With cloud computing, the mathematics of evolution may get easier to learn

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(From left) Bina Ramamurthy, Jessica Poulin and Katharina Dittmar say Pop! World's visual appeal makes the mathematical analysis of evolution more captivating for students than conventional representations. Credit: University at Buffalo

An innovative, educational computing platform developed by University at Buffalo faculty members and hosted by the cloud (remote, high-capacity, scalable servers) is helping UB students understand parts of evolutionary biology on an entirely new level. Soon, high-school and middle-school students will benefit from the same tool as well.

Pop! World, developed by UB faculty members with a $250,000 National Science Foundation grant, takes advantage of cloud computing,

which allows programs to run on remote servers instead of through departmental or institutional servers. That feature allows resource-intensive programs to serve many users regardless of their physical location without sacrificing speed or quality of service.

"The cloud serves as a way to distribute resources for free without limits on how many people can access it and with no regard to what kind of computer you are downloading to," says Jessica Poulin, PhD, research assistant professor in the Department of Biological Sciences in the College of Arts and Sciences, who developed Pop! World with principal investigator Bina Ramamurthy, PhD, research associate professor in the Department of Computer Science and Engineering in the School of Engineering and Applied Sciences, and Katharina Dittmar, PhD, assistant professor of biological sciences. "Everybody can get there."

UB faculty members designed Pop! World because they wanted to get college students more excited about population genetics; they also wanted to maintain the university's unique freshman lab requirements at a time when resources are growing more scarce.

UB is one of the few universities in the U.S. that encourages freshmen interested in biology to begin experiencing labs during their first semester on campus.

"We put our freshmen right into labs because students who might otherwise be lost from the major are captivated when they get to do science," Poulin says. "When you sit in a lecture hall with 400 people and someone is talking about flatworms, what do you care? Despite the logistical difficulties, and the intense demands on staff time, we think that getting freshmen into labs is one of our department's great strengths. We didn't want to discontinue it."

At the same time, Poulin says that it is difficult to convey the main

concepts of population genetics at this level, particularly those that are mathematically demanding.

Hired in 2008 to revamp UB's evolutionary biology curriculum for Bio 200, Poulin says that the department was seeking ways to maintain and improve the course and the lab for students without requiring additional resources, such as teaching assistants.

"Almost all of evolutionary theory can be mathematically modeled if you know enough information to begin with," she says. "If you enter the correct parameters into the computer, the computer will tell you what will happen after one generation or a thousand generations. I wanted students to be exposed to something that made them feel they were actually watching evolution happen. I wanted it to be captivating."

While some computational tools exist to help students with population genetics -- the mathematical analysis of evolution -- the result is often nothing more dramatic than a line graph.

"Our students grew up in the Internet age surrounded by MP3 players, wireless phones and social networking apps," says Ramamurthy, "so the visual aspects of Pop! World are certainly very appealing to them."

The UB team programmed Pop! World in Adobe Flash, which lends a highly visual, nearly tactile look to the program. While the current version illustrates evolution with red and green lizards, it is highly adaptable, so it can be used with any population of organisms. It also is highly scalable, so that it can be made more complex, to serve the needs of population genetics researchers, or less complex, to serve the needs of middle- and high-school students.

A preliminary version of Pop! World is running on the Google App Engine Cloud. It can be accessed by going to

http://popworld15.appspot.com/.

With the help of the NSF grant, the UB team is now creating a sophisticated version of the tool, expected to be available by Fall 2011.

"Our idea was to use general principles of population genetics not only to convey the principle in the context of evolutionary biology but to make sure that students understand visually what's happening with the mathematics behind it," explains Dittmar.

When an early version of Pop! World was used to teach evolutionary biology last summer, students and teaching assistants responded enthusiastically.

"The TAs loved it because it facilitated their explanations of a very complicated problem," Poulin says.

"Pop! World gives students the visual background they need to understand complex mathematical problems," Dittmar adds. "And it works kind of like a video game, which serves the current population of undergrads well."

That visual appeal is also expected to go far with middle-school and high-school biology students, groups the UB team hopes to excite about evolution; by spring, they expect to have completed a modified version for them as well.

By making evolutionary biology more visually appealing and, thus, more accessible, Poulin hopes that Pop! World will make evolution itself a more appealing subject for secondary schools to teach.

"There's a huge disconnect," she says. "The universities all accept evolution as fact. It's not a question. But many high schools and middle

schools don't want to touch it. They don't want to deal with the politics of it."

Her hope is that the visual and educational appeal of Pop! World and the ease of using it will begin to change that situation.

The UB team's grant, "A Cloud-enabled Evolutionary Genetics Learning Tool for Engaging the Cyber-savvy Generation" (NSF OCI CI-Team 1041280) from the NSF's Office of Cyberinfrastructure, will run for two years.

Provided by University at Buffalo