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Before Every Child Is Left Behind: How Epistemic Games Can Solve the Coming Crisis in Education

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Before Every Child Is Left Behind: How Epistemic Games Can Solve the Coming Crisis in Education[1]

David Williamson Shaffer and James Paul Gee

The Crisis

In his recent bestseller, *The World Is Flat*, Thomas Friedman (2005) argues that the United States is facing a looming crisis—a crisis with the potential to wreck havoc on the old and the young, on rich and poor alike. Freedman talks about this new crisis mostly in terms of foreign policy and global economics—what nation states, governments, businesses, and workers must do to adapt to the changing world at the beginning of the 21st century.

But this crisis is not just a crisis of economics or politics. At its core, this is a crisis in education—a crisis in education unlike any we've seen before. The coming crisis is a crisis of learning, and it is a crisis that we will have to face in school, at home, in workplaces, and in communities.

The coming crisis is this: Young people in the United States today are being prepared—in school and at home—for "commodity jobs" in a world that will, very soon, reward only people who can do "innovative work" and punish those who can't.

What do we mean by commodity jobs and innovative work? Let's start with the literal notion of a commodity. A commodity is a standardized product or service available to a mass audience at a reasonable price. The "old capitalism"—the capitalism of industry, manufacturing, assembly lines, and large corporations heavy with middle managers; the capitalism of the post–World War II world; a capitalism that was vastly successful in producing a massive middle class in the United States—was built on the production and sale of commodities (Greider, 1997; Thurow, 1999).

However, in a world in which the science and technology necessary to produce and sell commodities efficiently have spread across the globe, the competition to produce wealth through commodities is fierce as never before. The work of building wealth through the production of commodities has moved, by and large, to the lowest cost centers in the world, places with more trained workers willing to work for lower wages, places like China and India with huge and increasingly well-trained workforces.

The result is that countries like the United States—countries with higher wages—can no longer compete on the basis of making and selling commodities (Greider, 1997; Thurow, 1999). Their competitive edge increasingly comes from how well they produce products, services, and technologies that are new . . . special . . . non-standard—and thus not easily produced across the globe by competitors. The value of these innovative products, services, and technologies does not reside primarily in the material out of which they are made. Nor does value reside primarily

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in the labor by which these products are made or through which these services are provided. Value—what the modern economy will pay for—resides primarily in *knowledge*: knowledge about innovative design of new products, services, and technologies, but also knowledge about new forms of social interactions and relationships (Drucker, 1993; Gee, Hull, & Lankshear, 1996; Kelly, 1998; Rifkin, 2000).

All of this is old news, not a new crisis. Surely everyone knows by now that a great many U.S. jobs have been outsourced overseas in the last two decades. Old manufacturing towns across the country—places like Flint, Michigan—have been devastated in a crisis that began some time ago and is still under way today. We read about proposed solutions to this crisis in the news and hear them in political campaigns all the time.

So what is this new crisis? And what is new about it? How does this new crisis go beyond the old crisis of lost jobs? To answer this, let's turn to the idea of a commodity job. A commodity job is any job that because of technologies like computers and the Internet can be done wherever trained workers will work for less. A commodity job is thus any job—whether a call-center operator, engineer, or computer programmer—that can be done more cheaply and just as efficiently outside the United States.

The simple fact is that India, to take just one salient example, has call-center operators, engineers, and computer scientists who are as well trained as—and sometimes better trained than—those in the U.S. and who are willing to work for less than their counterparts here (Mehta, 2005). And in a connected world—a world in which even real-time, face-to-face interactions can be done across time zones via video conferencing—it doesn't matter anymore where people are (Castells, 2000; Kelly, 1998). Time differences can even be an advantage since, for example, Indian radiologists can read U.S. patients' X-rays while they and their doctors sleep at night

Notice that it doesn't matter whether a job has low or high status. Whether it involves stitching dolls' bodies or reading X-rays, a job is a commodity job if it can be easily outsourced. And it is easily outsourced if it requires only standard and standardized skills. Even jobs taking drive-through orders at local McDonald's restaurants have been outsourced overseas (Friedman, 2005). You can be speaking to someone in China while sitting in your car in Nebraska, waiting for your order to be delivered to the cooks via a fast connection between Guangzhou and Omaha. Your medical condition may well have been diagnosed by a doctor in Bangalore looking at test results online. For routine medical care in the not-too-distant future, you may well speak to a doctor located almost anyplace in the world via a camera on the Internet with a computer ready to test your blood pressure or your blood sugar level.

