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Chemistry 503
Content Integration Project Report
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This report demonstrates how I have integrated and will continue to integrate chemical content into my own teaching for the purpose of enhancing students' content knowledge.

The concept that I have wanted to more fully weave into my courses is how atomic structure and intermolecular attractions are based upon Coulomb's law: $V = (\underline{q_1 q_2})/ r$. I focused upon this physical law because it undergirds many of the periodic chemical properties of an atom (i.e. shielding, nuclear attraction, size, ionization energy, and electron affinity) as well as the intermolecular attractions that govern many macroscopic properties of various substances.

A written expression of Coulomb's idea includes three major points:

a) Opposite charges attract in order to lower energy; same charges repulse in order to lower energy.
b) The greater the magnitude of the charges q_1 and q_2, the stronger the force of attraction or repulsion.
c) The greater the distance between charges q_1 and q_2, the weaker the force of attraction or repulsion.

Development of Content Integration

A medley of pedagogical approaches seemed appropriate for stressing the importance and applicability of Coulomb's law. Most students are familiar with part a) of Coulomb's law, but are not exposed to the way distance and charge magnitude affect attractive and repulsive forces. I wanted to use a POGIL to introduce Coulomb's law in a non-threatening manner, and then use a traditional lecture/ power-point/ problem set format scattered with real-life examples to enforce mastery and inspire interest.

I modified the POGIL idea to fit in with my current lecture style to introduce Coulomb's law. I wrote the formula on the board along with POGIL-like questions. The students had to copy and then work together to arrive at answers, which we then went over. I chose to do a modified POGIL so as not cause any undue stress from students having to look at a mathematical formula in an unfamiliar situation. Once the formula was understood and the effect of the variables were introduced, it was easy to recall the exercise in the future with leading questions.

The idea of shielding and nuclear attraction (with core charge) was introduced via a traditional lecture/ power point format with accompanying practice exercises (e.g. comparing atoms' shielding and nuclear attraction). The relationship between core charge and valence electrons was taught using a POGIL and other worksheets. Students saw the relationship between increasing core charge and increased nuclear attraction (Coulomb's law!).

For the unit on intermolecular forces, which is what I am currently teaching, it seemed best to approach the topic via easily observable properties (e.g. volatility, vapor pressure, surface tension, viscosity) and applications, and then work backward toward introducing London dispersion forces, dipole-dipole force, and hydrogen bonding using a combination of lecture and pictures which reinforce the relationship between the magnitude of charge and the magnitude of intermolecular attraction.

Assessment of Content Integration

Content integration was assessed informally via students' voluntary responses in the classroom (i.e. answers to questions during lecture), the nature of students' questions, as well as more concretely by their ability to express their understanding in written form on open-answer questions on homework and quizzes. Students, so far, seem to understand part a)--Opposites attract, and part b)--Larger magnitude charges have stronger forces.

The last concept, Part c)--Greater distances lessen forces, is not quite mastered, as of yet. I hope to further introduce this aspect of Coulomb's law as the class explores the interconnection between intermolecular forces, physical state, and pressure. I plan on introducing this concept primarily through lecture and notes reinforced with demonstrations and whatever visual aids are readily available (e.g. videos of phase changes, flash animations or models that simulate what is happening on the molecular level). If possible, I will try to develop an appropriate POGIL, but attaining that goal is dependent upon my available time (and sanity).

Current and future goals

Currently, I am seeking to integrate molecular modeling software and visual aids such as flash animation to really help my students visualize the affect of electron distribution, charge magnitude, and distance (as affected by pressure).

In the more distant future, I plan on continuing to reinforce the concept by recalling the law and assessing student application of the law whenever relevant topics may come up. I am sure there are more advanced topics that rely upon an understanding of Coulomb's law, and I would be interested in researching them so that I can give my students a steady exposure to this concept (even in more advanced units).

Next year, I plan on introducing the Coulomb's law concept via a POGIL earlier in the course (within the first two weeks).

Reflection

The primary impact this project has had on my teaching is that it has made me more conscientiously aware of how I, as a high school Chemistry teacher, must seek to integrate my curriculum into the larger framework of scientific learning. The project itself served as a starting point for re-evaluating the time, methods, and depth of coverage assigned to various topics in my syllabus. I want my students to be successful in further physics, chemistry, and biology classes and relatively free from dangerous misconceptions. I would like to say that my second exposure to General and Organic Chemistry has reminded me of what foundations my students must have before going on to college-level Chemistry classes. The next topic that I wish to better expose my students to is the entropy topic that governs how all systems tend toward increased entropy and lowest free energy.

The secondary impact this project has had on my teaching is of a more practical nature. My default teaching mode is lecture (with nice pictures!) followed by a problem set. This project has made me more aware of the benefits and limitations of various pedagogical approaches given the lesson and the aptitude of the students. With topics that involve math or seem unfamiliar, POGILs and PIMs (the more self-directed approaches) at first met with resistance, and in some cases, despair. But, with a little bit of encouragement and the proper distribution of gung-ho, charismatic group leaders seemed to alleviate this problem in most cases. The more comfortable group dynamic and the support of fellow classmates also made students have a greater sense of ownership over their own learning. I have found that a teacher-centered review, however, is necessary for accountability and retention. When doing traditional lecture, the lectures that seemed to engage the student most were, predictably, those lectures that were interwoven with real life examples (e.g. pressure cookers, vacuum evaporators, geckos walking on the ceiling, distillation of alcoholic beverages), visuals, and hands-on lab experience.

I have not been the quickest to completely change my teaching style because though I have a desire to change, I sometimes find it difficult to make the time and effort (in my busy schedule) to change. I have, however, been pleasantly surprised by how worthwhile POGILs, questions of the day, and concept maps have been in improving student retention and review. I am looking forward to the far-reaching progress that results from slow and steady improvement of my teaching over time.