# FREE MODEL-BASED LEARNING RESOURCES

### Robert Tinker, President
### THE CONCORD CONSORTIUM

We are delighted to be able to offer a growing collection of free software and student materials that use this software. Through a series of grants from the NSF and the US Department of Education, we have produced amazing and innovative software packages and incorporated them into hundreds of powerful learning activities. Whatever you teach, at whatever level, we probably have software-based learning activities that can improve your teaching. Our strengths are in science at high school and college levels, but we also have algebra software, and sustainable development materials that can be used across all disciplines.

We are committed to making these materials widely available and, wherever possible, free. This article describes the models, learning activities that use them, and how you can get them. Although free, these are very high quality and have been extensively tested in real classrooms. By using these, giving us feedback, and letting us monitor your students' progress, you can help us collect research data. But that is not required. There are no strings attached. Enjoy and tell your friends.

THREE POWERFUL MODELS

**BioLogica** is a model of genetics built on various inheritance patterns at the level of molecules, genes, and individuals. Growing out of a decade-plus research program, many know the software by its earlier name: GenScope. Students can learn from open-ended exploration of the model or by working through a series of model-based learning activities.

To access BioLogica, you need to request a demonstration account. [Http://mac.concord.org/portalregistration/register.php? action=demo ] You will then be given a username and password that will give you access to a "Software" button on the left-hand panel. Look for biology software.

**The Molecular Workbench** is a sophisticated model of the interactions among atoms and molecules. Learning activities based on this model help clarify what is happening at the atomic level and have been used with all the sciences and engineering from middle school through college. Over 200 learning activities have been made and
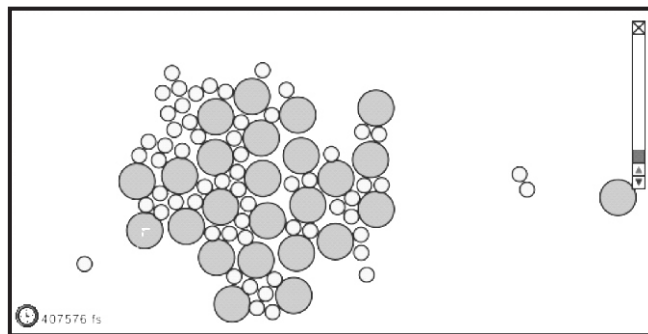


placed in a database. [http://molo.concord.org]. Your first step should be use the "Download Our Software" button to find out whether you have to download some free software. You can then use the database to find an activity, learn something about it, and launch it.

**Dynamica** is a model of classical Newtonian mechanics in two dimensions. Inspired by ThinkerToys, a popular package that ran only on the Commodore 64, this modern version is perfect for introducing vectors, kinematics, and dynamics in physical science and beginning physics courses. To access learning activities based on Dynamica, follow the steps described above for BioLogica, but then look for physics software.

### Activity Authoring

If you cannot find model-based learning activities that fit your needs, perhaps you would like to create your own. We have some great tools that you can use for this. The simplest is WISE [http://wise.berkeley.edu] developed by our collaborators Jim Slotta and Marcia Linn at Berkeley. WISE allows you to make activities or modify ones that
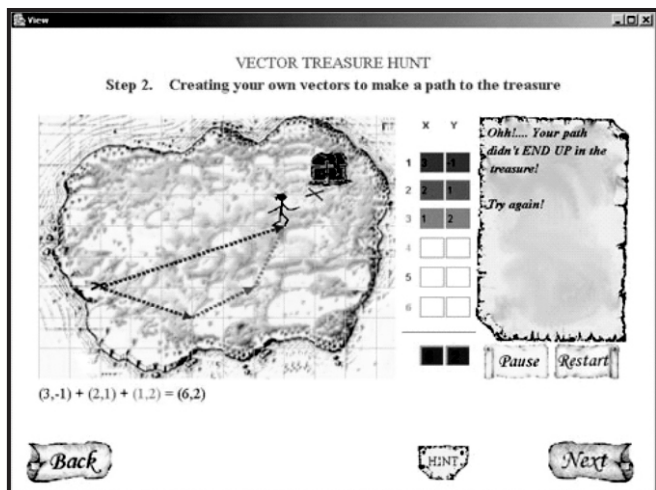
others have made. An activity is constructed from a series of steps. Each step can be one of several dozen kinds of step and each can be customized by filling in a form. One kind of step can be a BioLogica, Molecular Workbench or Dynamica model. This allows anyone to build and deliver a complete Web-based lesson that uses our models.

The **Molecular Workbench** [http://workbench.concord.-org/modeler/index.html] is embedded in its own activity building tool, a very special word processor. This word processor not only handles text, but also one or more models, buttons and other model controllers, graphs and other model outputs, and student response areas. This makes it easy to create documents for students that include models.

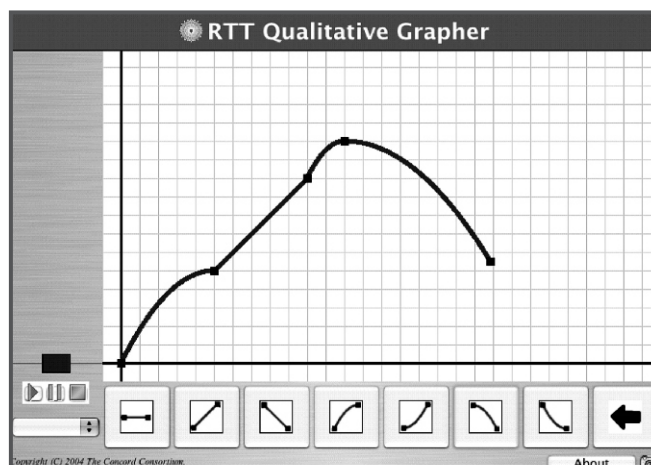For the more technical who need complete control over the software, we have Pedagogica, [http://pedago-gica.concord.org/] a control package that works with any Java application, Flash, and QuickTime.

