FINAL POSTER – Sabrina Shisler
TE 804

Unit Title: Chemical Bonding/Formulas/Shapes
Course and grade: General Chemistry; 10th Grade

I. Unit Planning

Synthesized Unit Objectives –

- State the characteristics that distinguish a compound from other types of matter.
- State two pieces of information a chemical formula represents.
- State the difference between ionic and covalent compounds (MI C.5.5A).
- Define or recognize: cations, anions, monatomic, and polyatomic.
- Given the name, write chemical formulas for ionic and covalent compounds using Charts I & II (MI C.4.2c).
- Given the chemical formula, write the names of ionic and covalent compounds using Charts I & II (MI C.4.2d).
- Define chemical bonding and indicate the two types of bonding and what they are.
- State the three types of intra-chemical bonding and state what characterizes each type.
- Between two elements, determine the type of bonding using electronegativity difference (ionic & covalent) (adapted from MI C.4.3e).
- State the difference between polar covalent and non-polar covalent bonds (adapted from MI C.4.3e).
- Draw Lewis dot formulas to represent what is happening during ionic and covalent bonds.
- Define the terms: cation, anion, unpaired electrons, lone paired electrons, bonding paired electrons.
- Describe hybridization and state which groups will hybridize.
- Draw Lewis structures, determine the number of bonded and non-bonded electron pairs (about the central element), and describe the shape of the molecules (about the central element) (MI C.5.5c).
- Determine the polarity for molecules with more than one element (MI C.4.4b).

Big Ideas/ Content Statements –

Structural formulas do not tell the shape of a molecule, but they are used to determine the number of unshared electron pairs and the number of bonds. Ball-and-stick models are often used to indicate molecular shape. When atoms bond, the valence electrons usually are found in pairs, either on one atom (unshared pair), or shared between two atoms forming a chemical bond (bonded pair). Both unshared and bonded pairs of electrons will repel other pairs of electrons due to the repelling of like charges. The valence-shell electron pair repulsion theory (VSEPR theory) was proposed because of this repulsion force between electron pairs. The VSEPR theory states that the pairs of valence electrons are arranged so that they are as far way from each other as possible in small molecules. The VSEPR theory does not apply in all molecules. Most exceptions include molecules that contain transition metals. There are five common molecular shapes, linear, trigonal planar, tetrahedral, pyramidal, and bent. The shapes of the molecules can be represented by Lewis Dot structures, and a way to discuss the arrangement of the bonds is to consider the bond angles in the molecule. A bond angle is the geometric angle between two adjacent bonds.

Ionic bonds are between an element that is a metal and a nonmetal element. The electrons are transferred from one atom to another in the formation of an ionic bond in order to obtain the octet, which consists of 8 valence electrons in the outer shell of the atom. The atoms acquire net charges when the electrons are transferred. The cation is the atom that is going to lose electrons to gain a positive net charge. The anion is the atom that is going to gain electrons, therefore acquiring a net negative charge. Covalent bonds are between two nonmetal elements. The electrons are shared between the elements. The number of covalent bonds that are formed depends upon the number of unpaired electrons in the outer shell, which is represented by Lewis dot formulas. The number of unpaired electrons in the dot structure is equal to the number of covalent bonds that will form in the molecule. Ionic bonds are stronger than covalent bonds because the force of attraction between the oppositely charged ions in the ionic bond is stronger than the force of attraction that exists when the electrons are shared in covalent bonds.

Annotation – I made the unit more interesting for the students by providing examples that the students may be familiar with from their everyday life. Some examples are the use of ammonia, water, and methane as examples for covalent bonds. The activities I provided as experiences for students throughout the unit included the use of Knex and gummy bears to show the shapes of molecules.

II. Lesson plans for 2 – 4 days (approximately 1 objective)

Objective – Draw Lewis structures, determine the number of bonded and non-bonded electron pairs (about the central element), and describe the shape for molecules (about the central element).

Major activities –

- Simulation and Knex activity: showed simulation of shapes online, then had students form molecules using Knex pieces. They drew Lewis dot structures, ball and stick models, and designated the geometry of the molecule.
- Example problems from notes and homework: when I presented how to do the front page of HW #3, I showed Styrofoam ball and stick models of the molecules.
- Gummy bear lab: the students formed given molecules with toothpicks and gummy bears. The students had to fill in the table before constructing the 3-D model of the molecule using the gummy bears. The table included determining the number of shared and unshared electron pairs, the shape of the molecule, and the polarity of the molecule. I walked around to give guidance as needed.
- Concept map presentation: used a concept map to review the main concepts of the unit before the test. I asked guiding questions to have the students explain the connections between concepts as a whole class.

