of presentations will inform the CER community on the status of this line of research as well as provide feedback others working in the field. Submissions for this symposium will be considered based upon their relation to the previous work done in authentic methods as well as novelty of implementations (different context, changes in details of the intervention, different assessment procedures, etc.)	College
Chemistry and community outreach: Events and ideas	Paul M Morgan	1. Chemistry, Butler University, Carmel, IN, United States. 2. Chemistry, University of Wisconsin Whitewater, Cambridge, WI, United States.	Symposium Description: This symposium is a place to share experiences and gain insight into chemistry and STEM outreach planning and presentation, and the use of outreach as a teaching tool. Talks within the symposium will address ideas, events, and experiences related to community outreach. Example topics could include but are not limited to: successful and unique outreach events; logistics and planning issues; development of college/university learning experiences centered on outreach events; safety; the assessment of outreach events. The content of presentations should adhere to the American Chemical Society's safety protocol. The performance of demonstrations will not be possible during this symposium.	College, High School, General Audience
Integrated 1st year science courses: Partnering with other STEM disciplines to transform introductory chemistry.	William Case	1. Biology, Chemistry & Physics, Converse College, Spartanburg, SC, United States.	Symposium Description: Students preparing for careers in science must learn to discuss connections between different disciplines and be able to propose how the tools and lenses of different disciplines can be used in novel ways. Providing our students with integrated curricular opportunities will ensure that such goals are met and will help prepare a pipeline of future scientists with the skills and knowledge base needed to tackle "big problems" in science. This symposium will highlight successful models of teaching general chemistry from an interdisciplinary perspective through parternships with colleagues in other STEM disciplines. The symposium will provide examples of team taught courses in which traditional general chemistry content is taught alongside content in other STEM related areas, with the goal of enhancing student understanding through application and integration.	College, High School

Overarching undergraduate curriculum reform	Douglas Robert Mulford	1. Emory University, Atlanta, GA, United States. 2. Chemistry Department, Oxford College of Emory University, Oxford, GA, United States.	Symposium Description: In the past few years there have been several institutions that have committed to innovative reform across the undergraduate chemistry curriculum. This symposium focuses on those programs seeking to make changes across multiple courses or labs as opposed to single course reform. Talks focusing on challenges to reform and implementation as well as the results of reform are welcomed. Reform efforts in progress are welcomed in addition to those that have completed rollout. Presenters are encouraged to highlight assessment efforts and plans.	College, High School, General Audience
Engaging students in analytical chemistry	Susan Plummer Oxley	1. Chemistry and Biochemistry, St. Mary's University, San Antonio, TX, United States.	Symposium Description: This symposium focuses of the development and application of student engagement strategies in analytical chemistry courses. Presentations may include activities in the classroom or the laboratory, incorporation of active learning strategies, or use of current scientific literature. Topics ranging from individual activities to broader pedagogical approaches are welcomed.	College
Chemistry teacher education	Sarah B. Boesdorfer	1. Department of Chemistry, Illinois State University , Normal, IL, United States.	Symposium Description: Teachers have a huge impact on students' chemistry education. They encourage and guide students, determine the content taught in their classes and in what way. Even when influenced by administrators, reform movements, colleagues, and their own experiences, chemistry teachers are the main link between students and chemistry education. This symposium intends to provide a space to share, explore, and analyze methods in which educators, researchers, and programs are educating chemistry teachers to develop their teaching practices. Chemistry teachers are included in this group as well as they also work to improve their own practice and their colleagues' practice. This symposium welcomes submissions which discuss research-informed or supported initiatives, programs, activities, and theory relating to educating chemistry teachers at all educational levels and years of experience.	College, High School, Middle School, General Audience
Adapting specifications grading to help bolster student performance across the chemistry curriculum.	Evonne A Baldauff	1. Chem Dept Stewart Hall, Waynesburg University, Waynesburg, PA, United States. 2. Chemistry, Waynesburg University, Morgantown, WV, United States. 3. Chemsitry, St. Edward's University, Austin, TX, United States.	Symposium Description: Utilizing Specifications (Specs) Grading in the chemistry curriculum can benefit student learning and retention. This method of assessment provides a detailed structure or method of evaluation to better assist students in understanding what is required for success in a course. Specs Grading can provide students with a clearer pathway to achieve learning objectives as well as a greater sense of ownership in their education. This symposium seeks to identify and share unique adaptations of Specs Grading that are being incorporated at all levels of chemistry courses. Outcomes describing the impact on student progress are of particular interest.	College, High School

