In a drama-inducing engaging educational activity, the server runs a central simulation portraying Mr. Vetro, a simulated human being with a collection of simulated organs that are distributed on handhelds. The server gathers data from client simulations and serves as a simulation coordination and visualization tool.

The teacher orchestrates the educational activity by assigning the control of different organs of Mr. Vetro to groups of students, giving them tasks to complete as a team, monitoring progress, and facilitating classroom discussions.

A Life Signs Monitor keeps track of Mr. Vetro's vital signs and displays them in the form of graphs or numerical values. ECG, heart rate, breathing rate, oxygen saturation, and oxygen delivered to tissue are some of the measures displayed.

In a simulation running on a handheld, a group of students controls the lungs of Mr. Vetro by varying lung parameters such as breathing rate and tidal volume as a response to changing conditions such as exercise and smoking.

Another group of students controls the heart of Mr. Vetro by varying heart parameters such as heart rate and stroke volume to adjust to changing conditions such as increased exercise intensity.

The central simulation is projected to the entire class and therefore serves as a classroom discussion tool.

With a wireless network, the handhelds send data to the server.

Innovative content can be used in K-12 educational settings, distance learning and corporate training applications.

Wireless Distributed Simulations enable unique and effective learning activities. Four information technologies (handhelds, desktops, the Web, and end-user programming) are connected into an engaging, inquiry-based learning environment. Innovative content can be used in K-12 educational settings, distance learning and corporate training applications.

What computers are for.

The C5 architecture enables the development and use of distributed simulations that are compact, customizable, and connected, continuous, customizable, and collective.

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Currently under development with NIH Phase II SBIR funding, the distributed simulations run on a variety of platforms: from PCs to PDAs, iMacs to iPAQs, cell phones to... to whatever comes next, we’re device friendly, wireless, and platform ready.

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Collective Simulations Evaluation

The Collective Simulations framework with the Mr. Vetro prototype and curriculum was evaluated by educational and assessment experts at the University of Colorado, School of Education. The curriculum was developed and adapted for classroom use in collaboration with local science teachers. The evaluation study occurred in three local high schools. Five science teachers participated: two teaching only using Mr. Vetro (treatment); two teaching only in their conventional way (comparison), and one teaching both using Mr. Vetro and in the conventional way. A total of fifteen science classes (Biology, AP Biology, Anatomy and Physiology, and IB Biology) participated. About 400 high school students, ages 14-18, were part of those classes.

The evaluation study results were successful along many dimensions:

**Technical:** our Collective Simulations framework features a flexible, modular architecture that enables the creation and easy customization of educational material for inquiry-based science activities at different K-12 levels.

**Educational:** both learners and teachers benefit from Collective Simulations. *Teacher practice* results provide compelling evidence that the instructional practices and learning experiences provided in the Mr. Vetro class were more conducive to promoting scientific inquiry and student learning of concepts. *Learning outcomes* suggest that students completing Mr. Vetro do just as well as the comparison group in multiple-choice items and outperform them on items that measure deeper knowledge of physiological phenomena and the responses of human systems in realistic scenarios the students were not explicitly taught.

**Motivational:** data shows that less advanced students get more engaged and interested in science than advanced placement students, regardless of the strong learning gains. Academically, it would be interesting to pursue some research focused on exploring the reasons behind this finding.

**Pragmatic:** some of the most exciting results are the real-life consequences that impact students at a personal level. For us, the fact that there are indications showing that the experiences with Mr. Vetro promote self-awareness (e.g. understanding personal health issues) and healthier life styles (e.g. deciding to quit smoking) is non-trivial, but instead, some of the most revealing and exciting results of this project.