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Teaching Atomic Structure Using Cooperative Learning

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Background Information

Cooperative Learning is a teaching pedagogy that is great to use, but often challenging to implement. In a high school general chemistry classroom (non-honors level), the range of math abilities across the student population often means that some students catch on quickly to the algebra-based concepts. Other students struggle with very basic algebra. The beauty of using Cooperative Learning is that the science teacher can use the higher ability students as another resource for the students that need to have concepts reinforced. In this atomic structure lesson, cooperative learning is used to teach the concepts of atomic number, mass number, isotope, and nuclear atom. Each learning group is created with the strengths (and weaknesses) of the students in mind. The students with a higher ability are challenged to help explain the atomic structure concepts to their peers. The students of a lower ability aren't left "off the hook". They are still responsible to teach their peers one of the atomic structure concepts, however, they are given a concept that is more clearly defined.

Lesson Plan

Overview

Students were placed in cooperative learning groups with the goal to teach the other members of their group a sub concept of atomic structure. Within each group, students took on the following roles:

Member A Atomic Number Expert.

This person was responsible for teaching the other members of the group what Atomic Number means. They explained how atomic number is found using the periodic table. These students also related atomic number to number of electrons and protons.

Member M Mass Number Expert

This person was responsible for teaching the other members of the group what Mass Number means. They explained how to find mass number and how it relates to any subatomic particles (proton and neutron).

Member I Isotope Expert

This person was responsible for teaching the other members of the group what an Isotope is. They explained how isotopes of one element are the same and how they are different. They also drew pictures of nuclei of different isotopes of the same element.

Member N Nuclear Atom Expert

This person was responsible for teaching the other members of the group how to show Atomic Number and Mass Number using the Nuclear Atom shorthand and the Isotope shorthand.

The groups were determined by the classroom teacher. Ideal group size was 4 students. Groups were balanced for gender as well as algebra ability. The students who took on the role of Member N (Nuclear Atom Expert) were strong leaders and could catch onto the concepts quickly.

Note: This activity is divided into three parts, which may be performed over one or more class sessions, as appropriate for the situation.

Part I.

The cooperative learning groups were formed, and the students worked as a team for the entire activity. For Part 1 the following steps were taken:

- Introduce cooperative learning groups.
- Assign students to their group along with their role.
- Use the section of the class textbook that covers atomic structure as a reference (such as Section 4.3 of *Chemistry*, by Wilbraham, Staley, Matta, and Waterman).
- Give overview of lesson to students.
- Break up students into 4 expert groups. The expert groups were Atomic Number, Mass Number, Isotope, and Nuclear Atom
- In addition to using the text as a reference, also use the periodic table as a teaching tool. The atomic number and mass number experts should become familiar with the location of atomic numbers and atomic weights on the periodic table. The isotope experts should become familiar with how atomic weight is a weighted average of atoms with different mass numbers but the same atomic number. Finally, nuclear atom experts should be able to relate how information is displayed on the periodic table to how it can be interpreted using the nuclear atom model.
- Give each student within the expert groups a worksheet with details about their jobs. They should work on this together. These worksheets should match problems from the chapter and serve as one way for the experts to understand their concept that they will be teaching.

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Part II.

Students continue in their cooperative learning groups and began teaching group members about the concept that they were experts on. Facilitation was done by the classroom teacher (as needed). After a 15-20 minutes of teaching, students again moved to expert groups and let the classroom teacher know what should be put on a quiz that would show competence in their area. The students were also assigned a worksheet to review all 4 concepts as homework so that they are prepared to take a quiz the next day.

This process will only take about 25 minutes. Since students need time on their own to study and prepare for a quiz the next day, the rest of the 45 minute class can be used for review. A review game would be ideal, such as board races or bingo. Using the nuclear atom experts from each cooperative learning group to run the review game would also work well.

Part III.

Then the students graded their worksheets in class and took a quiz over the four atomic structure concepts. The questions on the quiz were determined by the experts of each concept. The quiz was written by the classroom teacher. An example of this quiz follows:

Atomic Structure Quiz	25 pts				
Use the word bank to fill in the missing word. Each word will be used once.					
Atomic number Electrons	Mass number Isotope	protons neutron			
<p>1. The atomic number tells you how many _____ and _____ are in an atom.</p> <p>2. The bold, whole number found on the periodic table is called the _____. It is unique for each element.</p> <p>3. The total number of protons and neutrons in an atom is called the _____.</p> <p>4. An atom with the same number of protons but different number of neutrons is called an _____.</p> <p>5. The subatomic particle that has no charge is called a _____.</p> <p>6. Fill in the following chart</p>					
Atomic Number	Mass Number	Number of Protons	Number of Neutrons	Number of Electrons	Symbol of Element
6	13				
	25	12			
	175			84	
13			15		

Once the quiz has been completed, the students should use the rest of the time remaining to prepare for a lab on isotopes.

Results

Cooperative learning as a teaching method was very effective for teaching the concepts surrounding atomic structure. Because every student had to be an expert in one concept, nobody could behave passively. The groups were set up so that every group had one student that had strong leadership skills.

For the most part, the chemistry students did well with this cooperative learning lesson. There was a general enthusiasm for being able to do group work instead of listen to an instructor teach. As with any group of students, it is often difficult to keep the group on task. The expert groups were especially difficult to keep focused. These groups had six rather than four members, so socializing was a bigger problem.

Overall, this lesson was very effective, despite the classroom management issues. The students tested well on their quizzes. Since this method wasn't used in previous classes, it isn't possible to compare quiz scores from this year to previous years. This will be something that is tracked for future classes when this lesson is used again.

Extensions

In the days following, the students also completed a lab on isotopes in their learning groups. This lab introduced the students to the concept of atomic mass and how to calculate atomic mass. The students also completed a test that covered atomic structure, as well as the history of the scientists involved in the discovery of atomic structure. The unit included how to calculate atomic mass using isotopes and their atomic masses and abundances.

Other possible extensions include having the groups research and describe the chemical similarities of elements in a given column of the periodic table. This is actually a practical use of the material.