Prefessional development for laboratory teaching assistants	Jennifer Monahan	1. Chemistry, Saint Louis University, Saint Louis, MO, United States.	Symposium Description: The goal of this symposium is to share best practices in training Laboratory Teaching Assistants (Lab TAs). Lab TAs are an integral part of chemistry education in a college setting but not every college TA has the interest or natural skills to be a good teacher. Training Lab TAs to be both professional and scientifically competent is an ongoing task. Presentations should focus on evidence based best practices. Talks can relate to pre-semester training or weekly experimental meetings. Presenters are invited to share pedagogical training ideas and how the approach has helped Lab TAs and/or students become better scientists. Do you have any examples of small (or large) changes that gave big payoffs in the quality of the laboratory course? Can TA efficiency be improved without sacrificing quality? Have you developed balancing techniques to deal with multiple TAs of varying backgrounds?	College
International Chemistry: Transnational degree programmes – how can these degrees be successfully delivered in another country in your own language?	Julie Hyde	1. Chemistry, The University of Sheffield, Sheffield, United Kingdom.	Symposium Description: This Symposia is focussed on TransNationalEducation (TNE), educational programmes that are delivered in a country other than the country in which the awarding institution is based. When the qualification is a degree, they are referred to as TransNationalDegree (TND) Programmes. Teaching chemistry in your native language at a University in a different speaking country is the symposia focus. Sheffield (UK) has delivered a (3+1) BSc Chemistry degree since 2011 in English linked with Nanjing Technical University (NJTech) in China. The students spend the first three years in China taught by a “Flying Faculty” of Sheffield academic staff who deliver the academic lecture modules, I deliver the corresponding laboratory programme during 3 months each year. Successful completion of the first three years means the students will join the Level 3 group at Sheffield for the final year of their degree after which they graduate with a BSc from both institutions, to date 150 students have graduated from this joint programme. Do you deliver a joint programme, how successful is your programme? Do you want to set up a TND in another country? I am keen for other Universities from across the globe to come together and present about what they have delivered, to share ideas, outcomes and experiences. My book chapter also details valuable guidance.1 1Hyde, J. (2019), “Design of a three year laboratory programme for international delivery”, in Seery, M. K. and Mc Donnell, C. (Eds.), Teaching Chemistry in Higher Education: A Festschrift in Honour of Professor Tina Overton, Creathach Press, Dublin, pp 405-420.	College, High School, Middle School, General Audience
Inclusive excellence in chemistry	Paula Weiss	1. Chemistry, Oregon State University, Corvallis, OR, United States. 2. Center for Research on Lifelong STEM Learning, Oregon State University, Corvallis, OR, United States.	Symposium Description: As educators we are responsible for adopting classroom practices that create inclusive and culturally responsive learning spaces for students. This symposium will provide a forum for discussing ways to build capacity for inclusion and equitable opportunities to learn for all students in chemistry. This symposium invites presentations that describe models for faculty development and faculty experiences in course transformations.	College, High School, Middle School, General Audience

Engaging students online	Kristi Mock	1. University of Toledo , Toledo, OH, United States. 2. Institute for Teaching Excellence, York Technical College, Elgin, SC, United States.	Symposium Description: Science courses do not easily lend themselves to the online platform. As the push to offer online courses increases, we must find ways to help our students be successful in these nontraditional classrooms. Many of the teaching methods used in traditional classrooms are not available in an asynchronous online environment. Thus, we must be creative in the ways we involve the students with each other and the material. This symposium will look at the ways we are finding to encourage and engage our online learners.	College, High School
Teaching organic chemistry for biology and pre-med majors	Chelsea Gustafson	1. Natural Science Department, Oregon Institute of Technolgy, Wilsonville-Klamath Falls, OR, United States.	Symposium Description: The full year organic chemistry course has long been a rite of passage for biology majors and pre-medical professional programs. Given the wide breadth of biological and pre-medical sciences, including the recent expansion of areas such as molecular biology, chemical ecology, bioinformatics and computational biology, the traditional organic chemistry course with emphasis on synthetic pathways may not be the best approach for teaching organic chemistry to biology and pre-med students. As recommended by the Howard Hughes Medical Institute in 2008, highlighting the importance of structural organic chemistry concepts in the context of biological and medical sciences may better serve these students. Presenters are invited to discuss innovative approaches in teaching undergraduate organic chemistry to biology and health science students.	College
Diversity and inclusion in chemistry education research	Erin Saitta	1. University of Central Florida, Orlando , FL, United States.	Symposium Description: As national movements focus on broadening participation in chemistry as a way to advance science and diversify the workforce, there is a growing need to understand how the Chemistry Education Research field is defining and operationalizing diversity and inclusion in research design and analysis. This symposium provides a broad forum to discuss the advances, innovations, and challenges of researching underrepresented/under-served and/or marginalized populations involving but not limited to persons with disabilities, the LGBTQ+ community, and racial/ethnic minorities. We would like to move the conversation beyond what is being done in the classroom and focus specifically on areas related to chemistry education research. Submissions addressing the selection of frameworks & methodologies, mindfulness in defining populations, choosing interventions, and dissemination opportunities are of particular interest. Projects at any stage (from conception to completion) will be considered.	College

