says, is that "our politicians believe research should have a short-term financial return. Our effort is to change this unrealistic attitude that leads to enormous waste of resources through the funding of 'monkey projects' that ultimately do not deliver."

Human capital

More than the salary cuts, more than the changing laws and merging centers, more than the uncertainty and having to make do with little money, scientists in Greece are worried about keeping their community vibrant. "Greek scientists have always gone outside to study and work," says Provata. "The difference now is that students who are finishing their bachelor's degrees in physics don't even consider the possibility of staying in Greece. They are all asking for help to get out. And the ones who are outside the country and have gained experience do not consider the possibility of returning." Says Kokkoris, "I love my country, I do not want to leave. The level of our students is high. It is decadent to be forced to send all these young minds abroad. But what can I tell them about the future?"

The University of Crete and FORTH were created about 30 years ago by Greek scientists who returned from years abroad. Says Fotakis, "We have managed to act as a pole of attraction for prominent scientists and talented young researchers. Now we are in danger of losing them, or some of them. It's not only a financial problem, it's a political problem." One of the main dangers of the crisis, he says, "is that we have a repetition of brain drain. Human capital—not just researchers, but technicians and administrators, too—[is] more important than the actual infrastructure."

Until last fall, the Demokritos institutes were collectively able to offer scholarships for 100 PhD students, thanks to Greek national money. "If the blood is students, then the flesh is postdocs," says Papavasiliou. "Funding for postdocs hasn't stopped yet, but I am afraid we will not have them for long. Things are getting worse."

Many scientists say they are counting on the structural funds to tide them over. But Economou says he is "hoping for a miracle. It has to come soon if a culture of scientific excellence in Greece is to survive."

Toni Feder

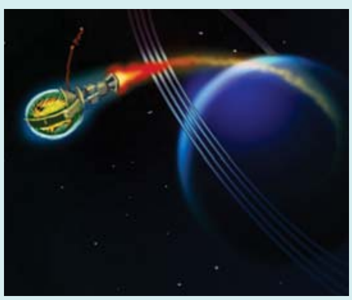
Computer games take their place in the science classroom

A 2011 National Research Council report found emerging but inconclusive evidence that educational science-based games improve learning.

When senior NASA officials came looking for someone to lead the development of a computer game that would teach science and engineering concepts, Daniel Laughlin, a project manager for the agency's education division, says he hesitated to admit he was an avid gamer. Back then, in 2003, video games were considered frivolous and not an "adult" hobby.

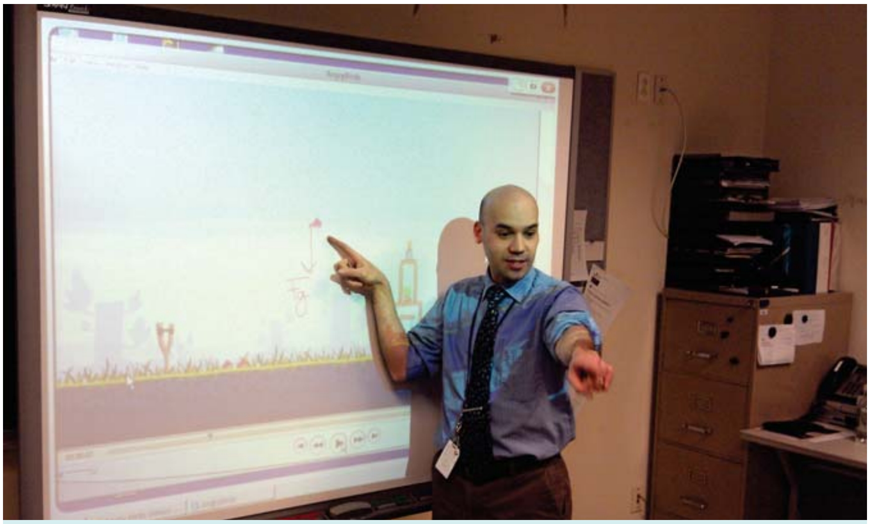
Attitudes have changed, says Laughlin, who took the job that resulted

MIT EDUCATION ARCADE/FILAMENT GAMES



VANDERBILT UNIVERSITY

Cracking science puzzles takes on a whole new meaning in the virtual world. In a soon-to-be-released online game (left), players help each other solve biology and math quests. In SURGE EPIGAME (right), players propel a spaceship using their knowledge of Newtonian mechanics.