The fact is that people are smart everywhere in the world, and China and India and many other countries are chock-full of people smart enough to be seamstresses and scientists, receptionists and radiologists. It is a mistake—a potentially disastrous mistake—to think of job loss in the U.S. as only about the old manufacturing jobs. Many of those are gone already—and the assembly lines that are left are high tech, anyway. Now the scientific, medical, technological, and engineering jobs are starting to go, too (National Science Board, 2002).

Commodity jobs are moving overseas, and if this were the whole story, we would still be talking about the old crisis, though with a new wrinkle: namely, the loss of highly skilled, as opposed to manufacturing, jobs. To survive this old crisis, new wrinkle and all, the United States has had to move up the "value chain" and produce more people who can do work that is centered on innovation and creativity, not reproduction of standard and standardized skills, whether the standard skills of a call-center operator, a chemist, or a computer scientist. By and large, this has led to calls for the United States to trade on flexibility, innovation, and breaking the mold, things on which we have prided ourselves historically (Friedman, 2005; Hagel & Brown, 2005; Kanter, 2001).

But here's the trouble. The looming crisis is that countries like India and China are not content simply to remain the commodity servants of the U.S. economy. And why should they be? They are now moving up the value chain themselves to produce people who can innovate—people who view their work not in terms of standard skills, but in terms of new ideas and new relationships. Countries with growing economies are gearing up their universities and their entrepreneurial centers to produce innovative work and innovative workers. Foreign students who once flocked to U.S. universities seeking advanced degrees are, more and more, staying at home or going elsewhere ("Surveys Show Declining Foreign Enrollment at U.S. Colleges and Universities," 2004). Many countries now fully intend to compete with our university system—heretofore the best in the world—to produce the world's innovators.

Of course, this not an inherently bad thing: when other countries compete to enrich their citizens, the world is a better and fairer place. But what it means is that the United States has to work and to learn smarter. Much smarter.

Schooling and De-Innovation

The problem is that, in the face of this looming crisis, we are doing just the opposite, and as a result, the picture is actually worse—much worse—than it appears. We have slashed funding for institutions like the National Science Foundation, an institution that could spearhead a new effort to produce innovative scientists and engineers. With our testing and accountability regime, we have ensured that our schools are better equipped than ever to produce commodity workers, but not innovative ones.

Yes, our government and our schools have made a noble effort to leave no child behind, to focus on so-called "at-risk" children and ensure, through standardized testing, that all children make adequate yearly progress. And this is all to the good. But standardized testing—and the regime we have put in place to raise test scores—produce standardized skills. Skills that are a dime a dozen across the world. A country like China may have a huge population in relative poverty and unprepared to compete for high-tech jobs. But China has over 300 million skilled and educated workers, more than the entire population of the United States, rich and poor combined (Friedman, 2005). India may have the world's largest underclass, but it will also soon have the world's largest middle class (Mehta, 2005).

The simple fact is that our standards-driven curriculum, especially in our urban schools, is not preparing children to be innovators at the highest technical levels—the levels that will pay off most in our modern, high-tech, science-driven, global economy. Inspired by the goal of leaving no child behind in basic skills, we are leaving all of our children, rich and poor, well behind in the new global competition for innovative work. Instead, we are busy preparing them for commodity jobs, most of which will be long gone by the time they finish school.

Take reading, for example. No one can deny that we should make sure all children, rich and poor, learn to decode print as early as possible. Everyone needs to be able to turn letters on a page into words they can understand. Indeed, we know this is crucial to success in school and later in life, and we have been making admirable progress in this area under the current system of reading tests. In one sense, this is a positive step, since under some progressive educational agendas, young children experienced the "culture" of reading, but too many of them—particularly poorer children—did not learn basic reading skills.