Authenticity and purpose when instilling the habits of mind of a chemist in self-regulated learners: How do you get students to want to learn how to teach themselves, and then do it?	Sylvia Rygiel Esjornson	1. Chemistry and Physics, Southwestern Oklahoma St U, Weatherford, OK, United States.	Symposium Description: Contributors to this symposium are invited to present and analyze mixed methods case studies of learning and teaching practices that illuminate the development of agency and efficacy in the learner who is studying chemistry. There is a subtle difference between “teaching yourself how to learn” and “learning how to teach yourself.” Participants are asked to explore this difference while describing learning activities they assign, and then discussing how the assignments incorporate student intention aligned with a purpose for learning chemistry. Presenters are asked to plan to present prepared remarks and then continue the session in order to brainstorm with other presenters and attendees. Colleagues considering participation in this symposium are invited to review the white paper “It’s a Gift: Disposed to Learn,” the work of Ruth Deakin Crick hosted on the corwin website or The Curriculum Journal Vol. 18, No. 2, June 2007, pp. 135 – 153 “Learning how to learn: the dynamic assessment of learning power,” Ruth Deakin Crick* Graduate School of Education, University of Bristol, UK. Crick observes, “The teachers themselves were the most important vehicles for development in their students of the seven dimensions of learning power.” Other theoretical frameworks of the learner or the learning process are also welcome. Do you persuade students to do their assignments mindfully and not reduce their learning opportunities to busy work? Please share some of your assignments with us and discuss your intentions and outcomes.	College, High School, Middle School, General Audience
Favorite half-hour lab experiments	George Lisensky	1. Beloit Colg, Beloit, WI, United States.	Symposium Description: Multi-week laboratory projects are great but some experiments are short and sweet. Perhaps you teach in a workshop format or do experiments during a class period. What is your favorite short lab? This could be something new, feature cutting edge research, be your take on a classic, an adaptation for time, a demonstration modified to be a hands-on laboratory experiment, an activity to introduce a topic, or a lab that is just fun. Lets share!	College, High School

Best practices in the use of peer mentors to facilitate active learning in undergraduate chemistry classrooms	Kuang-Chiu Joseph Ho	1. Chemistry & Chemical Biology, Univ of New Mexico MSC 03-2060, Albuquerque, NM, United States.	Symposium Description: Active learning pedagogies are widely accepted to produce gains in student retention and achievement and are being increasingly adopted by college-level chemistry instructors. Lower-division chemistry classes are often high enrollment and a potential barrier to instructors is how to facilitate activities in class with large numbers of students and just a single instructor. A solution to this problem comes through the use of near-peers who have taken and succeeded in the class and return to the class (for either course credit or money) to help facilitate active learning in the classroom. This symposium will focus on the practical aspects of using peer mentors in the classroom. Contributions are encouraged that describe different implementations of the peer mentor model, the training of the peer mentors, assessment of the model, lessons learned, as well as best practices for the use of peer mentors in the classroom. Submissions for this symposium will be considered based on their potential to inform the practice of instructors interested in or already implementing a peer model in their teaching. These models may include PLTL, PLGI, any other formal or informal models for use of peers to facilitate active learning.	College, General Audience
New methods in organic chemistry laboratory teaching	Marsha Grimminger	1. Chemistry - Natural Sciences, University of Pittsburgh at Johnstown, Johnstown, PA, United States.	Symposium Description: This symposium will highlight new experiments and methods used to teach sophomore level organic chemistry laboratory. Preference will be given to individuals who develop their own innovative labs to help students learn purification techniques, organic reactions, or classification with instrumentation. Presenters should describe their teaching goals, experimental details, and student assessment data.	College
Special projectsextending student's knowledge beyond the chemistry classroom	Carl Lawrence Aronson	1. Foundational Sciences, Texas A&M University Galveston, Bayou Vista, TX, United States.	Symposium Description: This symposium will highlight special student projects, such as chemistry based poster sessions and videos, assigned by faculty across the undergraduate chemistry curriculum. These unique projects significantly extend course coverage, bring important current scientific issues to the forefront of student inquiry, and significantly improve a student’s organization and presentation abilities, including the skills which are needed to take on task-focused team roles. The digital information age has rapidly pushed back the boundary walls of the undergraduate classroom past the academic building wherein chemistry lecture course sections are conventionally held. Personal smart electronic devices as well as both on-campus audiovisual studio production facilities, and high resolution wide-format printers were all considered rare and quite advanced just a decade ago. The current routine availability of these devices provide an entrée to sophisticated and polished student project presentations promptly embedding dynamic video, tailored audio, and exclusive photography.	College, High School, Middle School, General Audience
Takin' it to the streets: Chemistry beyond the classroom	Michael A Morgan	1. Science, Bravo Med Magnet High Schl, Redondo Beach, CA, United States.	Symposium Description: Chemistry education can take place in many forms and in many situations. Chemistry can be taught via the Chemistry Olympiad, Science Bowl, Ocean Bowl, Science Olympiad, Demonstration Outreach Programs, Chemistry Clubs, and many other activities that do not conform to the traditional classroom setting. Examples of these programs will be presented and discussed.	College, High School, Middle School, General Audience

