Moving From Chemistry Description to Explanation *via* VisChem Express Institutes

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Project Impetus

Conceptual understanding in chemistry is at the heart of the Next Generation Science Standards' (NGSS)[1]:

- Science and Engineering Practices
  - developing & using models
  - constructing explanations
- Disciplinary Core Ideas
  - matter & its interactions
  - motion & stability: forces & interactions
  - Energy

Current pedagogical practices and professional development (PD) are *not well aligned* with the conceptual rigor of the NGSS due to the:

<u>*Nature of Chemistry Knowledge and Pedagogy*</u>

- Understanding chemistry is difficult.[2,3]
- Particulate visualization builds conceptual understanding.[4-8]
- Visualization has a high cognitive burden.[9-11]
- Visualization update in high school chemistry is limited.[12,13]
- PD can improve chemistry education.[14-17]
- High school chemistry is ready for visualization and reform.[18-20]

Major Goals

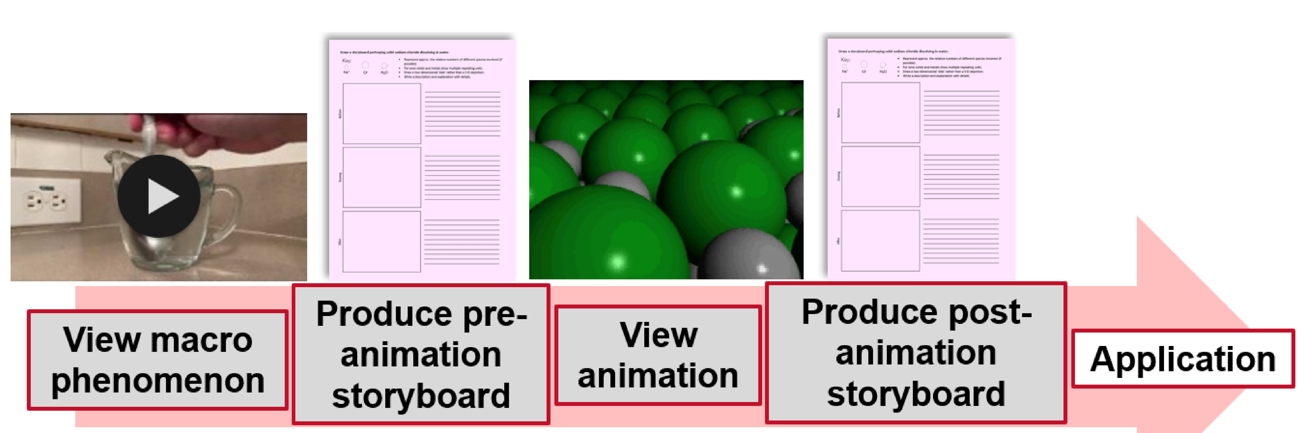
Research

- ❑ Use a design research approach to iteratively improve the PD and reveal key teacher moves and student learning outcomes that inform the *VisChem Approach*.
- ❑ Integrate learning theories with high-quality visualization tools informed by a cognitive learning model.
- ❑ Generate best practices for using animations to improve student conceptual understanding in chemistry.

Professional Development

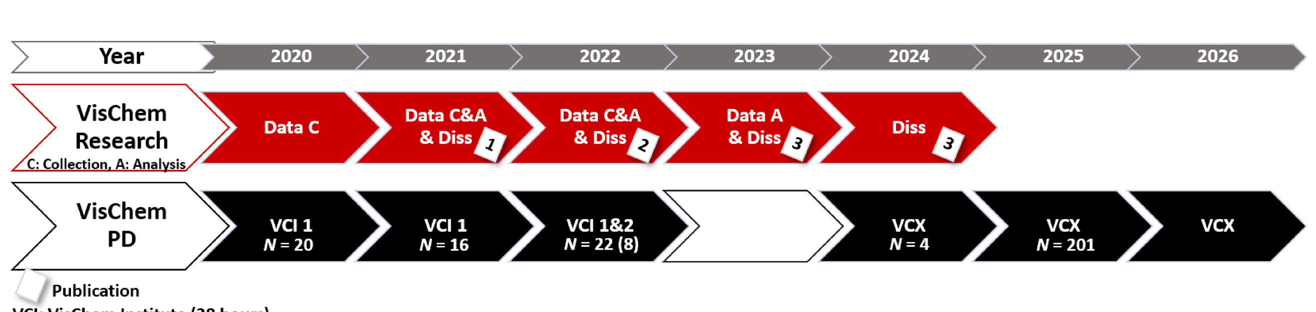
- ❑ Positively impact high school chemistry teachers and their students by improving teacher and student conceptual understanding of chemistry and teachers' instructional skills.
- ❑ Disseminate teaching resources and instruction best practices to the chemistry education community.
- ❑ Sustain the momentum and impacts of our program by building a community of practice consisting of high school chemistry teachers who share experiences and expertise with each other.
- ❑ Identify 'champions' of the *VisChem Approach*,' who are experienced and motivated participants, and willing to lead initiatives to promulgate the community of practice.
- ❑ Improve our understanding of teacher learning in chemistry regarding models and visualizations.

