

Author(s)	Avatar(s) & Environment	Suggested Learner Audience
Simulations for Secondary Science Teachers Conference Amy Bekins Dr. Martha Day Dr. Meenakshi Sharma Dr. Jomo Mutegi Dr. David Slykhuis Mursion Jordan Don	Host Avatar(s) Nina/Michael Simulation Avatars Ciara, Angela, Jordan, James, Stephanie Environment [ML3z] HSI Classroom	<ul style="list-style-type: none"> Pre-service Chemistry teachers
Delivery Mode(s) Available for Scheduling 1:1, Facilitated Group		
This scenario was created in partnership with AACTE and the convening, Enhancing Science Education through Virtual Reality: A Conference to Design Simulations that Enhance the Clinical Preparation of Secondary Science Teachers, is funded by the National Science Foundation (NSF) 20-572 Discovery Research PreK-12, award #2040747.		

Learner-Facing Vignette:

You are a High School chemistry teacher teaching an instructional unit on the polarity of water. You assigned the following assignment.

Draw a model which shows the polarity of water as well as the molecular interactions that cause surface tension in a drop of water. As you develop your model, consider the following:

- Make sure you label the partial charges in the water molecules.
- Make sure the interface (point where two systems meet/interact) between the water molecules and air particles is clearly shown.

Your class of five worked in pairs and one student volunteered to work alone. They have completed their assignments. You will now review each group's work (see supplemental materials) and elicit student thinking.

Outcome:

Elicit each student's thinking on their assignment.

Strategies/Best practices to consider:

- Ask open ended questions and ask follow up questions for clarification based on concepts/misunderstandings that you uncover.
- Match the students language
- Do not interject your understanding or assumptions into the students understanding

Information about Intensity Level: Low

- Low intensity sessions are meant to build confidence for the learner. This setting is recommended for first time learners.

Supplemental Materials:

This scenario is gearing toward practicing the following of the [Next Generation Science Standards 8 Practices of Science & Engineering](#):¹

Developing and Using Models
A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.
Constructing an Explanation (for science)
The products of science are explanations.
Obtaining, Evaluating, and Communicating Information
Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

Information for Course Instructor Scenario Selection:

This lesson utilizes the following Next Generation Science Standards listed below:²

- HS.PS1.3** - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
- RST.9-10.7** - Translate quantitative or technical information expressed in words in a text into visual form (e.g. a table or chart) and translate information expressed visually or mathematically into words.

Student Prior Knowledge

You have already taught instructional units on the following topics, but students still have varying levels of understandings on each topic:

Intermolecular Forces

Covalent Bond

Electronegativity

Polar molecules

Nonpolar molecules

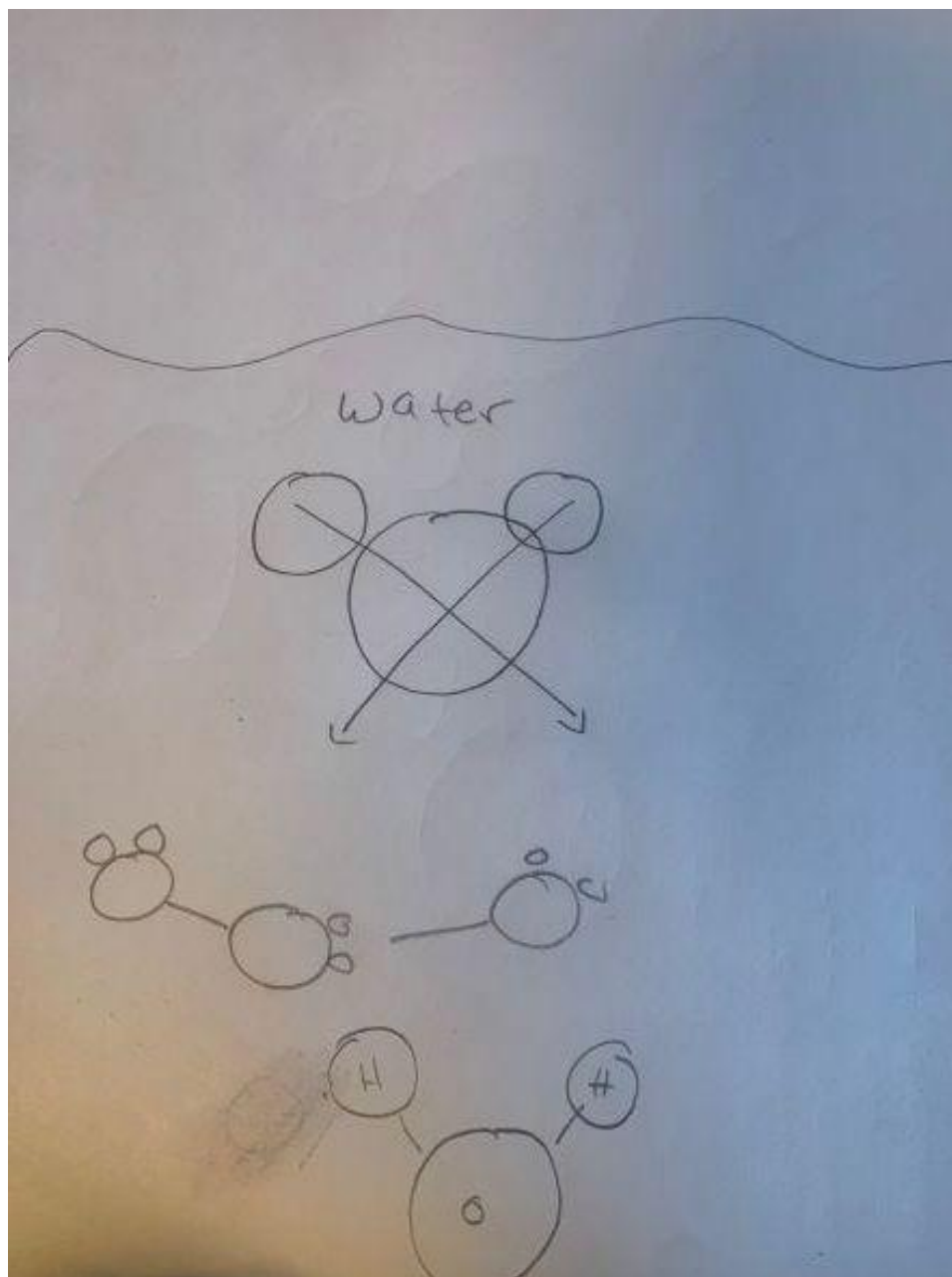
Hydrogen bond

Surface Tension

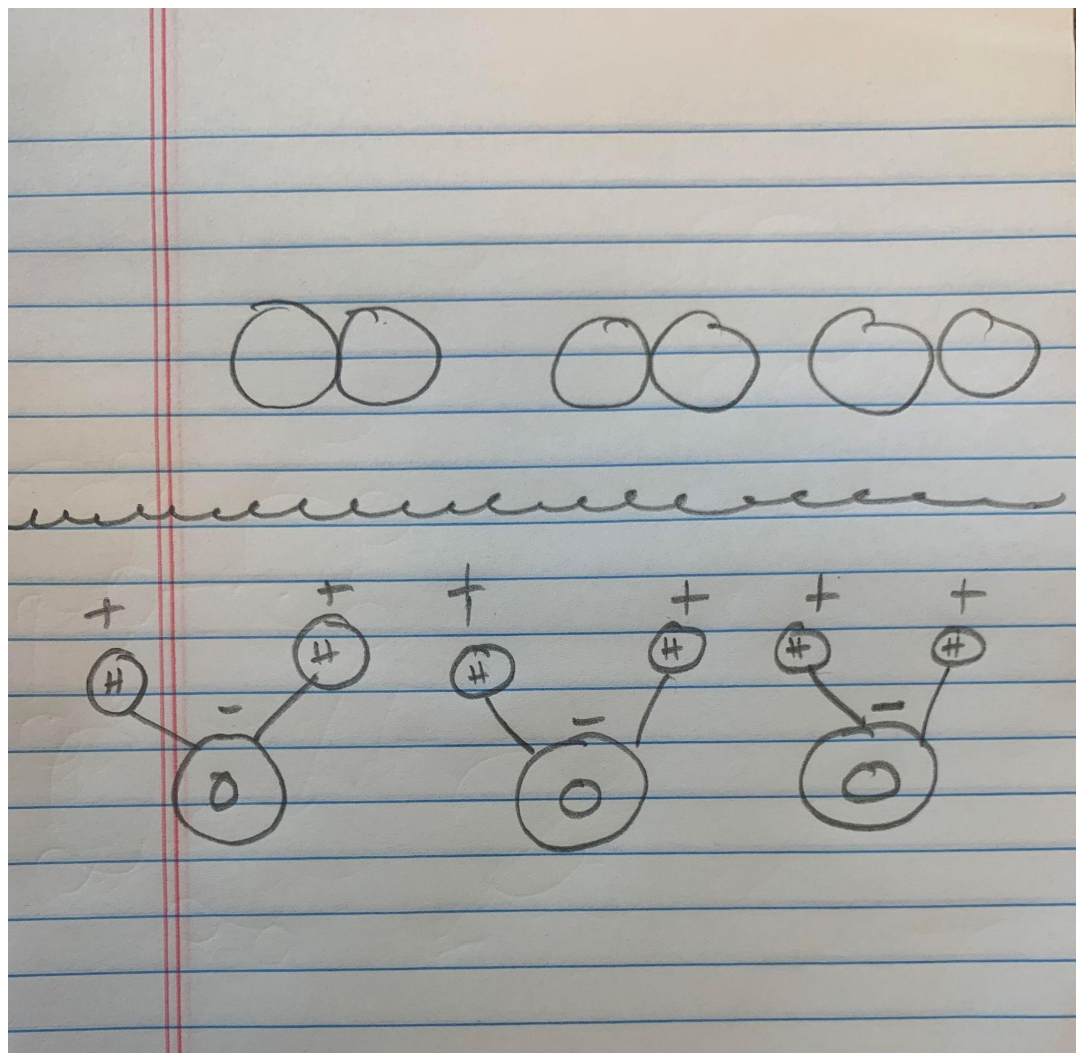
¹ NSTA, and using information from Appendix F of the Next Generation Science Standards © 2011, 2012, 2013 Achieve, Inc. "Science and Engineering Practices." *National Science Teaching Association*, 2014, <https://ngss.nsta.org/practicesfull.aspx>. Accessed 10 8 2021.

² Achieve. "Next Generation Science Standards." *Next Gen Science*, 2013, <https://www.nextgenscience.org>. Accessed 10 July 2021.