Reconnecting chemistry to society: Illustrating the importance and relevance of chemistry	Ozcan Gulacar	1. Department of Chemistry, University of California-Davis, Davis, CA, United States. 2. Chemistry, Stanford University, Stanford, CA, United States. 3. University of Bremen, Bremen, Germany.	Symposium Description: Students often express challenges, anxiety, and frustration with chemistry because of the hurdles in understanding and applying content. This issue can be explained by relating it to the complexity of the topics introduced, students' ineffective study strategies, or their lack of prerequisites, but, meanwhile, it is important to note that chemistry classroom pedagogy has shifted from exploration and discovery to passive learning using traditional lecture formats and cookbook laboratories. Many instructors ignore the real-world applications that are full of mysteries in favor of covering abstract, mathematical, or theoretical chemical principles. Science courses, including general chemistry, have been isolated from the environmental and societal problems of the world. In parallel, retention rates in STEM fields have been decreasing, and there is now a growing need to increase both the quality and quantity of people in the scientific workforce. This symposium will explore the methods and approaches that help students overcome their anxieties, alleviate their frustration, and increase their success by emphasizing the relevance and importance of chemistry through lectures, assignments, and laboratory activities. Presentations will address questions such as "How does the integration of relevant topics into chemistry courses influence students' self-efficacy and attitudes toward chemistry?", "What student attributes are developed through the implementation of activities involving the discussion of socio-scientific issues?", and "How does this pedagogy improve students' understanding of content? These questions form the basis for many studies of which the findings are still relatively new and not widely disseminated. This symposium will focus on conveying those results to a larger audience and start new discussions, which could initiate further research projects.	College, High School, General Audience
Beyond the textbook special topics box: Contextualizing content in General Chemistry and Organic Chemistry courses to serve the dual needs of chemistry and life sciences majors.	Francis Michael Rossi	1. Chemistry, SUNY Cortland, Cortland, NY, United States.	Symposium Description: Although the vast majority of students enrolled in general chemistry and organic chemistry are majoring in the life sciences, these courses rarely include learning objectives that directly address the molecular underpinnings of biological processes. The biological context of chemical topics is generally limited to textbook special topics boxes and the occasional ad hoc end-of-chapter problem. Content in these courses has historically been contextualized to serve the minority of students who will obtain advanced degrees in chemistry. This session will explore the content needs of students majoring in the life sciences and how general chemistry and organic chemistry courses can appropriately serve non-majors without compromising the needs of chemistry majors.	College, General Audience

Computational modelling and simulation in the undergraduate chemistry classroom and laboratory	Carl Lawrence Aronson	1. Foundational Sciences, Texas A&M University Galveston, Bayou Vista, TX, United States.	Symposium Description: This symposium will present a variety of faculty generated computational modeling and virtual interactive simulation techniques specifically tailored for concise presentation along with concomitant student-friendly exercises toward significantly augmenting example problem scope for students. Techniques used including molecular modeling, thermodynamics modeling, kinetics modeling, and interactive virtual animated simulation of chemical reaction and analytical laboratory processes across the undergraduate chemistry curriculum. Undergraduate chemistry faculty are routinely requested to cover a certain quantity of requisite subject matter within each lecture and laboratory course via presentation of example problems and procedures. Hence, often it seems a race to the finish line in order to present an optimal number of problems and their concomitant solutions within each subject area given limited class and lab time. Different types of computational modeling and interactive simulation provide a mobile mechanistic pathway toward extending example presentation opportunities for student learning and practice in a facile, user-friendly manner outside of class space and time.	College, High School, Middle School, General Audience
Chemical demonstrations designed to engage and inform students virtually and in person.	Bruce William Baldwin	1. Spring Arbor University, Spring Arbor, MI, United States.	Symposium Description: Sharing experience and pedagogical value for chemistry demonstrations that engage students of all ages.	College, High School, Middle School, General Audience
Going the distance: Making the transition betweenin-person and online chemistry laboratories	Brenna A Tucker	1. Chemistry, University of Alabama at Birmingham, Birmingham, AL, United States.	Symposium Description: As we move along in a technology driven world the traditional idea of an education based upon a lecture setting is ever evolving to incorporate new technologies. Each year more students elect to take online classes forcing educators to make a transition from teaching in-the-seat lectures to online courses. But what happens to the chemistry laboratory when the lecture is moved online? The purpose of this symposium will be to explore the advantages and challenges of moving a traditional chemistry laboraory to the online realm. Speakers are encouraged to share their experiences as they navigated the transition between traditional in-person and online laboratory experiments.	College
Making teachers out of researchers	Gauri Ramasubramanian	1. Chemistry & Biochemistry, University of Oregon, Eugene, OR, United States.	Symposium Description: Chemistry graduate teaching assistants form a major part of the undergraduate education system across most large universities.The time and effort invested in training them as TAs is substantial. Balancing their training as TAs as well as chemistry (PhD) researchers can therefore become very challenging. This symposium will open up discussions on what tools and skills we focus on while training our TAs as well as which teaching and/or learning practices we encourage so that 'chemistry', and not the apparent competition between teaching and research, continues to be paramount in our courses.	College, General Audience