FRANK NOSCHESE

Physics teacher Frank Noschese at John Jay High School in Cross River, New York, uses the popular game Angry Birds to explain Newton's laws to his class.

in the 2010 release of Moonbase Alpha, an online game in which players explore a virtual lunar base; study physical laws in the Moon's airless, low-gravity environment; or team up to repair a solar collector and oxygen generator before their oxygen runs out. The initial feedback, he says, is that "it is a very immersive experience."

It's that kind of response that is increasingly drawing science and math educators to digital games and simulations. In the digital world, says Laughlin, it's easier to teach Newtonian mechanics or to visualize such idealized concepts as a frictionless surface. He says several dozen teachers have told him they use Moonbase Alpha in their classroom. An accompanying 80-page curriculum has been downloaded several thousand times since the game's release.

Quest chains

Like hands-on lab experiments, computer simulations allow students to manipulate variables and test science concepts. "Games go one step further and allow [the students] to operate and explore within an environment," says Douglas Clark, an education professor at Vanderbilt University in Tennessee who used to teach science in middle school. Clark is the principal developer of a game called SURGE, in which the heroine must apply Newtonian mechanics as she navigates a spaceship through successive levels. Wisconsin-based company Filament Games plans to release SURGE—Scaffolding Understanding by Redesigning Games for Education—this spring.

Filament Games is also partnering with the MIT Education Arcade to design a "massively multiplayer online game" in which thousands of players will be able to simultaneously apply math and science concepts as they complete "quest chains" for each other, says Education Arcade director Eric Klopfer. "There could be a chain of tasks based on the Pythagorean theorem where players would need to measure and scale towers, or one based on Mendelian genetics where players need to breed plants to create a cure."

"If you don't engage students, you lose them, and it's getting harder and harder to engage them," says Chris Like, a physics teacher at Bettendorf High School in Iowa. He uses video tracking software to analyze the motion of characters and objects in popular games such as Angry Birds, in which birds are catapulted toward clusters of pigs that have stolen their eggs. Although the motion of objects and characters in many popular games violates Newtonian laws, "Angry Birds has good physics," says Frank Noschese, a physics teacher at John Jay High School in New York. Last month the game's designer, Finland-based Rovio Entertainment, and NASA released Angry Birds Space, which accurately simulates the trajectory of the catapulted birds in microgravity.

To supplement their labs, Like and Noschese use online simulations, such as those found at the comPADRE website, sponsored by the American Association of Physics Teachers and several other scientific societies, or at the PhET project, managed by the University of Colorado at Boulder. In 2001 physics Nobel laureate Carl Wieman and colleagues at the university launched the project—their first simulation showed how Wieman's research on laser cooling and trapping works. The PhET platform has since grown to include more than 130 simulations of physics, chemistry, biology, math, and Earth science concepts, including some that allow students to stretch DNA, explore gas properties, and build electrical circuits.

"It's amazing that the same simulation could be useful for teaching both a middle school student and a professor," says Wieman, who is now associate director for science at the White House Office of Science and Technology Policy (OSTP). With simulation labs, "the data comes out clean," but simulations cannot replace the hands-on lab experience, says Noschese. He adds that making his students program their own simulations gives them a leg up. "I've had some of my kids who have gone off to college write back to tell me how that experience has put them way ahead of their peers."

Learning by design

Increased internet access and the proliferation of Web-enabled mobile devices add to the popularity of educational games, says Kurt Squire, an education professor at the University of Wisconsin–Madison and cofounder of the Games+Learning+Society Conference, which will hold its eighth annual gathering in June. Yet even those who embrace such technologies acknowledge the need for more research on the pedagogical effectiveness of simulations and games as a teaching tool. A 2011 report by the National Research Council, *Learning Science Through Computer Games and Simulations*, found "moderate evidence that simulations motivate students' interest in science" and "emerging but . . . inconclusive" evidence that games improve science learning. Wieman, a coauthor of the report, says that OSTP is encouraging NSF and the Department of Education to explore better ways to assess learning using simulations and games. "But generally speaking, a really bad teacher can make a really great technology worthless," he adds, "and a really good teacher can be successful with cruddy technology."

The question is not if games are good or bad for learning, said Clark in a talk at the January 2012 NSF Cyberlearning Research Summit. Whether it's a hands-on lab, a classroom activity, or a digital game, "it's the design of a learning environment that determines how effective it's going to be."

Jermey N. A. Matthews