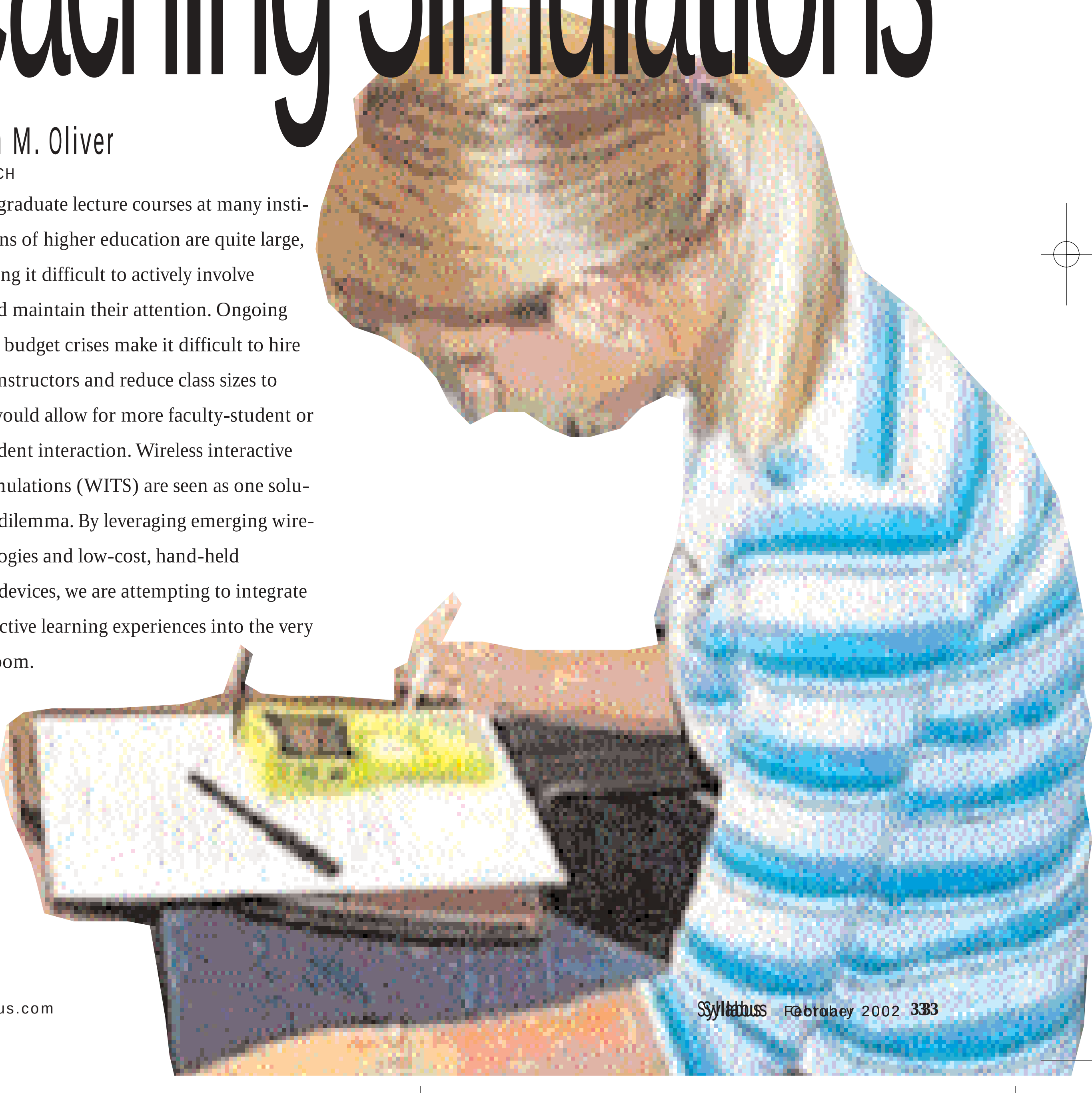
Wireless Interactive Teaching Simulations

By Kevin M. Oliver
VIRGINIA TECH

Undergraduate lecture courses at many institutions of higher education are quite large, making it difficult to actively involve students and maintain their attention. Ongoing and current budget crises make it difficult to hire additional instructors and reduce class sizes to levels that would allow for more faculty-student or student-student interaction. Wireless interactive teaching simulations (WITS) are seen as one solution to this dilemma. By leveraging emerging wireless technologies and low-cost, hand-held computing devices, we are attempting to integrate more interactive learning experiences into the very large classroom.