Promote understanding of chemistry through interactive instructional lecture demonstrations	David R Sullivan	1. Dept of Chemistry and Biochemistry, University of Oregon, Eugene, OR, United States.	Symposium Description: How to make clear connections to basic chemical principles and concepts by incorporating interactive chemistry lecture demonstrations will be the emphasis of this symposium. Both educational and entertaining chemical demonstrations will be showcased, but all demonstrations must have learning objectives and an assessment. A strong emphasis will be placed on safety, reasonable scale, and waste disposal.	College, High School, Middle School, General Audience
Using open educational resources (OERs) to enhance teaching and learning in the chemistry classroom	Deborah Berkshire Exton | Brooke Taylor | Adelaide Clark	1. Chemistry and Biochemistry, University of Oregon, Eugene, OR, United States. 2. Science, Lane Community College, Eugene, OR, United States. 3. Oregon Institute of Techonology, Klamath Falls, OR, United States.	Symposium Description: In an era of escalating textbook and ancillary prices, there is increased pressure on instructors to reduce the financial burden on students taking their courses. Open Educational Resources (OERs) are teaching and learning materials that reside in the public domain and can be freely used, without charge to students or institutions. OERs include everything from a single lesson or activity to videos, textbooks, or full online courses. In this symposium we will explore how instructors have developed and/or used OERs to reduce costs, how they are integrating resources into the classroom to improve their students' educational experiences, and how instructors have used the results of student outcomes or assessments to determine the efficacy of the OERs.	College, High School
Developing and assessing more than content knowledge	Renee S Cole	1. Department of Chemistry, University of Iowa, Iowa City, IA, United States. 2. Virginia Commonwealth Univ, Richmond, VA, United States. 3. Drew University, Madison, NJ, United States. 4. Chemistry, Virginia Commonwealth University, Henrico, VA, United States.	Symposium Description: Skills such as communication, teamwork, and problem solving are frequently cited as important outcomes for STEM degree programs, and they are part of the expectations listed in the ACS guidelines for Bachelor's degrees in chemistry. Additionally, the NGSS science practices articulate skills such as developing and using models, analyzing and interpreting data, and engaging in argument from evidence that are fundamental to practicing chemists. While there are many resources for developing and assessing content knowledge, the development of skills (such as those listed above) is often taken for granted, and they are rarely explicitly assessed in the classroom. This symposium brings together insights and recommendations from researchers and instructors who have created activities and assessment strategies to address "more than content knowledge" to make skill development an explicit part of the curriculum.	General Audience
Chemistry connections in art and archaeology	Kevin L Braun	1. Chemistry, Virginia Military Institute, Lexington, VA, United States. 2. Chemistry, Beloit College, Beloit, WI, United States.	Symposium Description: From assisting in the reconstruction of humanity's past to the preservation of priceless works of art, chemistry has played a critical role in the fields of archaeology and art. This symposium will explore how the interdisciplinary interface of chemistry, art, and archaeology can enhance the undergraduate classroom and laboratory. Presenters from high school and two and four-year institutions are invited to share curricula, laboratory experiments, and lectures that integrate these topics across the undergraduate curriculum.	College, High School, General Audience

Making middle and high school chemistry awesome!	Paula Weiss	1. Chemistry, Oregon State University, Corvallis, OR, United States. 2. Woodland High School, Woodland, WA, United States.	Symposium Description: In this symposium we invite middle and high school teachers to share their approaches to showing students the awesomeness of chemistry. Do you have demonstrations that wow students? Are your lab activities outstanding? Have some tips for amazing classroom décor and organization? Please come share! We want to see the awesome things that you are doing!	High School, Middle School, General Audience
Culturally responsive teaching in the chemistry classroom	Stacey Fiddler	1. Sylvania Campus, Portland Community College, Portland, OR, United States.	Symposium Description: What does culturally responsive teaching look like in the chemistry classroom? In this symposium, faculty are invited to share philosopy and best practices in all levels of high school and undergraduate chemistry courses. Presentations, interactive talks and discussion panels are welcome.	General Audience
Teaching scientific writing: Innovative assignments and pedagogy	Raymond C Dudek	1. Ward St at N Wittenberg Ave, Wittenberg University, Springfield, OH, United States. 2. Chemistry, SUNY Cortland, Cortland, NY, United States.	Symposium Description: Scientific writing in the undergraduate chemistry curriculum is often limited to lab reports. However, professional writing for chemists extends beyond this format. This symposium will feature innovative scientific writing assignments and pedagogies that increase student writing ability in laboratory or lecture.	College
Converting to green organic laboratories - stories and strategies: A discussion for the undergraduate laboratory	C Frederick Jury	1. Chemistry, Collin College, Plano, TX, United States.	Symposium Description: A symposium designed to help instructors generate the activation energy required for the conversion to green organic laboratories. Discussion of strategies for conversion as well as a sharing of success stories and challenges associated with this process.	College
Chemical demonstrations as three-dimensional instruction	Mark W Meszaros	1. Carolina Biological, Burlington, NC, United States.	Symposium Description: 3-Dimensional instruction guides students towards making sense of an investigative phenomenon and driving question. How can we transform chemical demonstrations to this new instructional model? Presenters will present their favorite chemical demonstration and discuss how they use it to engage students in sense making and incorporate the 3 dimensions as called for in NGSS.	College, High School
A day in the life of my classroom	Oluwatobi Odeleye	1. Chemistry/Biochemistry, University of Oklahoma, Norman, OK, United States. 2. Chemistry, Eastern Michigan University, Ypsilanti, MI, United States.	Symposium Description: Whether you have been teaching for one semester, or for 20+ years, we believe the classroom environment is constantly changing. Do you actively consider and implement different tools or techniques to create a student-centered classroom? Are you excited to share the different ways your classroom has evolved (or keeps evolving) and what a typical session in your classroom looks like? This symposium invites speakers to share tools and or techniques used in the classroom, and a reflection of lessons learned through the journey of the ever-evolving classroom. A presenter may wish to include what works well in the classroom and what doesn't, how they came to adopt the practice(s), and or tips and hints for implementation. The goal of this symposium is to highlight different pedagogical philosophies, provide an opportunity for participants to learn about new teaching practices that revolve around student-centered learning, and to engage in discourse that helps educators evaluate or re-evaluate teaching methods utilized in their classrooms and laboratories.	College, High School, Middle School, General Audience

