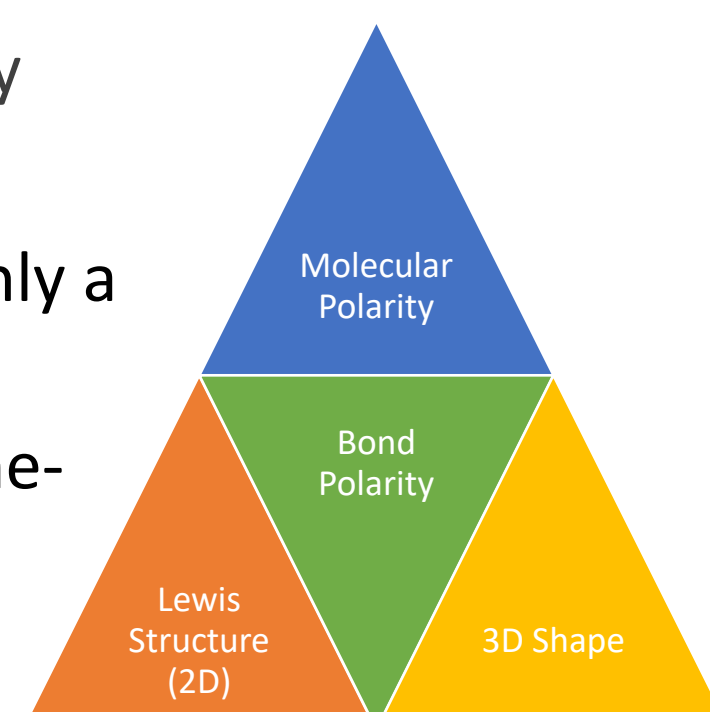


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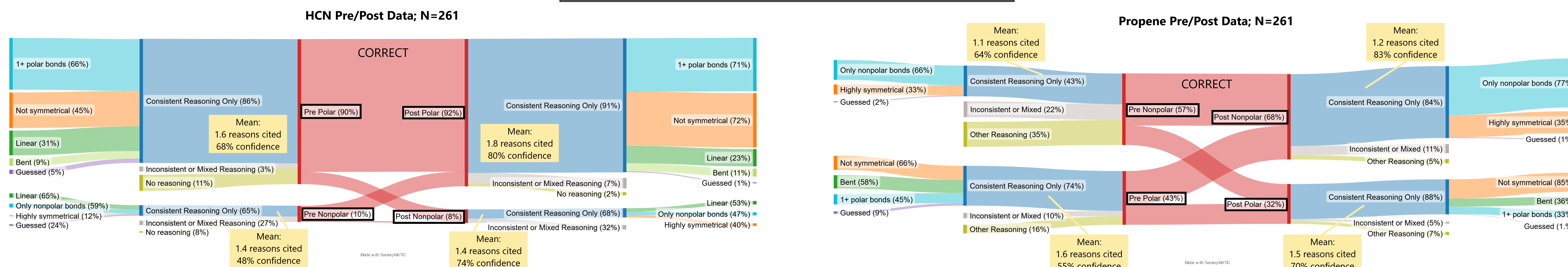
BACKGROUND: MOLECULAR POLARITY

Molecular polarity is a key concept for structure-property relationships, but students struggle with molecular polarity¹⁻⁷ and other structure-property relationships⁸⁻¹². Why?

- Complexity: depends on 3D symmetry and bond polarity
- Heuristics: students often consider only a *single* aspect in making polarity decisions; functional reduction³ or one-reason decision making¹³
- Prior content knowledge:



CONTRASTING PRE/POST DATA



RESEARCH QUESTIONS

- To what extent is this intervention successful in helping students master different aspects of the molecular polarity concept?
- What factors contribute to students' struggles with molecular polarity?