Make no mistake: all kids need to learn to read. But the future of countries like the United States doesn't depend on how many children, rich or poor, gain basic skills. It depends on how many children will be able to handle the complex and technical languages, symbol systems, and practices needed for success at the highest levels of the value chain—the "languages" of higher order mathematics, complex technologies, systems design, graphic design, communication, and the hard sciences. How many of today's school children in our public schools, rich or poor, are getting ready to master these at the highest levels? Not just to master them, but to be able to innovate in them? In the digital media- and entertainment-centered world of today and tomorrow, innovation takes place not just in science and technology, but in art, and psychology, and communications. Innovation crosses the boundaries of the traditional disciplines of schooling, and the jobs of the future will be in fields like graphic design where art and science meet.

Preparing for Innovation

The foundation for innovation has to be laid from the start. Mastery of complex technical languages (whether the language of chemistry or of graphic design), complex symbol systems (whether non-linear mathematics or neural networks), and complex practices (whether engineering of workplaces or ecosystems) does not start in college. It starts in kindergarten and before. It is a problem not just for our high schools, colleges, and graduate programs, but for our elementary schools as well. Just as it is best to start learning a foreign language early—better to start learning Russian as a second language at home early in life if you are really to master it—so today's technical languages, symbol systems, and practices demand learning that begins early in life and is sustained over the long haul (Gee, 2004; Neuman & Dickinson, 2001).

A number of economically well-off people in the United States and elsewhere across the globe already realize this. They use modern technologies in their homes to introduce their children early on to technical languages, skills, and knowledge—to create and support "islands of expertise" in sophisticated thinking (Crowley & Jacobs, 2002; Shaffer, in press-a). These islands of expertise may have to do with dinosaurs, mythology, computers, science, or art, but their real import is the preparation they give these children for lifelong learning as they face the ever increasing demands of complex language, symbols, and practices at higher and higher levels of schooling.

When parents interact with their children about these islands of expertise, they use complex language. They introduce children to resources such as books, media, and other technologies. And they engage children in ways of talking, thinking, and working that are technical, specialized, and "academic." They prepare their children for later learning and help them feel that "people like us" are good at learning complex, technical, and specialized things.

For example, consider what it means when this mother speaks to her 4-year-old child about a toy replica of a dinosaur egg at home (Crowley & Jacobs, 2002):

> That's what it says, see look egg, egg . . . Replica of a dinosaur egg. From the Oviraptor. Do you have a . . . You have an oviraptor on your game! You know the egg game on your computer? That's what it is, an oviraptor. And that's from the Cretaceous period. And that was a really, really long time ago.

This mother is speaking "school-based" technical language to the child, not just the vernacular. She is referring to a collection of books and computer games and other resources that are the foundation of the child's island of expertise in dinosaurs. She is engaging the child in early preparation for later acquisition of academic and specialized language tied to content in science, technology, and visual communication.

Some parents like this mother have children in schools that build on this "home work" and sustain it, engaging children with complex and deep learning from the outset, preparing them for future learning that gets ever more complex, technical, and centered in the content of science, mathematics, computers, engineering, and art (Gee, 2004). All too often, however, our public schools are doing no such thing.

We know they aren't because we know that more and more we are faced with a persistent "fourth-grade slump" (Chall & Jacobs, 2003; Chall, Jacobs, & Baldwin, 1990). What happens is this: A child appears to be making adequate progress in reading and the "basics" early on. Then, all of a sudden, starting in fourth grade or so, he cannot read and learn well in school when faced with complex content. The problem is that, fed on a steady diet of standardized reading and standardized tests, the child has learned to translate letters into words and sounds, but he simply doesn't know enough words, especially words connected to school content areas, to keep up! And once a child has fallen behind in this way, things just get worse as the language and thinking demands become more complex, technical, and specialized in middle school, high school, college, and beyond. What we get, in the end, is lots of kids in middle school who can decode but can't read the complex language of their textbooks. But today it is not nearly good enough to be able just to read that textbook—you have to be able to produce and not just consume, to make knowledge and not just receive it.

It is, in fact, too late, way too late, to begin your preparation for innovative work even in fourth grade, but all too often even privileged parents, let alone poor ones, are facing public school systems with a narrow focus on test scores, the basics, and helping "at-risk" children succeed in ways that will only prepare them for disappearing commodity jobs.

