

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 Soutt	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 pedagogical 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

<p>Teaching programming in the chemistry curriculum: Approaches, challenges, and best practices</p>	<p>Ashley Ringer McDonald</p>	<p>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.</p>	<p>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.</p>	<p>College</p>
<p>Molecular modelling in biochemistry to enhance visual literacy</p>	<p>Shane Austin</p>	<p>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.</p>	<p>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.</p>	<p>College</p>

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-form, 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 ways that 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 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	<p>1. Chemistry & Biochemistry, Merrimack College, North Andover, MA, United States.</p> <p>2. Science, Lane Community College, Eugene, OR, United States.</p>	<p>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.</p>	College
Graduate teaching assistants' role in undergraduate education	V. M. Berns	<p>1. Chemistry, Northwestern University, Evanston, IL, United States.</p>	<p>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 BCEE. 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 Dragisch 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 impact on 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.</p>	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 secondary 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 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 disciplines.	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. Chemistry, 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 Education and 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: Laboratory 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

<p>Incorporating environmental chemistry into the undergraduate chemistry curriculum</p>	<p>Krista A Barzen-Hanson</p>	<p>1. Department of Chemistry, Elmira College, Elmira, NY, United States. 2. Dept. of Chemistry, Elmira College, Elmira, NY, United States.</p>	<p>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.</p>	<p>College, General Audience</p>
<p>Integration of plant medicinal chemistry into the undergraduate chemistry laboratory curriculum</p>	<p>Corey E Stilts</p>	<p>1. Dept. of Chemistry, Elmira College, Elmira, NY, United States.</p>	<p>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</p>	<p>College, General Audience</p>
<p>Connecting the visible with the invisible</p>	<p>Pamela Auburn</p>	<p>1. Chemistry , Lone Star College, Houston, TX, United States.</p>	<p>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 macroscopic 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 macroscopic 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.</p>	<p>College, High School, Middle School, General Audience</p>

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 "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 enhance 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 success 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 led 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 undergraduate 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 addressed 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) fulfill 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

<p>Incorporating the maker movement into chemical education</p>	<p>Robert J LeSuer</p>	<p>1. Chemistry, The College at Brockport, SUNY, Brockport, NY, United States.</p>	<p>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.</p>	<p>College, High School</p>
<p>Integrating green chemistry and sustainability into chemistry education</p>	<p>Lloyd Bastin</p>	<p>1. Widener University, Chester, PA, United States. 2. Chemistry, University of Toronto, Toronto, ON, Canada. 3. Green Mountain College, Poultney, VT, United States.</p>	<p>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.</p>	<p>College, High School</p>
<p>When curricular change and transformed teaching do not go according to plan</p>	<p>Julia Chamberlain</p>	<p>1. Chemistry, University of California Davis, Davis, CA, United States.</p>	<p>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.</p>	<p>College</p>
<p>Learning through peer review: Using evaluation practices to foster deep understanding and professional skills</p>	<p>Breeyawn Lybbert</p>	<p>1. Chemistry, University of Wisconsin, Green Bay - Manitowoc Campus, Manitowoc, WI, United States. 2. Chemistry and Biochemistry, UCLA, Los Angeles, CA, United States.</p>	<p>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.</p>	<p>College, High School</p>

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 information 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

<p>Reimagining chemistry education: Integrating systems thinking into green and sustainable chemistry education</p>	<p>Natalie O'Neil</p>	<p>1. Department of Chemistry, University of York, Heslington, York, United Kingdom. 2. Beyond Benign, Wilmington, MA, United States.</p>	<p>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.</p>	<p>College, High School, Middle School, General Audience</p>
<p>Best practices for teaching chemical nomenclature, terminology, and symbols</p>	<p>Timothy M. Trygstad</p>	<p>1. Chemistry, The College of Saint Scholastica, Duluth, MN, United States. 2. Science, Rye High School, Rye, NY, United States.</p>	<p>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.</p>	<p>College, High School, General Audience</p>
<p>Exploring implementation of Peer-Led Team Learning and its outcomes</p>	<p>Kathleen Jeffery Christopher Bauer Scott E. Lewi</p>	<p>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.</p>	<p>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.</p>	<p>College</p>

<p>Linking lecture and lab: Helping students make explicit connections between the classroom and the laboratory</p>	<p>Kathryn D Kloeppe</p>	<p>1. Chemistry, Mercer University, Macon, GA, United States.</p>	<p>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.</p>	<p>College, High School, General Audience</p>
<p>Oral communication in the chemistry curriculum</p>	<p>Garland Crawford</p>	<p>1. Chemistry, Mercer University, Macon, GA, United States.</p>	<p>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.</p>	<p>College, High School, General Audience</p>

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 chemistry laboratories: 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.	<p>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/</p>	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.	<p>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 pursuing 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.</p>	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 critical 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 partnerships 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

Professional 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 Hyde, 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 Technology, 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

<p>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?</p>	<p>Sylvia Rygiel Esjornson</p>	<p>1. Chemistry and Physics, Southwestern Oklahoma St U, Weatherford, OK, United States.</p>	<p>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.</p>	<p>College, High School, Middle School, General Audience</p>
<p>Favorite half-hour lab experiments</p>	<p>George Lisensky</p>	<p>1. Beloit Colg, Beloit, WI, United States.</p>	<p>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!</p>	<p>College, High School</p>

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 projects extending 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

<p>Reconnecting chemistry to society: Illustrating the importance and relevance of chemistry</p>	<p>Ozcan Gulacar</p>	<p>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.</p>	<p>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.</p>	<p>College, High School, General Audience</p>
<p>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.</p>	<p>Francis Michael Rossi</p>	<p>1. Chemistry, SUNY Cortland, Cortland, NY, United States.</p>	<p>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.</p>	<p>College, General Audience</p>

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 between in-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 laboratory 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 philosophy 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 Biochemistry, 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 University, 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 University, 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