VisChem Approach



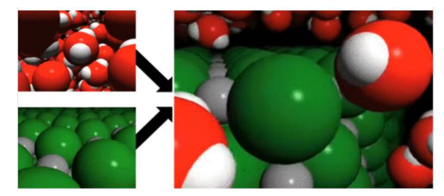
The Approach is aligned with a cognitive learning model built from multimedia learning principles.[21]

Research and PD Progress



Currently in grantee-approved no-cost extension year

Research Products



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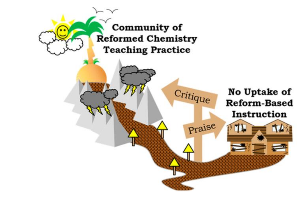

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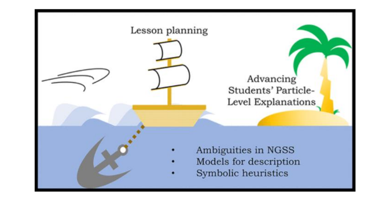

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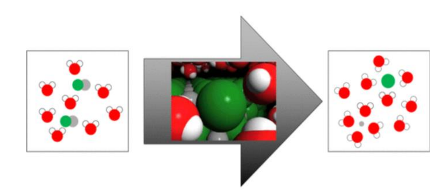

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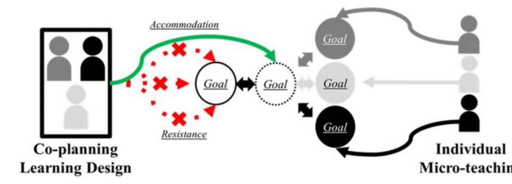

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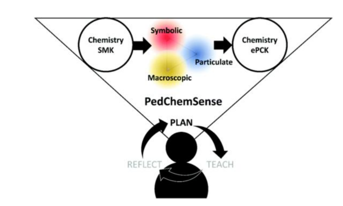

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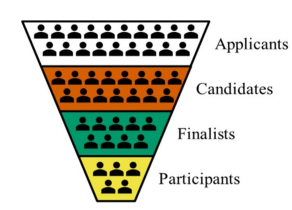

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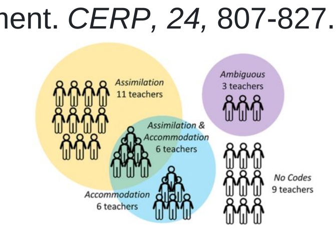

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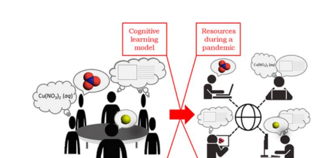