Collaborative, interdisciplinary and case study approaches in undergraduate chemistry teaching and learning	Li Qiong Wang	1. Chemistry Department, Brown University, Providence, RI, United States.	Symposium Description: This symposium is to promote collaborative, interdisciplinary and case study approaches in undergraduate chemistry teaching and learning. The effectiveness of student learning and challenges of implementing these approaches, in particular to a large undergraduate class will be addressed. Interdisciplinary case-study based courses created and taught through collaborative efforts among experts from different fields will be emphasized. The case study method has been widely used in professional schools of business, medicine and law. Recently it gains popularity in undergraduate colleges and universities. In stead of traditional teaching, students will be reading literatures or news articles on real cases and then come to the class with questions to discuss. The instructor will lead the discussion. The advantages of such teaching are to increase the critical thinking and problem solving skills for students. Since the real case is more relevant to their daily lives, students are more motivated to learn. The case study method often involves engaging hands-on laboratory activities that are directly related to their cases learned in the lecture to further enhance students' learning. The symposium presenters will share their success and challenges in teaching case study based interdisciplinary courses.	College
Innovative, research-based approaches to student-centered learning in chemistry	Mark Blaser	1. Chemistry, Shasta College, Redding, CA, United States. 2. Chemistry, Virginia Military Institute, Lexington, VA, United States. 3. Chemistry, University of British Columbia, Vancouver, BC, Canada.	Symposium Description: Despite decades of research on how people learn, chemistry instruction in higher education is commonly aligned with tradition instead of the most effective ways to educate students. These conventional methods often reinforce rote memorization and algorithmic problem-solving and do little to motivate students to construct their own knowledge and engage in meaningful learning. There is great potential to improve student success by adopting educational approaches that start by considering what we want students to learn and that incorporate methods which have evidence demonstrating their effectiveness. This symposium will feature presentations on innovative, research-based student-centered learning in chemistry, i.e. effective pedagogical approaches that diverge from the traditional teacher-centered classroom and that focus on learners' needs and take into account their differences. Contributions that share, critique and/or evaluate evidence-based course designs and instructional techniques are welcomed.	College
Teaching students to support their claims with evidence and reasoning	Jean M Weaver	1. The Prairie School, Racine, WI, United States.	Symposium Description: Oftentimes, students can solve problems or answer conceptual questions while their explanations lack situation-specific details and proper reasoning to soundly justify their ideas. Developing the skill of scientific argumentative reasoning requires a scaffolded approach and plenty of guidance, modeling, and practice. Many instructors use the CER (claim, evidence, reasoning) framework to help students identify key data and relevent background information to organize their thoughts and articulate their argument. In this symposium, presenters will share perspectives, reflections, insights, activities and strategies that are aimed at helping students improve their ability to justify and defend their opinions and ideas.	High School, General Audience

Effectives ways of teaching chemistry for non-science majors	Roshinee costa	1. Chemistry, The University of Akron, Twinsburg, OH, United States.	Symposium Description: Teaching and gaining interest about learning chemistry in non-science major classes are challenging. Different ways of teaching methods, and activities have been used to capture students' interest to give good learning experience in these courses. The main purpose of this symposium is to give audience the different teaching methods, and activities which can enhance learning in chemistry non-science major classes.	College, General Audience
Specifications grading in the chemistry classroom	sally meyer	1. Chemistry and Biochemistry, Colorado College, Colorado Springs, CO, United States.	Symposium Description: Specifications grading is a competency based approach to assessing learning. This symposium invites approaches to using this in the chemistry classroom, including the successes and failures of things tried. We would like to share the advantages and disadvantages to specifications grading.	General Audience
International perspectives onteaching chemistry	Charles Cox	1. Chemistry, Stanford University, Stanford, CA, United States. 2. Chemitry and Biochemitry, Univ. of Northern CO, Greeley, CO, United States.	Symposium Description: In the US, Chemistry is regarded as being a barrier course that generally prevents students from continuing in majors such as engineering, pre-medical, or pre-professional programs. This is a common theme shared across many institutions in the US, as well as, internationally. The goal of this symposium is to expand our lens broadly and consider the instruction, assessments, and curriculum for international chemistry classrooms. What are the challenges with teaching chemistry internationally? What interventions have been implemented to address challenges in student understanding? What are assessment strategies in lecture and laboratory? The symposium will focus on an array of topics addressing these questions and others across the chemistry curriculum. Presenters are encouraged to share their research, experiences, strategies, and successes in turning challenges into opportunities for novel ideas to be implemented and tested.	College, High School, Middle School, General Audience
Addressing student success in introductory chemistry courses: Strategies to increase student confidence, engagement, and persistence	Amy F Johnson	1. Chemistry, Eastern Michigan University, Ypsilanti, MI, United States.	Symposium Description: The first chemistry course for a student can be a deeply engaging experience filled with awe at the wonders of chemistry. It can also be a terrifying and doubt-inducing struggle through unfamiliar terminology and techniques. How can we as instructors purposefully design our courses to help students experience more of the former and much less of the latter? The purpose of this symposium is to highlight research results and evidence-based pedagogical practices that promote student confidence, engagement, persistence, and retention in introductory and general chemistry courses. We invite presentations situated in lecture and/or laboratory settings from those who teach at the high school and 2- and 4-year college levels. Time permitting, we will moderate a discussion between presenters and the audience at the conclusion of the session.	College, High School

