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Communication

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# ConfChem Conference on Interactive Visualizations for Chemistry Teaching and Learning: An Introduction

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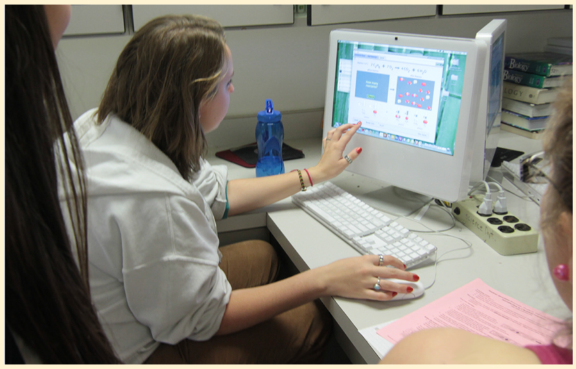
**ABSTRACT:** The chemistry education community has a strong history of using visualizations in teaching and learning chemistry. The spring 2015 online ConfChem conference, Interactive Visualizations for Teaching and Learning Chemistry, presented work in the areas of design, evaluation, and frontiers of interactive visualizations. The conference was held from May 8 to June 4, 2015 and was organized by Emily B. Moore, Director of Research and Accessibility for PhET Interactive Simulations at the University of Colorado Boulder and hosted by the ACS Committee on Computers in Chemical Education. This Communication introduces the topics presented during the ConfChem and provides context for the conference and an overview of the eight papers presented.



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## BACKGROUND

Visualizations in chemistry education, animations and simulations, provide powerful resources to support students' conceptual understanding and the representational fluency needed to envision the particulate-level world, communicate through chemical symbols, and make connections to the observable world. Advances in technology and access to technology in classrooms have allowed for increasingly *interactive visualizations* to emerge. This capability creates tremendous opportunities for engagement with pedagogically rich interactions and interfaces as well as challenges for understanding student learning and the design of effective visualizations. Faculty around the world are engaging in innovative work developing a knowledge base in effective design and evaluation of interactive visualizations.

To support chemistry educators in making informed choices regarding their selection and implementation of interactive visualizations, it is important to create opportunities to learn about and discuss effective uses of interactive visualizations and the ways in which interactive visualizations are designed and evaluated. In the spring of 2015, the ACS Division of Chemical Education's Committee on Computers in Chemical Education hosted such an opportunity, through the annual free online conference for chemistry educators (ConfChem), which this year focused on interactive visualizations for chemistry teaching and learning.[1] Information on participating in a future ConfChem can be found on the ConfChem Web site.[1]

From May 8 to June 4, 2015, high school teachers, college faculty, and educators who develop and research interactive visualizations discussed eight papers presenting new work related to design, evaluation, and the frontiers of interactive visualizations. During this time, 122 comments were posted, and to date 14,066 hits have been recorded on the ConfChem Web site.[1] Following this introduction are Communications by the authors of these papers, synthesizing their presented work and the ensuing online discussion. The first five papers focus on the design of animations and resulting analysis of student learning. The final three papers shift focus to a related topic, challenges and progress in making technological resources like animations and simulations accessible for students with disabilities. For reference, each ConfChem paper and associated discussion is included as Supporting Information for those Communications.

## OVERVIEW OF THE SPRING 2015 CONFCHEM PAPERS

Two papers were discussed each week. The first week featured presentations and subsequent online discussion of these papers:

1. "Insights into Molecular Visualization Design", by Resa Kelly
2. "Learning by Being: Playing Particles in the MeParticle–WeMatter Simulation", by Elon Langbeheim and Sharona T. Levy

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The authors of these papers describe the design process and evaluation of an interactive visualization. Kelly's work highlights the use of instructor interviews to inform the design of an electronic learning tool (ELT)[2] to support student understanding of precipitation reactions. Kelly then presents results from a classroom study indicating that the ELT supported student learning, particularly in understanding the hydration of ions in solution. In Langbeheim and Levy's work, the decisions and process in creating the underlying molecular dynamics model for an interactive simulation is presented, along with a classroom study to assess the effectiveness of student interaction with the simulation in comparison to only viewing the simulation.

In the second week of the ConfChem, two different multimodal approaches to studying the learning process of students were presented:

3. "A Multimodal Examination of Visual Problem Solving", by Sarah J. R. Hansen, Felicia Moore, and Peter Gordon
4. "Using an Interactive Simulation To Support Development of Expert Practices for Balancing Chemical Equations", by Yuen-ying Carpenter, Emily B. Moore, and Katherine K. Perkins

In Hansen et al., the use of eye-tracking, verbalizations, and paper-based assessments was used to study students' problem solving during use of an interactive simulation, "Reactants, Products, and Leftovers".[3] Their analysis of viewing patterns included four distinct student clusters. To highlight two of these groups, the authors compare and contrast findings between two representative students, including one student who relied heavily on numerical representations and another student whose viewing pattern changed based on the question asked. In Carpenter et al.'s work, analysis of simulation interaction data (e.g., mouse clicks) and student verbalizations was used to provide insight into how students learn to balance chemical equations with the "Balancing Chemical Equations"[4] simulation. Findings indicate that students' use of representations shifted as their skills improved, providing support that multiple representations within this simulation are beneficial.

In the next week of discussions, we wrapped up a focus on the design and evaluation of existing interactive visualizations with this paper:

5. "Research into Practice: Visualizing the Molecular World for a Deep Understanding of Chemistry", by Roy Tasker

Here, Tasker shares his work developing VisChem animations[5] and associated learning activities while also describing the potential and pitfalls of animations.

We then shifted focus to one of the frontiers in educational resource development, creating resources accessible to students with disabilities.

6. "The Cutting Edge: Educational Innovation, Disability Law, and Civil Rights", by Paul Grossman and Emily B. Moore

In this paper, Grossman presents a guide to disability law, how it has evolved over time, and what to expect in the future. This paper sets the stage for the final week's discussion:

7. "Technological Challenges to Equal Access of the Virtual Laboratory Experience for the Blind", by Cary Supalo
8. "Designing Accessible Interactive Chemistry Simulations", by Emily B. Moore

In Supalo's work, the challenges faced by students who are blind or have low vision are described, along with thoughts on institutional barriers to access for students with disabilities. Moore describes a new initiative by the PhET Interactive Simulations project to develop inclusively designed interactive simulations that include new accessibility features.

## CONCLUSION

Throughout the Spring 2015 ConfChem, the chemistry education community showed a strong interest in the topic of interactive visualizations. Participants asked questions about study methodologies, design practices, and classroom implementation. Participants also shared ideas, personal experiences, and opinions and expressed appreciation for learning more about the simulations they use and an interest in new interactive visualizations to use in their classrooms.

## AUTHOR INFORMATION


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### Notes

The authors declare no competing financial interest.

## REFERENCES


(1) American Chemical Society, Division of Chemical Education, Committee on Computers in Chemical Education. 2015 Spring ConfChem: Interactive Visualizations for Chemistry Teaching and Learning. http://confchem.ccce.divched.org/2015SpringConfChem (accessed Dec 2015).

(2) Electronic Learning Tools for General Chemistry. http://chemteam.net/ELT/login.html (accessed Dec 2015).

(3) Reactants, Products, and Leftovers Simulation. https://phet.colorado.edu/en/simulation/reactants-products-and-leftovers (accessed Dec 2015).

(4) Balancing Chemical Equations Simulation. https://phet.colorado.edu/en/simulation/balancing-chemical-equations (accessed Dec 2015).

(5) What Is VisChem? http://www.vischem.com.au (accessed Dec 2015).




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