

# TEACHING CHEMISTRY ONLINE

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## Abstract

This paper describes teaching chemistry online using examples from Broward Virtual, a franchise of Florida Virtual School. Selected activities that enhance the online chemistry learning experience are presented along with some observations about teaching chemistry in the online environment. Advantages and disadvantages of online chemistry are discussed.

**Key Words:** Chemistry Education, Online Chemistry Education

## Introduction

Developments in supercomputers and high-speed Internet have increased opportunities for a wide range of online education innovations. It is quite possible to teach chemistry online as the ability to incorporate laboratory simulations, video clips, and soon to come video streaming with the aid of high-speed Internet. Online courses are on the rise both at secondary and post-secondary institutions. The number of online courses continues to increase every year. In the State of Florida, the Florida Virtual High School officially came into existence in August 1997 (1). The current enrolment is over 40,000 students anywhere in the world. This paper describes an online chemistry course offered by the Florida Virtual School through the Broward Virtual Education.

## Adaptations

Teaching online is a demanding task and it requires the teacher to realize that your time is not spent creating and delivering lessons; your time is spent in guiding the students through the online curriculum. Telephone and email contacts with each student are essential to substitute the face-to-face time. Another adaptation is that the student is allowed to submit assignments at least twice for full credit. The student submits an assignment to the teacher and the teacher grades it giving detailed information about the sections of the assignment that are incorrect. This helps the student review the information they have not yet mastered. Then the student is allowed to redo the assignment and submit it for full credit. Each course has a pacing guide that dictates the minimum number of assignments that are to be submitted each week. An important part of the teacher's job is to track the student's pace and to contact the student if they fall behind. Many students comment that it is very easy to get sidetracked by other activities and fall behind in an online course.

## Online Activities

The Online High School Chemistry course incorporates all possible learning styles and learning domains. For example, activities such as students writing a poem about an element, composing a song about petroleum refining, and designing a bookmark extolling the virtues of antioxidants are a part of the chemistry course. The assignments are designed to increase the student's computer skills along with chemistry knowledge. The students must construct data tables, incorporate graphics, design a concept map, convert document files to rich text files (.doc to .rtf) and use a discussion board along with being able to attach a file to turn in their assignments.

At the beginning of the course, a review of basic math and computer skills such as data collection, conversions, graphing, and exponent rules that a student needs to take an online chemistry course is provided. Online graphing programs and graphing calculators are often found on the Internet, free for the students to use as needed in the course. Students have access to all needed information at their fingertips - one click away - it doesn't rely on the student to be organized and retain all of the class notes and work.

The Online High School Chemistry is a laboratory-based course. Often, one of the first questions asked by teachers, students and parents is how the students complete this component. Several chemistry laboratory activities can be adapted to be performed at home fairly easily - those that cannot be adapted at home can be found on the Internet as simulations. It is quite possible to perform most classroom experiments at home with a thermometer and some measuring devices. The thermometer is provided to the students, but the measuring devices are not. If the student does not have measuring cups and spoons with metric measurements labeled, then the student must use conversions to see how many milliliters are in a tablespoon, teaspoon, or cup. Following are some brief examples of experiments contained in the Online High School Chemistry course.

1. Creating Lewis dot models using gumdrops and toothpicks.
2. By crushing red cabbage in hot water until the water turns into a pH indicator that can be used to determine whether chemicals are basic, neutral, or acidic. If the solution turns red/pink it is an acid, if it stays purple it is a base, and if it turns green/blue the solution is basic.
3. By using the red cabbage indicator, vinegar and a variety of antacids, the student can compare the effectiveness of the antacids.
4. An adapted calorimeter experiment, using a burning peanut to warm water in a suspended soda can.
5. Discovering the effect of size, temperature, and agitation on the rate of solution by using rock salt and table salt. This activity is also useful for introducing nanoscience.
6. When vinegar is combined with baking soda - a gas is given off and the students are asked to design an experiment to conserve the mass.

They are asked to submit the numbered steps along with the balanced equation.

7. Using Alka-Seltzer and different temperatures of water, you can determine the effect of temperature on reaction rates. Additionally, by using whole, broken and crushed tablets, you can determine the effect of surface area on reaction rates.
8. Phase changes can be studied by using a pan with water on the stove and a thermometer. Starting with ice, the temperature is taken every 15 seconds, while the pan is heated on the burner. At the end students complete a phase change graph.
9. Students first learn about exothermic and endothermic reactions. Then they measure the temperature inside an empty jar, while soaking a steel wool pad in vinegar. Remove the steel wool from the vinegar and wrap it around the tip of the thermometer and place it back into the jar. Record the temperature and determine whether the reaction is exothermic or endothermic and write the equation.
10. A counterintuitive demonstration to show the effect of temperature on air (mixture of gases) and the effect of pressure: students heat a soda can in hot water, and then immerse it quickly (upside down) into cold water.

### **Online Learning Resources**

United Streaming is a company that has over 5,000 video clips (5-25 minutes in length) that can be utilized in an online course fairly inexpensively. A video clip gives the student a live or animated version of the science content. Another way to deliver interactive experiences for the students is by searching and using suitable simulations available on the Internet. Examples of Internet resources follow.

<http://www.hazelwood.k12.mo.us/~grichert/explore/dswmedia/density.htm> (This site allows students to predict and find the densities of various objects.)

<http://gcsescience.com/> (This site allows students to see and play with the activity series.)

Note: Some sites may require the students to join, while others are free.

### **Discussion and Summary**

There are both opportunities and challenges for teaching online chemistry. According to a report from the Office of Program Policy Analysis and Government Accountability (1) the Florida Virtual School is "generally attaining its mission of reaching underserved students, including students in rural school districts and students in high minority schools" (p. 1). Access to the online

teacher is an advantage because the teacher is much more available for help when the student needs it mostly around the clock.

The availability of content rich resources to select a suitable theme to deliver the content around is a positive aspect of teaching chemistry online. In the Chemistry course the themes are the water treatment plant, petroleum refinery, nuclear power plant, hospital, a fertilizer manufacturing company, and a special effects studio. These themes involve science, technology and society (STS) interactions and help students to realize the importance of chemistry in everyday life.

Another positive aspect is the limitless opportunity for students to revisit and review the information in the lesson numerous times, until comprehension occurs. This helps English as Second Language (ESL) students.

Unfortunately cheating remains an issue with online courses. Cheating can be reduced by using software products, like Turn-It-In-Dotcom. This software searches the web and any previous student work entered into the program to look for authenticity. In math-based subjects the student are required to identify all variables, state the appropriate equation and then solve the problem to receive full credit. Cheating is also not uncommon in the brick and mortar schools and often the teacher is the best line of defense against it.

Often online courses are portrayed as a panacea for improving education. One of the critical factors overlooked in online education is the nature of the subject matter. Chemistry courses demand powerful personal computers for multimedia presentations, simulations, high-level critical interactive discourse, and adequate technical assistance for uninterrupted delivery through the Internet. Teaching chemistry online demands access to a variety of scientific information and the availability of quality chemical information on the Internet. Likewise, policies that favor adequate administrative, fiscal and instructional resources for implementing online chemistry are needed. If not delivered properly, online courses could lead to shallow learning experiences (2). More research and development efforts are critical to shaping technology as an efficient tool for delivering online chemistry instruction. How the Internet is developed to the advantage of students engaged in chemistry learning will determine the success of online chemistry courses.

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