

Chemistry Solutions



AACT ▸ Periodical ▸ Issues ▸ Current Issue ▸ A Student Centered, Web Based Approach to Teaching Unit Conversions

MARCH 2016 | TECH TIP

A Student-Centered, Web-Based Approach to Teaching Unit Conversions

By Zachary Jones

Even before the broad adoption of the Next Generation Science Standards (NGSS), like many other chemistry educators, I had started to move away from teacher-centered instruction.

Instead, I now draw upon student-driven inquiry approaches when designing lessons, and [Process Oriented Guided Inquiry Learning](#) (POGIL) and [Modeling](#) are two of my favorite methods to draw ideas from. I also use technology as a key component in many of my learning activities, because there have been so many wonderful simulations created in the past few years.

The [PhET tutorials](#) from the University of Colorado and the [AACT simulation archive](#) are favorites of mine because, along with a well-written lesson plan, they allow students to guide their own learning at a pace that is suitable for their ability level. However, when it comes to the many mathematical skills in chemistry (e.g., unit conversions, the mole concept, stoichiometry), there are not as many lesson plans that allow students to discover concepts and pace their own learning.



Activity: Unit Conversion Online Tutorial

FOR THE TEACHER

Submitted by:
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Summary:
In this activity, students will interact with a web-based tutorial that uses a drag-and-drop interface to learn how to convert between units of measurement using dimensional analysis. The tutorial allows students to learn at their own pace, and also provides feedback while they are working problems.

Grade Level:
High School or Middle School

Objectives:
By the end of this activity, students should be able to:

- Convert between units of measurement using dimensional analysis
- Understand the purpose of using dimensional analysis for converting between units of measurement

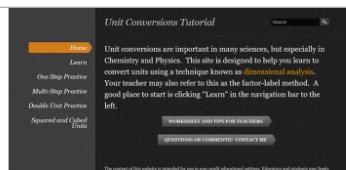
Chemistry Topics:
This activity supports students' understanding of:

- Quantitative Chemistry
- Dimensional Analysis

Time:
Teacher Preparation: minimal
Lesson: 45 minutes

Materials:

- Computer (must run on Windows), compatible with Adobe Flash
- Calculator



Online [Unit Conversions Tutorial](#) homepage.

Over the past few years I have been developing a [web-based tutorial](#) to teach students unit conversions. The tutorial uses a drag-and-drop interface, since web-savvy teenagers are so comfortable with that approach. The tutorial has been effective with my students and it appears that others have found it useful as well. More than 25,000 students and teachers have used the website in the past year [\(1\)](#).

Download the [Unit Conversion Online Tutorial Activity](#) from the AACT resource library.

Who is this tutorial suitable for?

The tutorial is appropriate for any student in sixth through 12th grade who is learning to convert units for the first time. My students are in 10th grade, and most have not learned to convert units in other classes. If they have any prior experience, it is limited to pushing decimals using a handful of metric units. This tutorial has worked well with students who are advanced in math, as well as with those who are below grade level. If a student can confidently multiply and divide, they will find success with the website.

Students should have a basic understanding of units before using the tutorial. Specifically, they need to recognize units of volume, mass, and length. They also should know the difference between metric and English measurements.

How do students access the website?

There is no cost to use the [website](#), and students do not have to register. I often pair two students on one computer to start the tutorial. The goal is to foster conversation and group problem solving. There is a "learn" module in the tutorial, and this is where I recommend that they begin. From there, students go through increasingly challenging modules until they can convert derived units (for example mi/hr to m/s) as well as cubed and squared units (for example ft^3 to cm^3).

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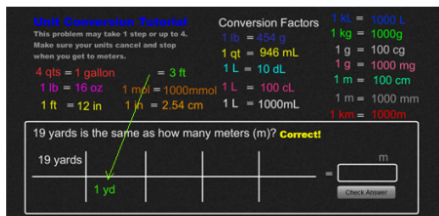
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About the Author

Zachary Jones is a chemistry teacher at Legacy High School in Broomfield, Colorado. He has a B.S. in chemistry from Fort Lewis College in Durango, Colorado, and an M.S. in organic chemistry from Utah State University. Before becoming a teacher in 2005, he was a medicinal chemist for 10 years at Array Biopharma in Boulder, Colorado.