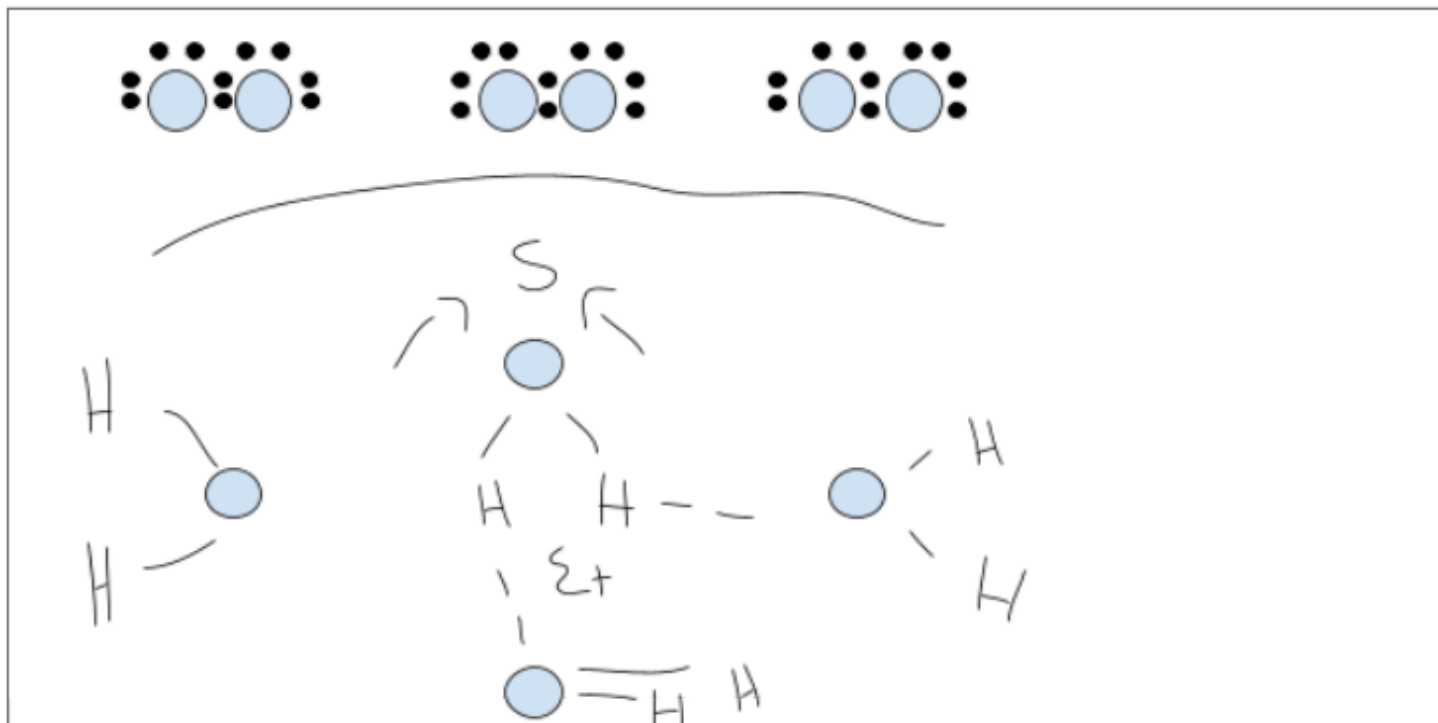
Ciara and Jordan



Angela and James



Stephanie



Background (Internal, not Learner-Facing)

Review Time Advanced Mursion Bank: up to 1 hr 15 mins Independent Study 1 hour rehearsal with trainer bill to Trainee directly to Client	Delivery Mode(s) 1:1, Facilitated Group
Scenario Specific Content Intensity Level: <ul style="list-style-type: none">Low: Students will begin ready to work. They will generally be easily engaged and interested. 1 or 2 students may exhibit 1-2 off-task behaviors but will easily be redirected. Host Specific Inquiries: <ul style="list-style-type: none">N/A	

What is this scenario intended to address?

This scenario is intended to give learners an opportunity to practice eliciting student thinking effectively in Chemistry without imposing their own understanding on the students.

Simulation Specialist Goal:

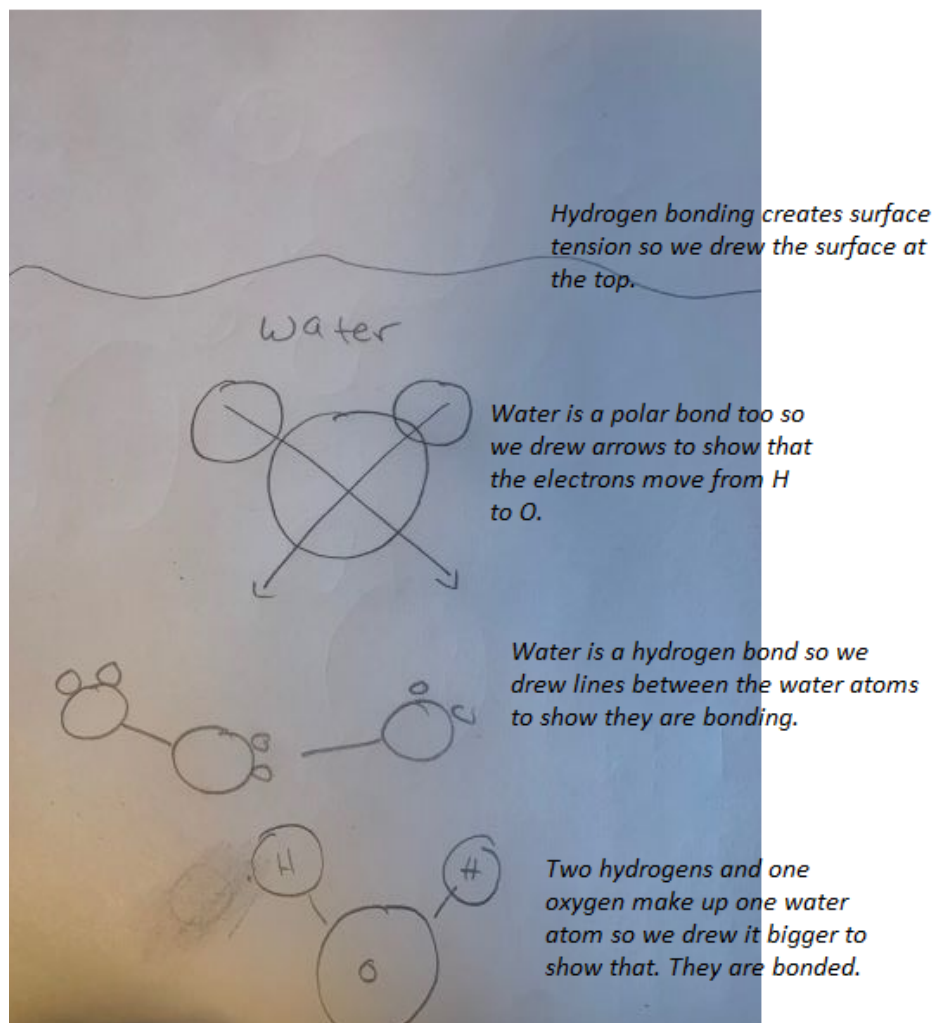
Present an authentic and engaging opportunity for the Learner to practice eliciting student thinking one-on-one and with a small group of students.

Avatar's perspective:

NOTE: This scenario requires the SIM to have a basic understanding of Polarity and Surface Tension as it relates to water. Please review the [Sim Specific materials](#) in depth *before* reviewing the avatar perspectives. Once you have completed the independent study (SIM Specific Materials AND Avatar Perspectives), note any questions you have and reach out to Julie or Jordan to set up a rehearsal at least 2 days before your scheduled simulation. This simulation is robust, it is suggested to have two tabs open or information in front of you, one with the cheat sheet of chemistry concepts and one of the avatar perspectives to easily switch between the two.

Ciara and Jordan

Student Explanation



Misconception: Does Not Fully Understand Surface Tension

While this model is very unspecific, they do understand a lot of the concepts but did not create the model appropriately. They **do NOT fully understand what causes surface tension**.

They DO have a strong understanding on polarity, hydrogen bonds, electronegativity.