The New Equity Gap

The looming crisis—our surrender in the face of the coming competition for innovative work—is aided and abetted by a new, nearly totally ignored equity gap. A number of people, in both the popular press and in academia, have argued that children's popular culture today is more complex than ever before (Gee, 2003, 2004; Johnson, 2005). It demands complex thinking, technical language, and sophisticated problem-solving skills. Take a look at the language on a *Yu-Gi-Oh* card or Web site, for example. It is often more complex—more technical—than the language children using the cards see in their schoolbooks or hear in their classrooms. Or consider the complex problem solving and decision making required to play a video game like *Age of Mythology*, a real-time strategy game with over 300 commands—a game played successfully by many 7-year-olds, though not always by their parents!

Modern video games—games like *Age of Mythology*—often come with the software by which they are made, so that players can "mod" (modify) the game, creating their own scenarios and maps. Often players trade these scenarios and maps with other players via the Web. When children have parents who help turn *Age of Mythology* into an island of expertise, tying it to books, Internet sites, museums, and media about mythology, cultures, and geography, the children pick up a wide range of complex language, content, and connections that serve as preparation for future learning of a highly complex and deep sort. When children are encouraged to learn the technologies with which to modify video games and interact with others about them by creating Web sites and new content, they pick up the beginnings of value-added technical skills, preparing them for the long march up the value chain towards innovative work.

But what about the children who do not have these opportunities, opportunities now readily available to, and sometimes put to good use by, privileged families? Can they get *this* in school? Can they get this sort of modern learning system, directed towards preparation for future innovative work, in school? Not in a lot of the public schools we've seen. Today's popular culture has great potential to be recruited into such high-value learning systems. But this doesn't happen all by itself. Kids need a network of parents, teachers, and other mentors to use popular culture as a tool for long-term growth into complex thinking, complex language, complex content, and innovative work.

In other words, this ability to leverage modern technologies and popular culture for learning is creating a new and massive equity crisis, a crisis not mitigated by—and perhaps even compounded by—today's technologically impoverished schools. So the looming crisis—our surrender to the challenge of preparing public school children for innovative work—is going to hit the poor harder than the rich. But that's cold comfort, since everyone will get to suffer amply unless something is done.

So the looming crisis is that the rest of the world is racing ahead to move up the value chain. Other countries are moving from attracting commodity jobs to fostering an education system and a social system that will create and sustain innovative work on their home ground in a wired world. In the end, countries like China and India may attract innovative work and even innovative workers from places like the United States. If we don't change our schools and society to prepare children for innovation, we will have to beg innovators from other countries to immigrate to the United States. Indeed, in many cases this is already happening. Students from Asia already dominate in numbers and talent many of the technical departments in our graduate schools, while young people in the U.S. opt for what they perceive as fast riches in occupations like law and business.

Beyond "Progressive Reform" and "Back to the Basics"

The solution to this crisis is not in our schools alone. We must transform learning in and out of schools for children and adults. But schools play a critical role, and the time to tinker with them, as we have done for decades, is fast coming to an end. We need wholesale change. And the change we need is neither liberal nor conservative. Both liberals and conservatives have, with the best of intentions, done too much already to contribute to the looming crisis, rather than to solve it.

Liberals have too often advocated pedagogies that immerse children in rich activities and focus on the learners' own goals and backgrounds. This is empowering, but for many children it hides the "rules of the game": the skills, values, assessments, and willingness to work hard that learners must recognize and master to succeed in a world that no longer rewards commodity jobs. Some children, often from privileged homes, pick up the rules of the game at home and use liberal schooling as a fruitful and empowering practice ground. But not everyone is so fortunate.

Conservatives have too often advocated pedagogies that stress telling learners what they need to know and then skilling-and-drilling them on factual knowledge: the kind of knowledge standardized tests usually test. If you teach students to pass paper-and-pencil tests, they often—surprise, surprise—improve their scores on standardized assessments. But decades of research have shown that students fed on a steady diet of facts and isolated skills cannot apply what they know to real-world problems. Hardly a recipe for building expertise and innovation.

We are only going to speak to the looming crisis when we get out of thinking that liberal or conservative pedagogies are our only choices. One solution to our crisis—and one way to get out of the liberal-conservative bind—is an approach to learning that we call *epistemic games* (Shaffer, in press-b). We don't say this approach is, by any means, the sole solution to our new crisis, but it is one example of the types of solutions that are required. Epistemic games are about having students do things that matter in the world by immersing them in rigorous professional practices of innovation (Shaffer, 2004). In this approach, students do things that have meaning to them and to society, supported all along the way by structure, and lots of it—structure that leads to expertise, professional-like skills, and an ability to innovate. So we have the immersion dear to liberal pedagogies and the structure dear to conservative ones.