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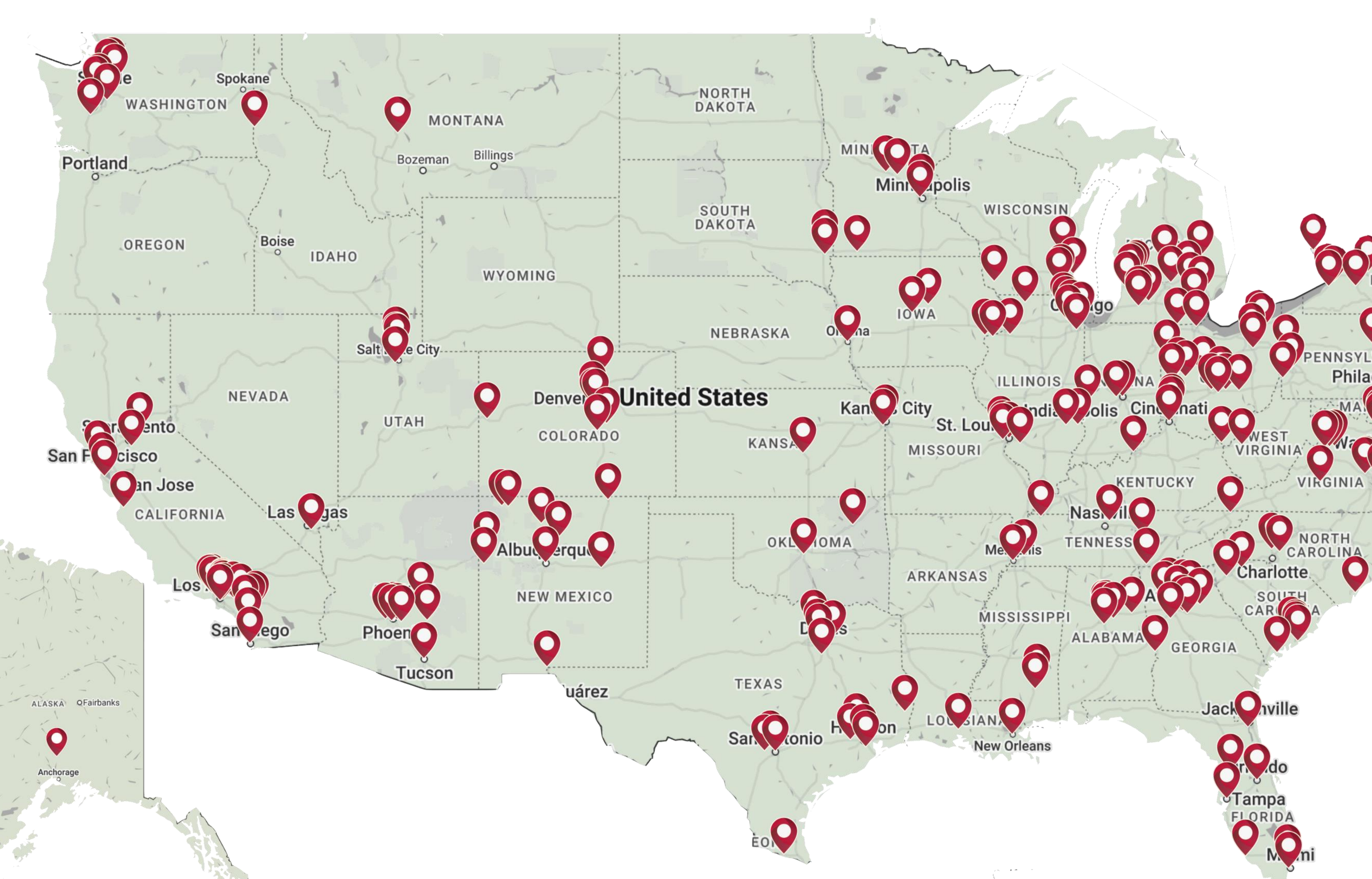
VisChem Institutes

Promotion via US Secondary Chemistry Networks

Participants' Schools



VisChem Participants

Institute Date	*N*
2020-2022	66
BCCE 2024*	4
Sat 22Feb 2025*	59
Sat 22Mar 2025*	63
Sat 26Apr 2025*	79
Tue 24Jun 2025*	apps