The tutorial uses a dimensional analysis (factor label) approach. Many chemistry and physics teachers teach with this method of problem solving, and I often get emails from educators around the world saying how familiar the interface feels. Students drag and drop parts of conversion factors to see if the units cancel. After each such movement, the tutorial gives the student feedback — either “Correct!” or “Try Again!” Finally, they can calculate the answer and check to see if they are correct.



Tutorial showing dimensional analysis approach.

How is this tutorial more effective than a traditional approach?

The tutorial has built-in differentiation. Because students are allowed to progress through the tutorial at their own pace, they can take the time they need to master the concept. While most of my chemistry students need to be able to convert all types of units, I also teach low-level courses where they only need to be able to do basic conversions. I often have students in these courses who can complete advanced modules, even though they are not part of the course, because they can go at their own pace.

“Students get instant feedback, much like they would receive in a small class, where the teacher can walk around and provide each student attention on the spot.

Students get instant feedback, much like they would receive in a small class, where the teacher can walk around and provide each student attention on the spot. This personal and immediate feedback can be very powerful and in my experience students have increased their rate of learning. In his article, “Seven Keys to Effective Feedback,” [Grant Wiggins](#) notes that quality feedback needs to be timely and ongoing, but does not necessarily provide the student with the solution. Teachers should provide a correction and then allow the student to determine the next steps. With this in mind, the tutorial is designed to give students feedback as they work through the problem. They are prompted to self-correct the moment they make a mistake, which encourages them to think about what they need to do before they can proceed.

Some potential pitfalls—and how to avoid them

I find that students will avoid canceling units if not monitored. This tutorial has undergone many revisions over the years, as I have watched how students interact with the website. It is crucial that they make the transition from drag-and-drop to pencil and paper. To encourage them to do so, I developed a progress sheet that students fill out as they go through each module. Before going on to a more advanced level, they must turn in the progress sheet so that I can verify they are canceling units correctly on paper. At that time, I can also ask clarifying questions to gauge their level of understanding.

To further encourage them to adapt to pencil and paper, the last few problems of each module do not have the drag-and-drop interface, so that the student (and I) can see if they have successfully mastered the technique. (The worksheet is also available for [download](#).)

Because students can learn at their own pace, some will finish all levels in a single class period, while others may take additional time. It is important to have supplementary activities for students who finish early. My students have online homework, so I let those who finish start on their next assignment.

The website does not work on iPads or mobile devices. The tutorial uses Flash-based applets, so it will only work on standard Microsoft Windows computers. I have received a number of emails from teachers requesting that I make the site available on all devices. Unfortunately, this is a side project for me, and my programming skillset is limited. (Anyone who can provide me with help is welcome to leave a comment or contact me through the website.)

The tutorial only improves a student’s ability to convert units. Further activities need to be devised to provide real-world experience with the measuring tools and to develop a sense of the relative proportions of the measurements. (For example: How much material constitutes a mole?) The website also does not explain why units cancel. I usually spend a bit of time the following day demonstrating that any value or unit divided by itself is one, and therefore the units are not actually “disappearing.”

Conclusion

There are many tutorials available for teachers to use when designing a student-centered lesson for a chemistry course. My goal for this website was to address the mathematical challenges in a chemistry course using techniques found in PhET tutorials and POGIL lessons. It is my goal to develop the website to include other specific math-based concepts such as the mole concept, stoichiometry, and solution calculations. I hope that you find the tutorial useful. Please leave suggestions or questions about the website in the comments section

References & Footnotes

1. Website traffic is monitored using Google Analytics.
2. Wiggins, Grant. “Seven Keys to Effective Feedback.” *ASCD Educational Leadership*, Sept. 2012, Vol. 70, 1.