Annotation – The simulation introduced the concepts involved in the Knex activity. The Knex activity required the students to draw the Lewis dot structure, determine the geometry of the molecule, and draw the ball and stick model for each molecule, which was also a requirement for the homework assignment. The notes introduced another concept of polarity, which was an added requirement for the homework assignment. The gummy bear lab gave the students a more concrete, hands-on example of making a 3-D molecule. It required knowledge of all the concepts presented in the notes and asked in the homework problems.

III. Analysis of student work (from the above activity cycle)

Simulation and Knex Activity - Most people drew the correct number of valence electrons for the elements involved in the bonding, but a few students had the wrong number of bonds. Most students had the correct geometry, especially if they had the correct drawing. Many students drew the molecules in 2-D rather than 3-D. The most common incorrect/incomplete response was that students did not take into account the greater repulsion of the lone pairs of electrons than the shared pair of electrons.
If the students did not remember what they had learned in past units, then they struggled with the construction of the molecules and drawing the Lewis dot structures. The scaffolding from prior units was helpful and necessary, but the simulation was not needed for students to have good understanding of the concepts.

Example Problems from Notes and Homework – Students did well determining the shape of the molecule, drawing the Lewis dot structure, and counting the number of shared and unshared electron pairs for the homework problems. The most common mistake that students gave the incorrect polarity of the molecule. I had only introduced the polarity of the molecule as a whole as I went over the front of the homework, so the students were just learning how to determine whether the molecule was symmetrical or not. Many students forgot to list one of the answers, most commonly the number of unshared and shared pairs of electrons were omitted from their answers. A few of the molecules gave the students particular difficulty, such as NOCl and C_2H_2. These molecules require double and triple bonds, so I believe that is why the students had trouble with drawing the Lewis dot structures for these molecules.

Gummy Bear Lab – Students did well determining the number of shared and unshared electron pairs for the molecules that did not have double or triple bonds. They also did well determining the geometry of the molecule. The overwhelming misconception was the polarity of the molecule. Many of the students gave the incorrect polarity of the molecule. There were a couple of molecules that gave the students particular difficulty. The molecules were N_2 and H_2S. The problem with N_2 was the determination of the shared and unshared pairs of electrons because there is not a central element since it is a binary compound. The problem with H_2S was the sketch of the molecule, which led to incorrect determinations of the shape of the molecule.

Concept Map Presentation – The concept map was presented to the class as a whole, so it was difficult to form a summary of the ideas. A couple of students had a difficult time remembering the two main type of bonding we had discussed, inter- and intra-chemical bonding.

IV. How I adjusted my lesson.

Simulation and Knex Activity - I decided to present the homework and model how to do the first page instead of doing the simulation. After I presented the homework problems, I still had the students complete the Knex activity. 1^{st} block finished the activity much faster than 5^{th} and 7^{th} blocks and their answers were closer to the ideal responses. Next time I would either get rid of the simulation demonstration, or shorten it so that I only showed the 3-D model. I could use the simulation as a link on the notes presentation, and I would only take a couple of minutes to present the link.

Example Problems from Notes and Homework - I think that I would present the homework the way my mentor did from the beginning because 1^{st} block seemed to understand the concepts a little better than 5^{th} and 7^{th} blocks based upon the analysis of the ideal responses. I emphasized how to determine the polarity of the molecule more in 1^{st} block after I saw that that concept was causing 5^{th} and 7^{th} block students the most difficulties. The emphasis helped a little, but not enough to tell if the difference in results in the analysis was due to that increased emphasis. I think this activity works well the way it is, but I may include an example molecule on the front that requires double or triple bonds. The introduction of double and triple bonds was made for binary compounds, but I think the double and triple bonds in the tertiary molecules caused the students some frustration.

Gummy Bear Lab - I changed the lab so that I had each person fill out a handout in 5^{th} block, but it took too long to mark when the students showed me their gummy bear molecules for every person, so I decided to have one handout turned in per pair. Next time I do this lab I would get more gummy bears per group so that I would not have to check every two molecules constructed. Maybe I could check every three or four molecules if I gave each group a few more gummy bears. I was pretty busy checking their molecules, especially for the large classes. This time spent checking the molecules could have been spent giving the groups that had incorrect or incomplete molecules extra help.

Concept Map Presentation - When I showed my video on this stage of my application activity cycle, some of the people in my group suggested that I have each student complete a concept map the class before so that the students can tell me how to construct the concept map. Another person in the group suggested that instead of having the concept map already made, I could have made the concept map as we went along. This could have kept the students more engaged in the review activity. Another way to keep the students more engaged could have been to have the students write down the concept map for some points.