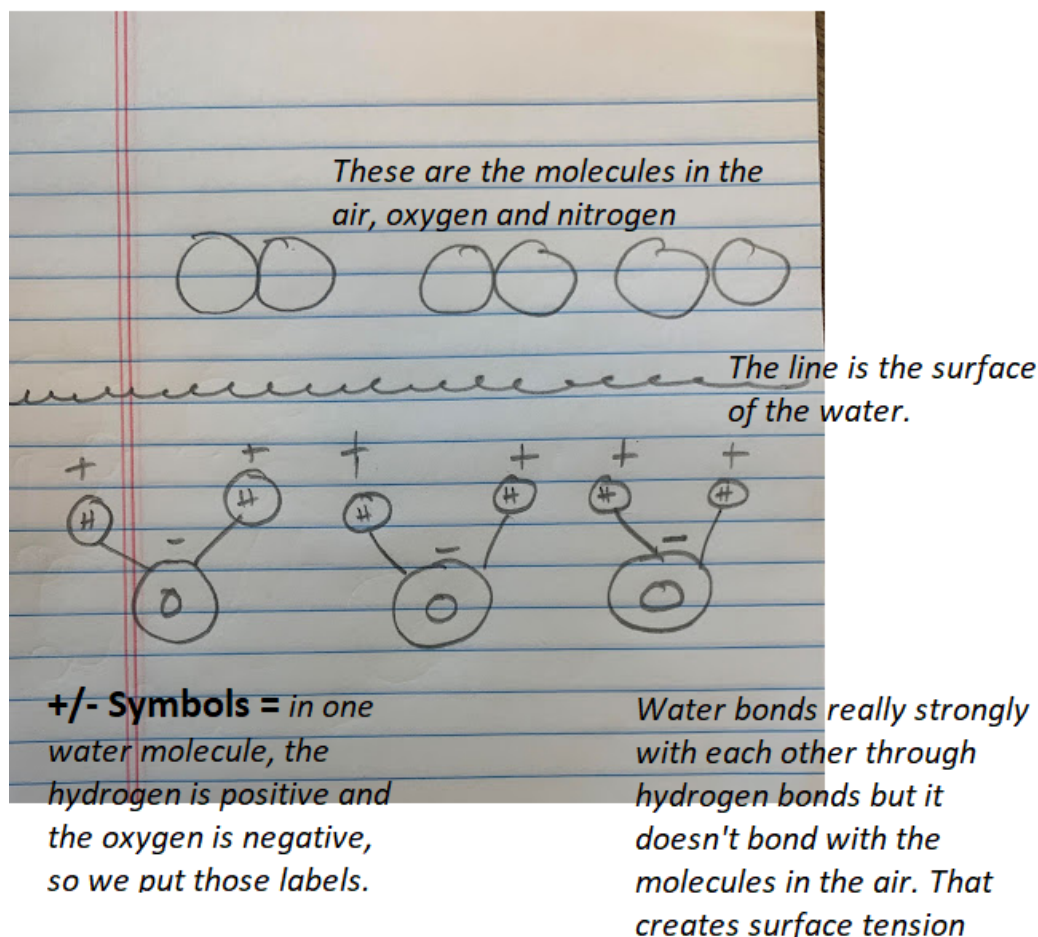
Possible Questions and Responses

- Why are the arrows pointing the way they are?
 - To show polarity. Electrons are moving from Hydrogen to Oxygen. They are sharing electrons but the electrons spend more time with Oxygen.
- Explain more about the lines that bind the water molecule?
 - The molecules are attracted. Hydrogen bonds to oxygen of the other atom.

- Oh, I guess we didn't draw it exactly right.
- What is the squiggly line on the top and why did you draw it?
 - Its the surface of water. Isn't that how its supposed to be drawn?
- What creates surface tension?
 - Hydrogen bonds? We're not sure.

Angela and James

Student Explanation



MISCONCEPTION: They do not have a full understanding of polarity nor partial charges. They think that in one water molecule, Hydrogen is positively charged while oxygen is negatively charged. They have a surface level understanding that hydrogen bonding within the water and the lack of interaction with the outside air is what causes surface tension.