The word *games* may come as something of a shock here. But let's hold off a bit dealing with that shock. We'll answer the question "Why games?" in a minute, but first let's get to what *epistemic* means, because in some ways that's the crux of the matter. The point is that these are not just any old games. These are, first and foremost, *knowledge games*.

Epistemic Frames

We must begin to foster rigorous learning for innovative work. But the problem is that *innovative work* is by definition something that *cannot be standardized*. It is the domain of innovative practitioners, people who are sometimes referred to as *reflective practitioners* or, more simply, *professionals*. By professionals, we don't necessarily mean people who work in the traditional professions, such as medicine, law, and engineering, but rather anyone who does work that cannot be easily standardized and who continuously welcomes challenges at the cutting edge of their expertise. Innovative practitioners work in domains with a high degree of uncertainty, domains that therefore require discretion and judgment. In innovative work, no two problems are quite the same, and no set of rules—or even routinized experience and expertise—can determine what an innovative practitioner should do next.

Innovative work can't be standardized, but, nonetheless, the people who do innovative work are not simply "doing whatever they want." Innovative practitioners use the knowledge, skills, and ways of thinking of some professional community (in the broad sense of professional). Learning to innovate always involves becoming part of some group of people with a common repertoire of knowledge about and ways of addressing problems in the world. What's more, these professional communities already know a lot about how to produce innovative practitioners. If they didn't, the communities would die out. So communities of innovative practice—professionals in the broad sense of the term—can tell us a lot about how to help students prepare for innovative work (Shaffer, 2004).

When people become members of a community, they start to think and act in particular ways. They develop the skills of the community. They start to care about things that matter to the community. They start to see themselves as members of the community, and to think about things in ways that other members of the community do. All of this is only to say that a community has a local culture (Rodhe & Shaffer, 2004), and becoming a member of the community means developing that culture's distinctive ways of doing things, of valuing things, and of knowing things.

We call a community's distinctive ways of doing, valuing, and knowing its *epistemic frame* (Shaffer, in press-a). We use this term because an epistemic frame "frames" the way someone thinks about the world—like putting on a pair of colored glasses. For example, lawyers act like lawyers, identify themselves as lawyers, are interested in legal issues, and know about the law. These skills, affiliations, habits, and understandings are made possible by looking at the world in a particular way. Acting and valuing and talking and reading and writing like a lawyer are made possible by *thinking* like a lawyer. The same is true for doctors, but for a different way of thinking—and for master carpenters, graphic designers, and so on, each with a different epistemic frame.

The key step in developing the epistemic frame of most communities of innovation is some form of *professional practicum* (Schon, 1983, 1987). Professional practica are environments in which a learner acts in a supervised setting and then reflects on the results of his or her action with peers and mentors. Skills and knowledge become more and more closely tied together as the student learns to see the world using the epistemic frame of the community. Think of internship and residency for doctors, moot court for lawyers, or the design studio for architects.

So now here's the good news—the first good news we've had about our education system in quite some time: *The very same technologies that are making it possible to outsource commodity jobs make it possible for students of all ages to prepare for innovative work.*

Which brings us to the question, "Why games?" Doctors know how to create more doctors; lawyers know how to create more lawyers; master carpenters know how to produce more carpenters; graphic artists know how to produce more graphic artists; and the same is true for a host of other socially and economically important innovative practices. And now new technologies connected to computer games, video games, and simulations—as well as handheld computing devices and the Internet—can let students learn to innovate by participating in simulations of professional practica (Shaffer, 2004, in press-a, in press-b; Shaffer, Squire, Halverson, & Gee, in press). The technologies that are sending away jobs for people with standardized skills as measured on standardized tests are the very tools that can help students learn to think outside the box the way the pros do.

Contemporary video games are profoundly engaging and motivating to young people. They keep the gamer focused for hours at a time. Rigorous learning requires lots of time and lots of engagement and motivation (Gee, 2003). But aren't games' fun and learning work? Well, actually, no (Shaffer, in press-b). Skilled professionals (in the broad sense of the term) draw deep pleasure from what they know and do. That is what keeps them challenging themselves at the cutting and ever growing edge of their competence. Innovation is fundamentally playful, but far from driving away rigor, such pleasure and playfulness drive the practitioner towards greater challenges and higher standards of accomplishment.