INTERVENTION DESIGN



	Water	Carbon Dioxide	Set 1	Set 2	Set 3	Set 4
H ₂ O			Molecular Formula		3	5
			Lewis Structure (2D)	5	4	3
			3D Shape	10	5	2

Distribution of Molecular Representations

Theory: Perceptual Learning Intervention¹⁴

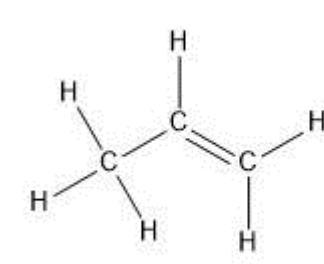
Perceptual Learning (Gibson, 1969) – "an increase in the ability to extract information from the environment as a result of experience..."

Properties	Effects
1. Classification based on structure	1. Generativity, or remote transfer
2. Numerous trials with feedback	2. Fluency effects
3. Minimal explicit instruction	3. Implicit pattern recognition vs. explicit knowledge
	4. Delayed testing effects

PRE/POST ASSESSMENT

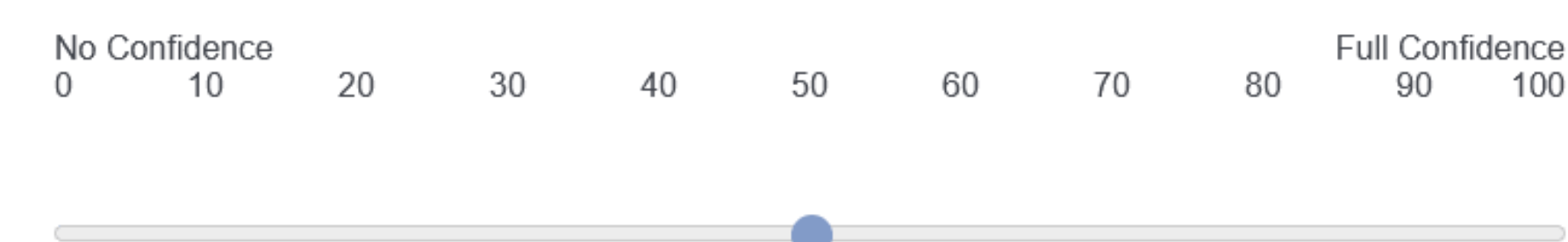
How is the following molecule best classified?

HCN



Select ALL statements that explain your reasoning for the polarity classification selected above:

Drag the slider bar below to reflect your confidence in the polarity classification selected above:



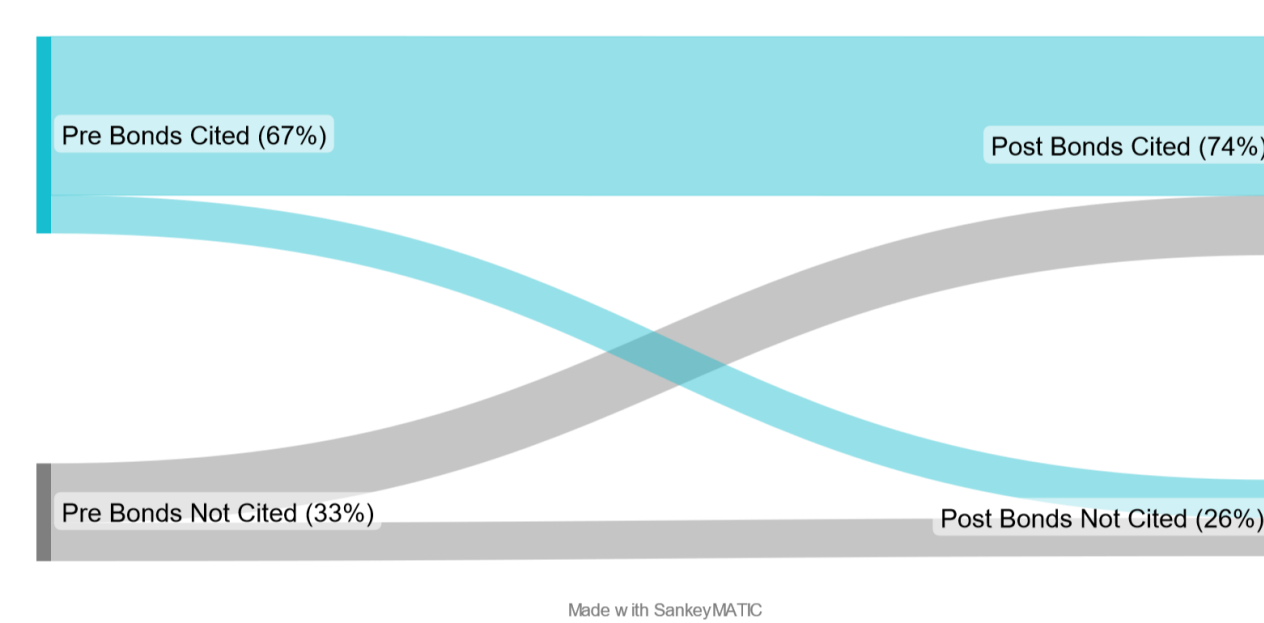
* SUBSET: CONSISTENT REASONING ONLY PRE/POST