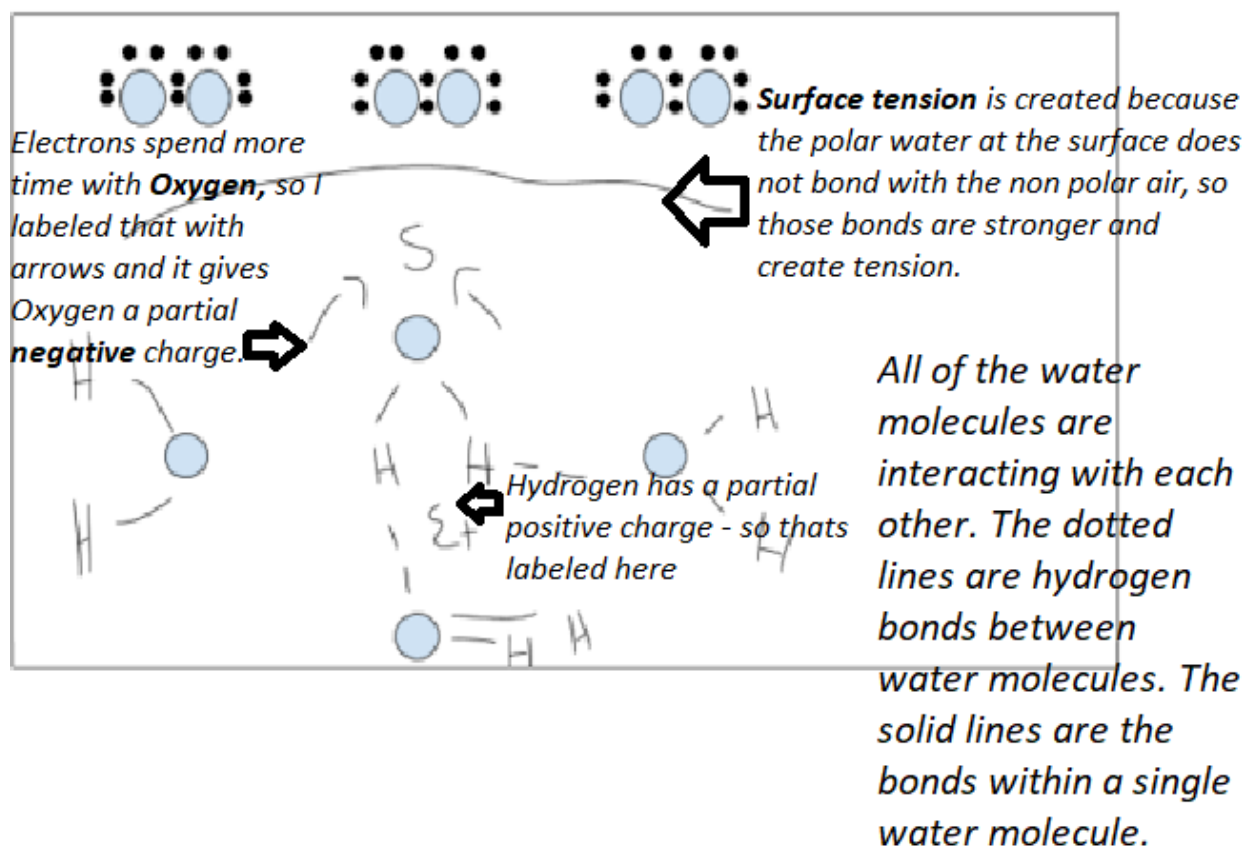
Possible Questions and Responses

- Why did you label the H with a + and the O with a -?
◦ Hydrogen has a positive charge and O has a negative charge.
- How do they get that charge?
◦ Umm, because of the electrons.
- Is the water polar or nonpolar?
◦ I think its polar because of the negative and positive charges?
- Why is water a hydrogen bond?
◦ Anything that bonds with hydrogen is a hydrogen bond, and oxygen is bonding with hydrogen in a water molecule.

Stephanie

Student Explanation

At the top is the air molecules, which are non polar bonds and do not bond with the water molecules



What the student did: Stephanie has the strongest understanding of all concepts and the most detailed model but it is still lacking some details and clarity. She can, however, articulate all of the concepts clearly and will be the one to help her peers out if prompted by teachers.