In other words, epistemic games are games that let players learn to work and thus to think as innovative professionals. Epistemic games are games that let students develop the epistemic frames of innovation. Epistemic games are fun, but they are fun because they are about innovation and mastery of complex domains. Epistemic games are about *knowledge*, but they are about knowledge in action—about making knowledge, applying knowledge, and sharing knowledge. Epistemic games are rigorous, motivating, and complex because that's what characterizes the practices of innovation upon which they are modeled.

Epistemic Games

We've argued that the only way to prepare students for a world that rewards innovative work (and punishes standardized skills) is to move beyond both traditional progressive reforms *and* back-to-basics approaches. The key is to understand how new technologies make it possible to develop post-progressive *pedagogies of practice* (Shaffer, 2004) that are neither liberal nor conservative in the traditional pedagogical sense. Computer and video games can let students learn using the techniques of communities of innovation—ways of learning that stress immersion in a practice, supported by structures that lead to expertise, professional-like skills, and innovative thinking. Epistemic games are thus one way to solve the innovation crisis.

To illustrate what we mean by an epistemic game, we'll describe *Madison 2200* (Beckett & Shaffer, in press), a computer-based game in which high school students work as urban planners to redesign a downtown pedestrian mall popular with young people in their city. Urban planning is a great example of innovative work. Urban planners take a central role in keeping urban systems in balance, developing land use plans that meet the social, economic, and physical needs of communities. Urban planning requires deep understanding of both social and scientific issues. Urban planners use sophisticated technologies to solve complex problems, including geographic information systems (GIS) that make it possible for planners to ask creative "what if" questions and get feedback to inform their work. Learning to think and work like an urban planner involves learning to use GIS models and other tools to solve complex real-world problems in which science, society, economics, and technology intersect.

We developed *Madison 2200* as part of a summer enrichment program for “at-risk” students. In our first test, 11 high school seniors worked with a graduate student for 10 hours over two weekend days playing this urban planning role-playing game. The players had no prior experience with urban planning. At the start of the game, the students received a project directive from the mayor, addressed to them as city planners, to create a detailed redesign of the local pedestrian mall. An information packet included a city budget plan and letters from concerned citizens about issues such as crime, revenue, jobs, waste, traffic, and affordable housing—just the kind of materials and issues that real urban planners use, and that urban planning students see as part of their training in college and graduate school. The players watched a video about the pedestrian mall featuring interviews with people about the street’s redevelopment, then conducted a site assessment for themselves, just the way real planners and planning students do.

Next, players began to work in teams to develop land use plans, using an interactive GIS model of the downtown area that let them assess the ramifications of proposed land use changes. For example, if a player was interested in raising the number of jobs, she might choose to place a new retail business in the downtown area (see Figure 1). The model would show whether that proposal would raise or lower the number of jobs predicted for the neighborhood. However, the model would also show how other issues would be affected by the same land use choice, thus leaving players to make a decision about the overall impact (and therefore the utility) of alternative land use proposals. After completing a land use plan, players created a revised downtown map and presented their plans to a representative from the city planning office.

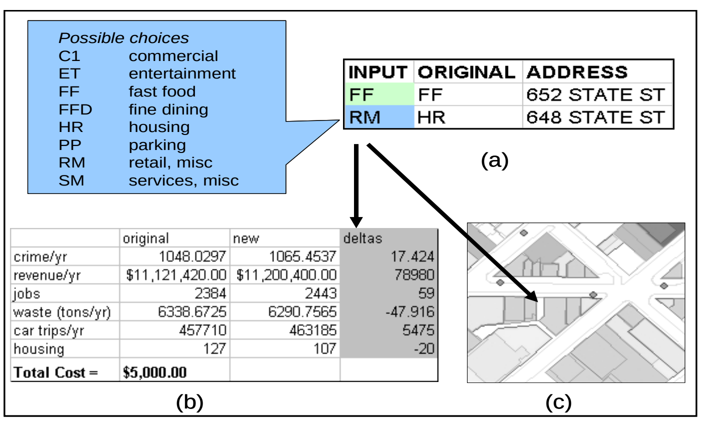

Figure 1. A player makes a land use change in the GIS model (a). The change is reflected numerically (b), and spatially on a map of the downtown area (c).

