Using Alice’s Visualization Capability to Promote Student Learning in the 9-12 Classroom

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A student’s ability to visualize an abstract concept is the foundation of understanding. Symbolic representations of the concept are often presented in textbooks as data tables, graphs, two dimensional representations, three dimensional representations mapped onto a two dimensional page, and photographs.

Symbolic representations are adequate once a student can refer back to a visual when the symbol is presented. In the field of Chemistry, the electron configuration of the three subatomic particles of an atom: proton, neutron, electron, are often represented in a static form.

Using a three dimension (3-D) software program such as ALICE, provides the opportunity to present the subatomic particles of an atom in a dynamic real time visualization. Students can navigate from outside the atom to the nucleus at the center of the atom and back out by using any device that manipulates the cursor such as a mouse or touch pad.

Manipulation of the mouse allows the student to navigate the electron configuration of any atom on the periodic table, zooming in and around the different electron orbital energy levels of the atom.

This real time model allows the Chemistry student to manipulate the electrons to show electrons moving from one energy level to another and then returning to the original energy level thereby releasing electromagnetic radiation in both the visible and invisible spectrum.

Two of the authors attended a professional development program in July 2008 called SPIRIT (Surprising Possibilities Imagined and Realized through
Information Technology) that taught participants how to use Alice to develop lesson plans in their subject areas. All teachers in the program were required to develop three Alice-based lesson plans. The first author created an interactive Alice world to help his students visualize the electron.

This Alice world helped fulfill part of the requirement for one of the three lesson plans he created in the program.
Most current textbooks and associated online representations rely on demonstrating the concept but not allowing the student to explore the concept model by manipulating it in real time.

Some advanced and polished examples of Interactive Science Simulations are found at http://PhET.colorado.edu the PhET project at the University of Colorado.

These are very sophisticated modeling examples but do not allow the student to modify the viewpoint at will. These Interactive Science Simulations are very well defined with predefined presentation options.

In contrast, the three-dimensional software, ALICE, allows the high school student increased flexibility to interact with the model from a user point of view. Also, with a few hours of introduction to using ALICE, the student can modify the template world to extend the model to other concepts.

The student becomes a co-creator of modeling the abstract concept. This frequently results in a student's increased interest and ownership of the concept model and may lead a student to develop a new model to better visualize the abstract concept.

Students of all ability levels found the ability to navigate through a three-dimensional visual representation of the electron configuration of an atom to be enlightening. The students now had a visual to represent an abstract concept that made little sense previously.