POSSIBLE QUESTIONS THAT CAN BE ASKED TO THE GROUP? (Any student can answer)

- Why does water have a bent shape?
 - *Students do not know/are unsure.*
- In most of your models, the O and H atoms are different sizes, why is that?
 - *Oxygen is much larger than Hydrogen.*
 - *Oxygen has 8 electrons in its inner and outer shell*
 - *Hydrogen only has 1 electron.*
- Most of you indicated the surface with a wavy/squiggly line, why is that?
 - *That's just the way the surface looks?*

SIM CHEAT SHEET - to be used in simulation. In a real classroom, students would have their notes to refer too, so SIMS can have them to, even though avatars might not fully “understand”, they would have written notes.

Sim Specific Information:

NOTE: Please review the concepts in the order they are listed as an understanding of each is required for a full understanding of the following concept.

Intermolecular Forces - the forces of attraction or repulsion between neighboring particles (atoms)

Covalent Bond vs Ionic Bonds: **Covalent** - a chemical bond that involves the sharing of electron pairs between atoms. These electron pairs are known as shared pairs or bonding pairs. The stable balance of attractive and repulsive forces between atoms when they *share* electrons is known as covalent bonding. **Ionic** - “ions” are formed when atoms lose or gain electrons by transferring from one atom to another. The resulting ions are then oppositely charged. The ions are then attracted to each other because they have opposite charges. This bonding is called an ionic bond.

Electronegativity: (stop at 0:47) Electrons carry a negative charge. Electronegativity is the ability to attract electrons. If electronegativity is high, then it pulls at the electrons strongly. If it is low, it does not pull at electrons as much.

Nonpolar bond (start at 0:47): when two atoms have a similar electronegativity, when they bond and share electrons, they share them equally. The charges between the atoms are balanced and there is no difference in charges at the poles.

Polar bond (start at 1:18) Atoms do not always share the electrons equally. A polar bond is a covalent bond between two atoms where the electrons forming the bond are unequally distributed. One atom spends more time with the electrons, therefore taking on a partial negative charge. The atom that spends less time with the electrons carries a partially positive charge. The bonded atoms, therefore, have a partial and opposite charge at either “poles” of the atom, one being partially negative, the other partially positive.

Hydrogen bond: A type of polar bond that occurs in molecules containing hydrogen and the highly electronegative elements nitrogen (N), oxygen (O), or fluorine (F). **Water is a hydrogen bond.**

[Video explanation of electronegativity, polarity and water hydrogen bonding](#)

Polarity of Water: The electrons are unequally shared, with the oxygen atom spending more time with electrons than the hydrogen atoms. Since electrons spend more time with the oxygen atom, the oxygen atom carries a partial negative charge and both hydrogen atoms carry a partial positive charge.

Surface Tension - the property of the surface of a liquid that allows it to resist an external force. The term is typically used when the liquid surface is in contact with a gas. In this case it is water and air. The water molecules in the center or bulk of the water are forming many weak hydrogen bonds with the other water molecules. The water molecules at the surface, however, do

not bond with the air and only bond with what is below or next to them in the bulk of the water. Because there are fewer hydrogen bonds at the surface, the bonds are actually stronger and creates “tension” at the surface.

More resources

[Video explanation of polarity](#)

Periodic Table: arrangement of elements

Rows: Periods (series) the atomic number of the elements increase as you move along the periodic table

Metals are on the left side of the staircase, **nonmetals** are on the right side. **Metalloids** form the staircase.

Columns: groups (families)

Example of a Good Model with correct labeling

There is no interaction between the air molecules and the water molecules at the surface, so the water molecules are the surface are not experiencing any pull from the side that faces the air. They only experience pull from the sides and below them. Because they have of the pulls (hydrogen bonds), those bonds are stronger, creating surface tension.

AIR



SURFACE OF WATER

Key

	Polar Bond
	Hydrogen Bond
	Partial Negative Charge
	Partial Positive Charge