In other words, this was a game that students played by the rules of urban planning. They were redesigning their city, but they weren’t just doing whatever they pleased. Their choices were constrained by the science of urban planning: by the economic, social, and physical realities of life in a city. And their actions were structured—highly structured—by the practices of urban planning. They learned to read and interpret documents the way urban planners do. They learned to conduct a site assessment. They learned to create a land use plan. They learned how to make a project presentation. And they had to learn to put these skills together, in the way urban planners do, to create a convincing proposal for the development and renewal of their city. The structure that supported learning these skills and abilities was built into the design of the game and supported by adults who held the players accountable to professional standards of excellence.

As a result of playing by the rules of urban planning, students learned to think like urban planners. When we interviewed players before and after the game, those conversations showed that players had begun to understand the complex issues and systems involved in urban planning in new ways, and perhaps more important, that they were able to apply their understanding to solve new kinds of problems. After playing the game, for example, all of the students saw how the game had changed the way they think about cities. One student said: "I really noticed how [urban planners] have . . . to think about how the crime rate might go up—or the pollution or waste—depending on choices." Another said about walking on the same streets she had traversed before the workshop: "You notice things, like, that's why they build a house there, or that's why they build a park there." Players' thinking about the science of urban planning became 72% more complex, and considered, on average, 20% more factors that impact city planning, as measured in concept maps completed before and after the game. These changes were dramatic enough to be statistically significant despite the small size of the sample in this first test of the game. More important, it was working and thinking as urban planners that helped these students think in new ways about the world around them. After playing the game, they consistently referred to the urban planning model and urban planning practices when talking about economic and social issues.

A game like *Madison 2200* is a rich, immersive experience, to be sure, but it is not just a game in which kids "play around." It is a game in which players learn to work (and thus to think) as urban planners, and we can imagine (and in some cases are starting to build) games in which students learn to think like doctors, lawyers, architects, engineers, journalists, and other innovative practitioners. For example, in the game *Digital Zoo* (Svarovsky & Shaffer, in press), players work as mechanical and biomechanical engineers to design virtual structures and creatures—the kinds of things you might see in a computer-animated movie from a major studio. Players learn the engineering design process, keep design notebooks, and make presentations to clients, just the way real engineers and engineering students do. Not surprisingly, they also learn about things like physics and biology: things like the center of mass, and the period of waves, and how muscle pairs function in multilegged locomotion. In one after-school program in which we tested *Digital Zoo*, players' use of scientific justification to answer textbook science problems went up 600% on average after playing the game. Oh yes, and did we mention that these biomechanical engineers creating innovative virtual creatures and learning biology and physics are mostly in sixth and seventh grade?

In other words, with epistemic games students don't have to wait to begin their education for innovation until college, or graduate school, or their entry into the workforce. In these games, learning to think like innovative professionals prepares students for innovative work. These games are based in the ways in which professional practica create the epistemic frame of innovative practices. That means doing particular things in particular ways, and being assessed relative to a particular set of external norms. It means coming to think about problems and care about issues in particular ways.

By playing these games, students begin their apprenticeship in innovative thinking—learning to think using a variety of epistemic frames, to see the world and solve problems in multiple ways. These games are part of the solution to the crisis in innovation because to compete in a global economy we don't need kids with basic skills. We need engineers who also know how to think like graphic designers; doctors who also know how to think like computer programmers; urban planners who have a deep understanding of the law; teachers who understand the practices of innovation; and politicians who have a deep understanding of and respect for the process of innovation across a wide range of professional communities.

To be clear: epistemic games are not necessarily games that are played strictly for pleasure—but then pleasure isn't what makes a game a game in the first place. Pleasure is the by-product of good game design and good game play. *Play* is the world someone enters when he or she wants or needs to resolve in imaginary form desires that cannot be immediately gratified. In play, we participate in a simulation of a world we want to inhabit, and an epistemic game is play that gives learners access to a particular form of innovative thinking. When it succeeds, it is fun, not because fun is the immediate goal, but because taking on a new set of values is an essential part of an epistemic frame, and thus of an epistemic game (Shaffer, in press-b).