Student Benefits

The classroom interactions programmed for the WITS system fall into a category of tools known as manipulation tools, simulations, or microworlds (Hannafin, Land, & Oliver, 1999; Rieber, 1992). These tools tend to have the same overall structure; they allow students to externalize their thinking by "playing" some value or inputting some variable into a system. This input has some effect on the overall system, which is shown to the student. The student analyzes the results that their input had on the system, and if it is not desirable or not what they expected, they revise their initial input or attempt some modification of it. The games typically proceed through several cycles, each of which provides the student with more information to revise their initial understanding or personal model.

This process has been termed "reflection-in-action" (Schon, 1987) and "theories-in-action" (Land, 1995). The cycle leads to the development of robust and flexible "mental models" in students (see Vosniadou, 1994). Students are able to appreciate a system from multiple angles, having inputted differing values into the system over multiple cycles of the game. Students will have a better understanding of course concepts via their experiences, and the instructor will not have to re-teach poorly understood content. Inquiry cycles are difficult to conduct, but not impossible, without technological systems that allow students to rapidly test and experience many models in a short period of time.

The Technology

The WITS project has undergone a "proof of concept" stage at Virginia Tech, involving the development of software to run economics games on the Cybiko wireless hand-held device. We have been successful in linking up to 30 students together simultaneously to participate in simulated markets and trading scenarios for a Principles of Microeconomics undergraduate course.

Each student is provided with a Cybiko device, which links via open radio frequency channels to a "host" or "broker" Cybiko at the front of the room. The host device is connected to and passes student signals to a laptop at the front of the classroom. The laptop accepts student registration data, randomly pairs students with other "players" in the market, sends a student pair a particular game scenario, receives and processes game inputs from students, then delivers game results back to students. Cumulative game results across all student pairs are graphed on the laptop and projected on a screen in front of the class.

The decision to utilize Cybiko was based on cost-effectiveness, since wireless capabilities are already incorporated into the unit and wireless cards do not need to be purchased on top of the base unit price. The project is funded by the Mellon Foundation's Cost Effective Uses in Technology in Teaching program (CEUTT) as well as the National Science Foundation (NSF). A key goal for both grants is to design a system that is not only pedagogically sound, but also feasible within typical university budget constraints.

While our beta system may be cost-effective, it has functional problems. One primary bottleneck in the described system has been the single host Cybiko device which has difficulty receiving and passing all of the student data to a laptop. We need to scale up the system to larger classes and have been unable to do so with this bottleneck.

Alternative options are under consideration, including the purchase of more expensive handheld devices with wireless cards to communicate directly with a laptop. The removal of a host handheld device should increase connection speeds, however this could be a costly system if dependent upon one of our emerging campus wireless "zones" that would require additional connection fees for each device from university computing services.

A second solution is possible, but further down the road. Students at our university must purchase a computer, but they are not required to purchase a laptop. With a portable computing requirement, students could bring their own wireless-enabled laptops to class for initial setup and interactions. Students would not have to pick up a loaned handheld device or purchase their own for class activities. It will be critical to illustrate the learning effectiveness of such systems and encourage several classes and majors to participate. Added costs to students will be difficult to sell if "lecture" halls are not widely transformed to "activity" halls.

Project Extensions

A long-term goal for WITS is to create a customizable system. Economic games are but one example of the aforementioned cycle, where students make some input, analyze the results, then revise their initial ideas about the situation. This "reflection-in-action" is a valuable instructional strategy across numerous fields: sociology, political science, engineering design, chemistry, physics, and many more.

Our software requires further refinement, specifically a user-friendly interface that allows instructors to program their own unique game models with specific conditions and to rapidly change game conditions in response to student questions (e.g., "What if we add variable X into the system?"). For example, one can envision a class studying genetics, with students inputting various mutations into a system with some overall effect as the output. As the cycle is repeated multiple times in succession, students quickly see the different effects their inputs/actions have on the system.

This allows the students to build flexible and robust mental models about the systems they are studying. Students don't just understand the effect X has on Y, they also understand the effect V, W, and X have on Y from a second modified example of the game, the effect V and W have on Y without X from a third modified example of the game, and so on. Understanding is broadened. While a generic interaction is probably better than a lecture class with no activity, a multi-cycle interaction designed to build robust student mental models will be better than a simplistic multiple choice response (e.g., "If you are satisfied with today's lecture, select A, unsatisfied, select B.").

Kevin M. Oliver, Ph.D., is an Instructional Design and Evaluation Specialist in Educational Technologies at Virginia Tech. xxxxxxxx@xxxxx.edu

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