*VisChem Express

VisChem Express Institute Content

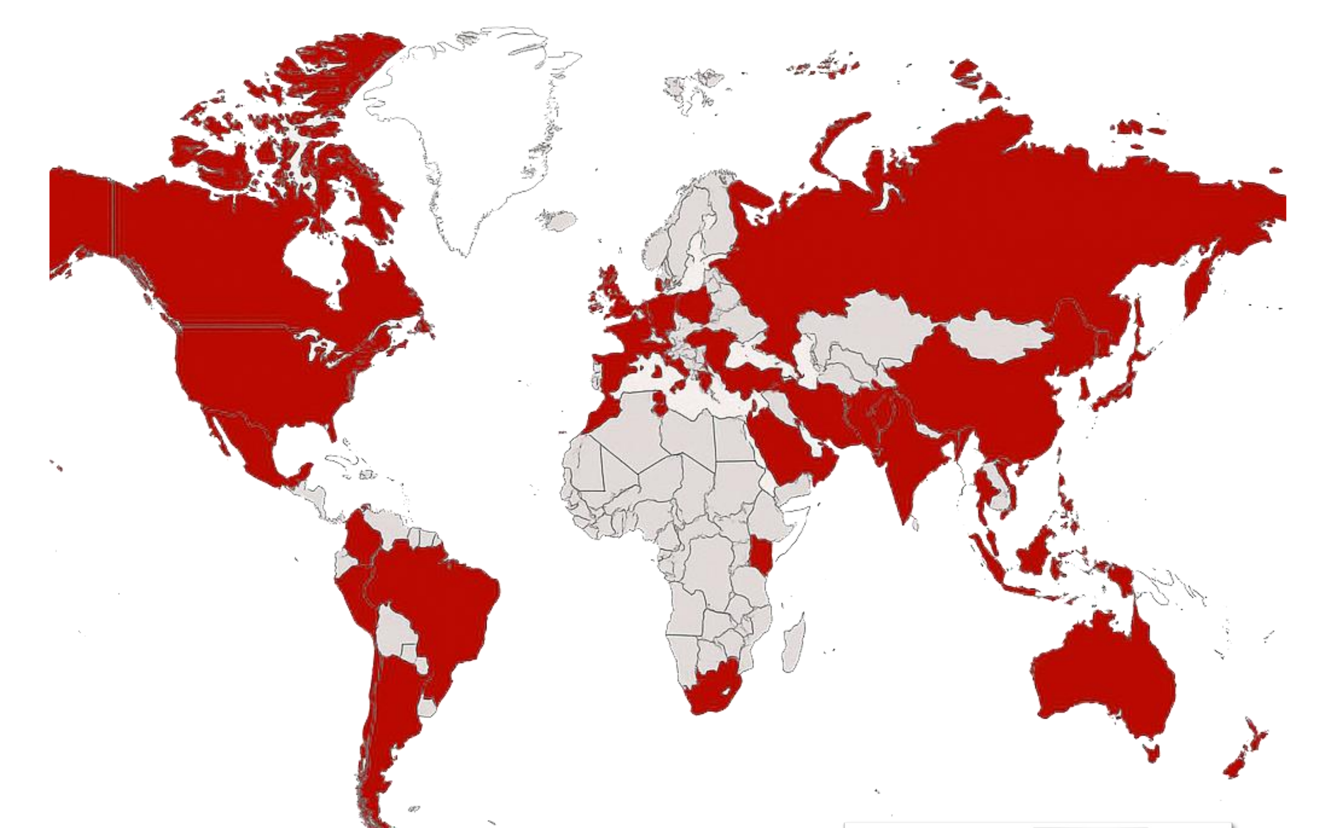
Learner Experience
- Experience VisChem as a student in a chemistry class
- Generate teaching moves with VisChem animations & storyboarding templates

Student Storyboards
- Connect cognitive learning model to VisChem
- Analyze student drawings
- Engage facilitation resources; discuss teaching moves
- Experience VisChem again

Quantitative Visualization
- Apply VisChem to quantitative chemistry topics:
  - ✓ Formula units
  - ✓ Stoichiometry
  - ✓ Molarity
  - ✓ pH

Models & Resources
- Experience VisChem as a learner while analyzing as a teacher
- Discuss limitations of VisChem animations as models
- Browse CoP resources

VisChem Community of Practice



Engagement with VisChem CoP

- 1,450 users worldwide (in 42 countries)
- Mean engagement time/active user: 42m 45s
- Mean engagement rate = 46.8%

Engagement Rate = Engaged sessions/Total sessions × 100
Engaged session: lasts ≥10 seconds, has a conversion event, or includes 2+ page views

Future Work

Deliver More VisChem Express Institutes

- ❑ Facilitate at least five more in the next grant year
- ❑ Ensure variability in timing of offerings (informed by VisChem Teacher Think Tank)

Grow VisChem CoP by Members and Resources

- ❑ Develop one or more additional CoP resource(s) based on what VisChem Express completers suggested for how the CoP could support their instruction with the VisChem Approach: (1) concrete classroom examples & modeling; (2) more ready-to-use lesson plans & templates; (3) collaborative sharing space; (4) new & expanded animations/resources; and (5) guidance on sequencing & scaffolding
- ❑ Engage secondary chemistry teacher networks and CoP members to recruit more CoP members

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VisChem publication citations appear with images in *Research Products* section and may be found at VisChem.org.

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Yezierski Research Group

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