## ALGEBRA INTERACTIVES

We are developing online courses for algebra teachers that include a collection of very simple but interesting software packages called Interactives [http://rtt.pbs.org/rtt/interactives.cfm] that anyone can use without taking the course. The **Qualitative Grapher** challenges the user to connect motion to a sketch of a graph. The **Linear Transformer** provides a real-time, two-way connection between symbolic and graphic representations of linear functions. The **Piecewise Linear Grapher** extends the previous ideas to graphs composed of pieces of straight lines. The **Function Analyzer** relates three representations of linear functions, including one based on area. While these four Interactives are all related to linear functions, look for more advanced ones soon, along with student activities for each of the interactives.

## SUSTAINABLE DEVELOPMENT EDUCATION

Our Center for a Sustainable Future has developed three software packages [http://www.concord.org/research-/sustainable.html] designed to get students thinking about the future and how it might husband global resources. The **What-If Builder** is a writing tool for short stories that have many different outcomes, depending on what the reader selects. It both delivers such stories and lets students author and share them. The **Community Planner** is a simplified spatial modeling and visualization tool that allows students

to create a map of a neighborhood, town, or community, and analyze the map based on indicators that they can help define. The **Ecological Footprint Calculator** estimates how much land is needed to sustain the user's lifestyle and how many earths would be required if everyone had the same consumption patterns. If you don't feel like inventing student activities based on these, you can search our database [ http://csf.concord.org/esf/-index.php?module=curriculum&type=unit&func=view&order=theme ] of over 60 tested activities related to sustainable education for grades K12, many of which use this software.

## VIDEO PAPER BUILDER

VideoPaper Builder [ http://vpb.concord.org/] is a tool jointly developed with TERC that simplifies making video case studies of teaching. A video paper can consist of video, captions, a narrative about the video, and artifacts, such as lesson plans and student work. All these need to be synchronized and indexed. VideoPaper Builder simplifies doing this. The resulting video papers are a great way to stimulate thoughtful discussion about teaching learning. The software links together various models, generates menus, links, framesets and slide shows, and organizes the imported files as an HTML coded document viewable in a web browser. By the time you read this, we will probably have version three of VideoPaper Builder that works on all platforms and is far easier to use.

## UNDER DEVELOPMENT

We are currently creating more applications to extend the utility of our growing collection of software. The following are a few of the projects that you can expect soon.
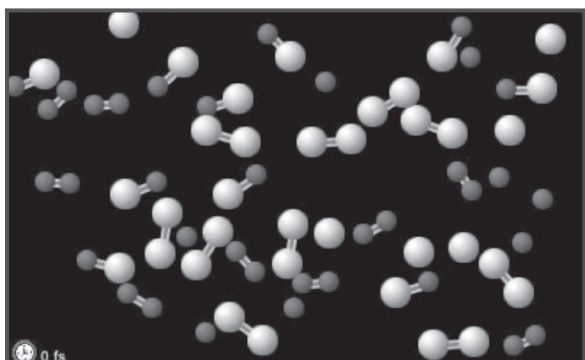


**Electrica** will be an electric circuit model with a display that uses color to represent voltage and moving marquee lights to indicate current. When used with Pedagogica, this will be a great engine for students to explore electricity and electronics.

**Probeware.** We already have a wonderful program called CCProbe for probes and sensors. It collects real-time data from a variety of sensors and runs on handheld computers as well as full-sized ones. Unfortunately, CCProbe now only works with some hardware we created for a past project. We are now expanding the capacity of CCProbe and interfacing it with a number of different commercial probeware packages.

**Evolution.** We are adding random mutations and a population level with environmental pressures to BioLogica and linking this to the Molecular Workbench. The result will be a mechanistic model of molecular evolution forced by the environment.
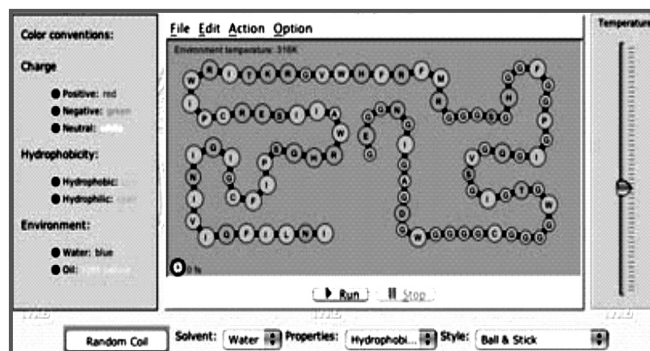


All of our software is copyrighted under one of the so-called open source licenses. This means that anyone can have access to the source code and make changes in it. We do this because open source is a strategy for long-term support of this software. All our work is grant-supported, so when the grant runs out, our ability to support the software ends. If a community of educators starts using this software, then it is in the interest of all members of the community to maintain and improve it. Like democracy, this is a risky strategy, but it seems to be better than any alternatives. Help us make it a success by using the software to help grow the community of educators dependent on this wonderful software.