Teaching communication skills in the undergraduate chemistry Curriculum	Ami P Johanson | Kimberly Anne Lawler-Sagarin	1. Elmhurst College, Elmhurst, IL, United States. 2. Chemistry, Aurora University, Aurora, IL, United States.	Symposium Description: Chemistry students must develop strong written and oral communication skills in college to prepare them for entry into the workforce, graduate school, or professional school. The question remains where and how to best incorporate these skills into the undergraduate chemistry curriculum. Do we incorporate these skills within content courses or create separate courses? What methods best teach these skills? How do we incorporate technology? How do we teach students to communicate effectively with both technical and non-technical audiences? This symposium will explore innovative methods to incorporate written and oral communication skills within the undergraduate chemistry curriculum.	College, General Audience
Promoting Interdisciplinary undergraduate chemistry research	Min Li	1. Chemistry and Physics Department, California University of Pennsylvania, California, PA, United States.	Symposium Description: This symposium focuses on promoting interdisciplinary chemistry research for undergraduate students. Research skills is essential for all chemistry undergraduate students and plays an important role in higher education. Interdisciplinary research topics can involve food chemistry, environmental chemistry, geochemistry, green chemistry and forensic chemistry, etc.. This symposia invites presentations that contribute ideas on developing research proposal, evaluating students' performance, seeking funding, publishing research findings, presenting at national conferences, etc.. Interdisciplinary research projects will expand students' learning of chemistry knowledge in classroom and laboratory and will prepare students with more real-world research and analytical skills for their future careers. Any other inquiries should be directed to the symposium organizers: Min Li (Primary Contact) California University of Pennsylvania Li@calu.edu	College, High School, Middle School, General Audience
Using humor to teach chemistry	Van Quach	1. Seminole Community College, Sanford, FL, United States. 2. Physical Sciences, Seminole State College, Sanford, FL, United States.	Symposium Description: There are many strategies we may use to compete for the time and attention of our students, but humor still seems to be one of the most effective. Through the use of analogies, anthropomorphisms, cartoons, jokes, or just crazy classroom antics, many of us are using humor to teach our classes. Numerous research studies support the notion that humor can be used to create a comfortable learning environment, bring content to life, and increase brain activity. The organizers believe that humor makes us better teachers and helps our students understand and retain information. Presenters will share their best jokes, stories, analogies, and humor strategies, doing their best to keep content to a rating of PG13. Bring your funny bone and irreverence, but leave your political correctness at home. Join us for a romp through the humor that is being used in chemistry classrooms today.	College, General Audience

General chemistry laboratory: curriculum and best practices	Jenine Maeyer	1. Chemistry, University of Pennsylvania, Haddonfield, NJ, United States.	Symposium Description: The goal of this symposium is to provide an opportunity for general chemistry laboratory instructors to come together and share information about the structure of their laboratory course, current curriculum, recent redesigns or tried-and-true experiments, best practices, teaching or grading strategies, and/or exams and assessments. As instructors, it is wonderful to get an idea about one new, interesting experiment, but it can also be helpful to see what others are doing as a whole picture. Have you been teaching for a while and found something that works well, or did you recently revamp your general chemistry laboratory curriculum and have results to share? What projects, units, or experiments work well at your college or university? This symposium is a place to share this information to other general chemistry lab instructors.	College
Is it fair is to assess non-major general chemistry I and II courses using ACS Exams?	Manjusha T Saraswathiamma	1. Chemistry, Minnesota State Community and Technology, Moorhead, MN, Moorhead, MN, United States.	Symposium Description: Assessment of multiple sections of a course is known as course assessment. It is used to assess the consistency in achieving the learning outcomes across a number of courses taught by different faculty and/or offered in different modalities. Often an assessment tool like a common examination or assignment is selected as an evidence that needs to be collected across the courses. Designing a course assessment tool is challenging because there are many variables that are beyond our control like the academic preparedness of students and their prior learning. Many chemistry departments across the country have been using ACS exams as a tool to assess courses and programs. There has been a lot of research work published on the practicality and homogeneity of using a common standardized test. One of the many challenges is the content disparity between courses taught at various institutions versus the ACS-EI exams. ACS exams are designed mainly to assess content mastery and not many skills beyond that. Being in a multiple-choice format, it has its own limitations to test other competency that science students need to acquire at a higher secondary level. Most programs successfully using the ACS exams as a common assessment tool are have four-year chemistry major programs. It would be encouraging to hear stories from non-major programs as well.	College