Chi Square Testing on 2x2 Contingency Tables; $\alpha = 0.05$

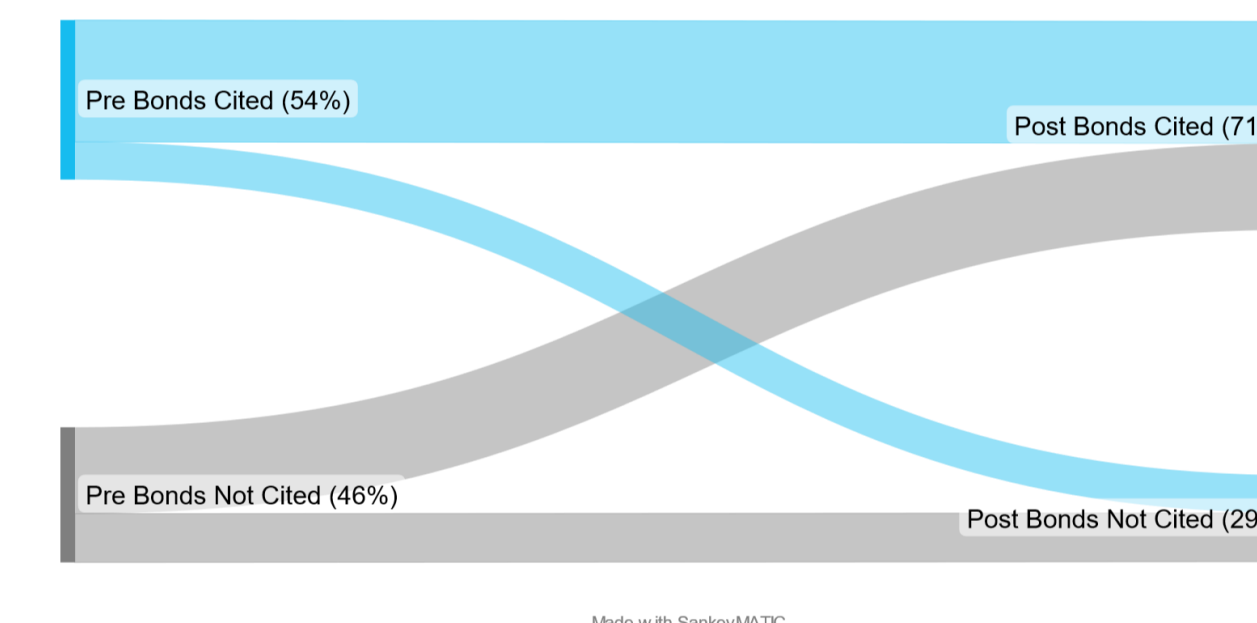
		HCN Post		
		Bonds/None	Symmetry/None	Shapes/None
HCN Pre	Bonds/None	$p < 0.05$		
	Symmetry/None		$p < 0.05$	
	Shapes/None			$p < 0.05$