Twenty-first century innovative assessments in chemistry and other STEM related courses	Cary A Supalo	1. Educational Testing Service, Princeton, NJ, United States.	Symposium Description: This symposium seeks contributors who feel they are currently, or intend to, implement new assessments in their chemistry courses that go beyond the traditional paper-and-pencil assessments we all know and love. The presentations can focus on any age group in any educational setting (e.g. post-secondary classroom, enrichment programs, online classrooms) and can encompass technologies and methodologies that stretch and/or redefine the traditional assessment practices of our profession. In particular, the use of computer-based assessments in all branches of chemistry curricula is of interest. Methodology is the primary focus of this symposium, however any formal data that can be shared about the effectiveness of these innovative approaches is welcome. It is these new unique forms of assessment that are helping to drive the chemical education profession forward. Presentations included in this symposium are intended to serve as illustrative examples of work that may be replicated and implemented in other venues.	General Audience
Chemistry access for all is paramount	Ashley Elizabeth Neybert	1. Independence Science, West Lafayette, IN, United States.	Symposium Description: In this symposium, the importance of all students to be able to have an equitable chemistry experience will be explored. Topics may include modifications to the traditional chemistry classroom suggested to improve access for all students regardless of disability, economic status, gender, race, and other characteristics necessary to give an equitable experience in chemistry to all people.	General Audience
George R. Hague Jr. Memorial AP Chemistry Symposium	Lisa McGaw	1. Ag, Science and Engineering, Northern Oklahoma College, Stillwater, OK, United States.	Symposium Description: This symposium honors the many outstanding contributions made by George Hague to chemical education. This symposium is designed for teachers of Advanced Placement Chemistry. Topics presented will include ideas, demonstrations, laboratory experiments and other practices related to AP Chemistry. The Chief Reader and from other members of the AP Chem Reading leadership team will present a detailed analysis the 2019 AP Chemistry Test and new AP Chemistry Course and Exam Description.	College, High School
Developing future scientists: Project SEED and other models for involving high school students in chemistry research.	Don Warner, Douglas S Masterton	1. Chemistry, Boise State Univesity, Boise, ID, United States	Symposium Description: Engaging students in research is known to be an effective educational strategy and shown to improve students' content knowledge, academic performance, attitude toward the STEM disciplines, and, importantly, interest in science and engineering careers. This symposium will describe strategies and projects that are being used to engage high school students in meaningful and transformative chemistry-related research. The American Chemical Society's Project SEED program, for example, removes barriers to participation for students from low-income families by offering stipends for 8-week mentored research projects. Project SEED and other approaches used to engage high school students in meaningful chemistry research will be highlighted.	College

TED style talks: Chemistry instructors making connections to people and real world applications	Don Warner	1. Chemistry, Boise State Univesity, Boise, ID, United States	Symposium Description: On a daily basis, chemists shape the future by tackling many of the most pressing challenges facing society, impacting policy, exploring new frontiers in science, and inspiring students. This symposium will give chemists the opportunity to present their work by telling their story in a concise and inspiring way, making it clear to anyone that their work matters. Presenters will describe how their research and scholarship connects with real-world applications, students, colleagues, and the general public in TED-style talks. The symposium will empower presenters to communicate the value of their work to any audience and attendees will witness effective strategies for sharing their own work.	General Audience
Building community and promoting interaction in online courses	Deborah Exton	1. Chemistry and Biochemistry, University of Oregon, Eugene, OR United States	Symposium Description: Online courses, by their very nature, involve the interaction of individual students with their computers. However, best practices in teaching and learning strongly indicate that interactions between students and between students and their instructors promote conceptual understanding and improved learning outcomes. This symposium will provide examples of interactive exercises, showcase instructor methods for promoting interactivity and share lessons learned from implementation.	College
Assessment and measurement in research and practice	Thomas C Pentecost	1. Chemistry Department, Grand Valley State University, Allendale, MI, United States. 2. Chemistry, University of South Florida, Tampa, FL, United States. 3. Chemistry and Biochemistry, University of Wisconsin-Milwaukee, Milwaukee, WI, United States. 4. #27, Bemidji State University, Bemidji, MN, United States. 5. Luther College, Decorah, IA, United States.	Symposium Description: In the ever-changing landscape of chemistry education research, one question has continually stood the test of time: How do we know what our students know? This symposium invites contributions which emphasize evidence-based assessment and measurement practices at the undergraduate level for both research and practice. Contributions are especially encouraged which feature novel methods of classroom and/or programmatic assessment as well as those with implications for the broader chemistry education community.	College, General Audience

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