		Propene Post		
		Bonds/None	Symmetry/None	Shapes/None
Propene Pre	Bonds/None	$p < 0.05$		
	Symmetry/None		$p < 0.05$	
	Shapes/None			$p < 0.05$

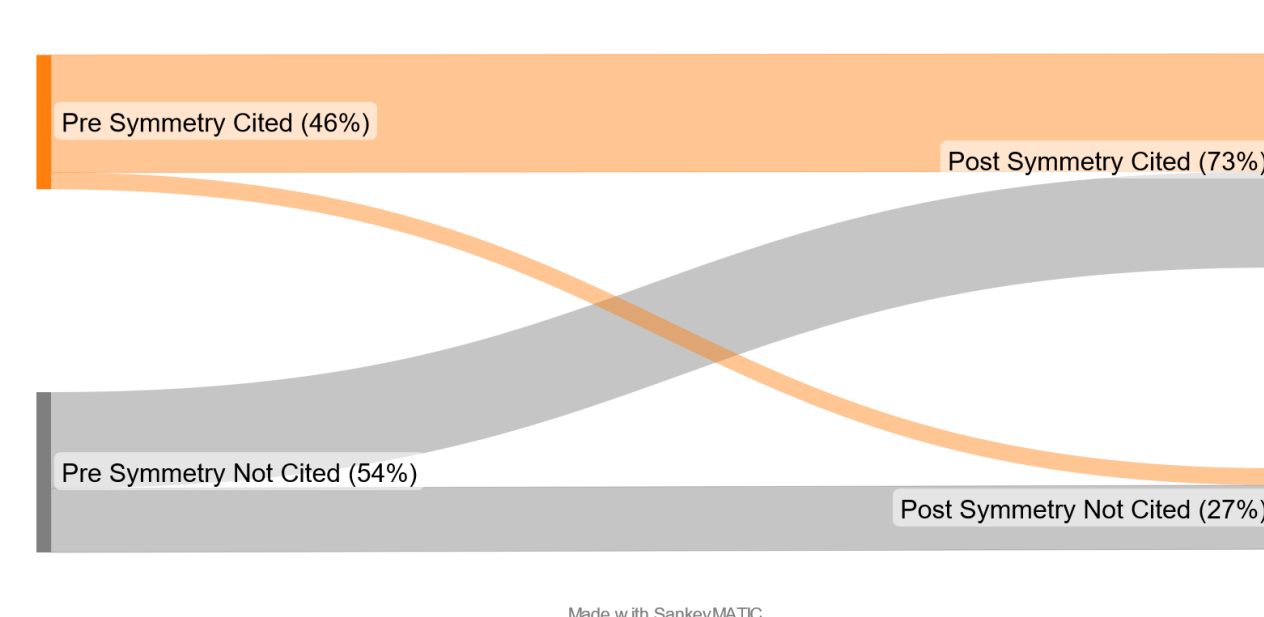
HCN Pre/Post Bonds; N=193



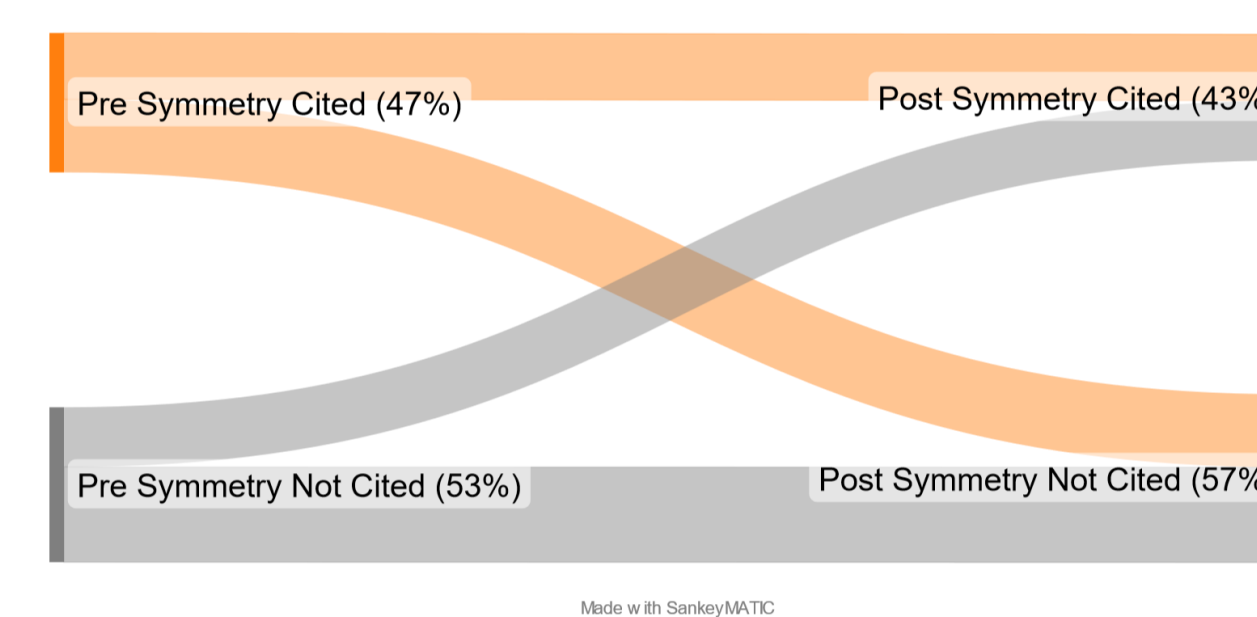
Propene Pre/Post Bonds; N=133



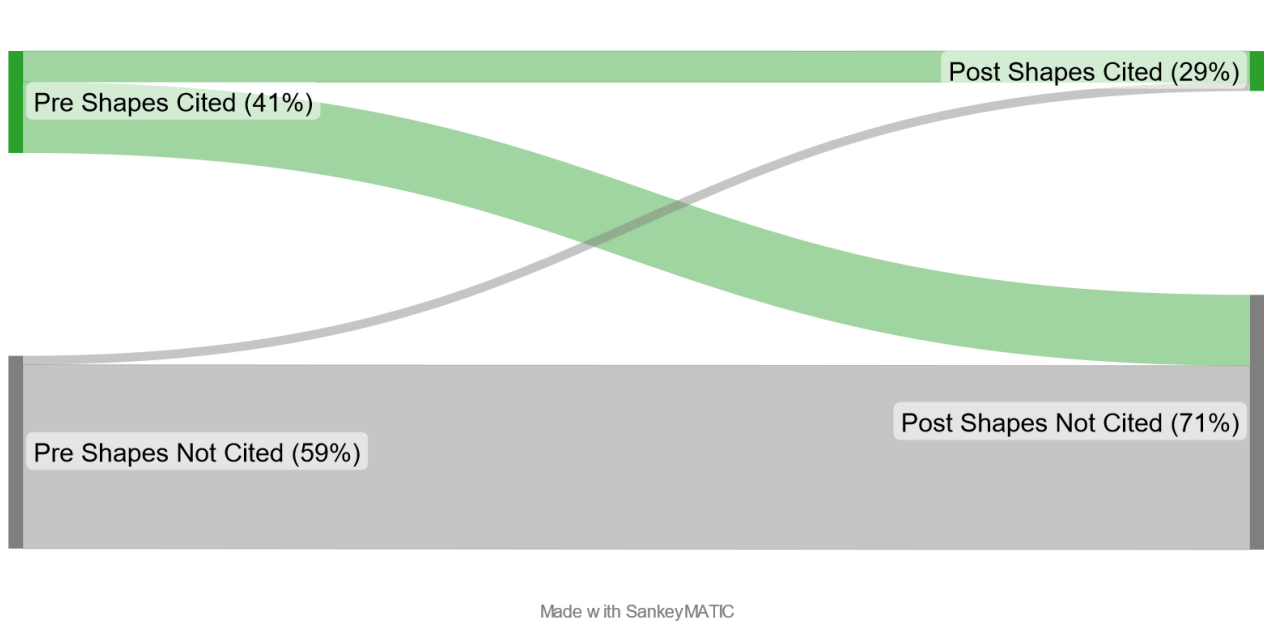
HCN Pre/Post Symmetry; N=193



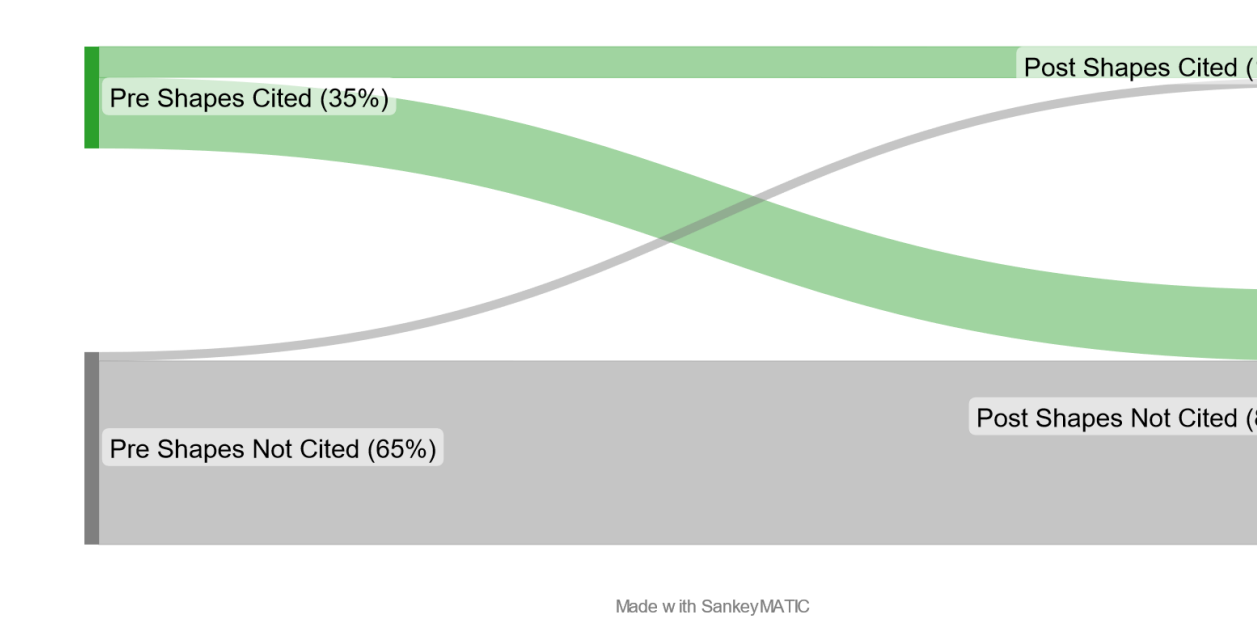
Propene Pre/Post Symmetry; N=133



HCN Pre/Post Shapes; N=193



Propene Pre/Post Shapes; N=133



RESULTS

- Molecular Polarity Pre/Post Assessment with this analysis is a useful tool for investigating student reasoning
- Pre/Post provides evidence of Intervention learning gains:
 - Increase in Correct % (HCN +2%, Propene +11%)
 - Increase in "Consistent Reasoning Only" (HCN +3/+5%, Propene +14/+41%)
 - Increase in mean confidence for both (+12% \geq)
 - Decrease in guessing for both
 - Largest increase in symmetry reasoning for HCN (+27%*)
 - Largest increase in bonding reasoning for Propene (+17%*)
- Statistically significant differences in Pre/Post citation patterns of bonds, symmetry, and shapes reasoning for subset of students

FUTURE WORK

- Complete data analysis (Pre/Post, qualitative open-responses, molecular representations, etc.)
- Additional Molecular Polarity Intervention research:
 - Longitudinal study for retention of learning gains
 - Generalizability study with larger data set of greater diversity
 - Qualitative study to capture the student experience
- Create additional Perceptual Learning Intervention modules for challenging chemistry concepts

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