Epistemic games like *Madison 2200* are also about facts, and lots of them. Students playing *Madison 2200* had to learn a complex set of zoning codes and to understand what they meant and how to use them. They had to figure out the relationships among complex variables such as the crime rate, housing stock, land values, tax revenue, waste, transportation, and pollution. But this information was not merely inert facts. In the context of the game, it was knowledge in action and knowledge in context. It was part of a form of innovative thinking—and thus the kind of learning that students need to prepare for innovative work.

You may have noticed that in describing *Madison 2200* and *Digital Zoo* we talked about summer enrichment programs and after-school programs. That's because schools, as currently organized, make it difficult to prepare students for innovation through epistemic games. Teachers can't spare the time from getting students ready for the next standardized test, and, not surprisingly, innovation is difficult to accomplish in 40-minute chunks of time, spread from room to room and subject to subject throughout the day. So to develop and test epistemic games, we look outside schools, to places where children have time to think and work in depth with and about complex problems—and where the adults who structure that hard work can focus on students' innovative thinking rather than on their performance on tests of basic skills.

But schools *could* be about epistemic games rather than assessment games. And solving the innovation crisis in our educational system through epistemic games would also address other crises that plague our schools, crises that have received more publicity in recent years. For example, research has shown for some time now that even students who pass typical school tests cannot actually apply their knowledge to solve problems. Students can write Newton's Laws of Motion down on a piece of paper but still cannot use them to answer even a simple problem like, "If you flip a coin into the air, how many forces are acting on it at the top of its trajectory?"—a problem that can be solved, of course, using Newton's Laws of Motion. This disconnect between stored and applied knowledge simply doesn't happen in epistemic games. It doesn't happen because epistemic games are based on making and applying knowledge. Instead of learning facts, information, and theories first and then trying to apply them, the facts, information, and theories are learned and remembered because they were needed to play the game successfully.

We've already mentioned the "fourth-grade slump." Thirty years of research has shown that many children who pass reading tests in the early grades cannot learn content later on when the emphasis shifts in school from "learning to read" to "reading to learn" (Chall, 1967; Chall et al., 1990). The fourth-grade slump happens when children are not well prepared for the increasing linguistic and cognitive demands of the complex forms of language, symbolic representations, and thinking demanded by academic content areas like mathematics, science, and history. Epistemic games speak directly to the fourth-grade slump by using the complex forms of language, symbolic representation, and thinking that are needed to learn complex content. Learners learn to read, talk, and act within a domain of professional practice. For learners like the "at-risk" players of *Madison 2200* and *Digital Zoo*—learners who may be behind not just in reading but in reading to master complex content—this may be the best, and perhaps the only, way for them to catch up with the global competition.

Why Johnny Can't Innovate

If epistemic games are a path to success in the face of a crisis of innovation, what we're doing in many schools today is nothing short of taking the road to disaster. Rather than having students play epistemic games like *Madison 2200* and *Digital Zoo*, school systems around the country are cutting classes in art and music and computers to make room for more basic reading and mathematics instruction.

In 1955, Rudolf Flesch published *Why Johnny Can't Read*, arguing that phonics was the one true way to teach reading. Fifty years later, this is the new gospel of our schools. Pedagogical conservatives applaud. Progressives lament. And we say that Johnny—and Johnny's parents, and teachers, and our society as a whole—have bigger things to worry about. The problem is that schools fixated on teaching everyone to read are ignoring a far more serious problem: that our students won't have the skills they need for life in a connected world and global economy.

This crisis—and make no mistake, it will be a crisis when we start to see the consequences of the pedagogical choices we're making today—this crisis is a problem of teaching to the lowest common denominator. Schools must stop being primarily about making sure that "at-risk" children acquire basic literacy and numeracy skills. That is a noble goal, to be sure, and all kids do need to acquire those skills. But in today's world—much less in the competitive world of tomorrow—it is, quite simply, not enough. It is not enough for our children, and not enough for our economic survival, if schools are only about providing a basic level of standardized skills for jobs that no longer exist. Schools have to start being about bringing *everybody* up—up to the challenge of long-term preparation for innovative work. Otherwise, the United States simply will not have enough innovative people to compete in the world right around the corner. Or perhaps we will just give up. After all, we can always compete by taking back the commodity jobs as the rest of the world outsources their low-paid work to us.

The crisis of teaching to the lowest common denominator is also a crisis of equity. If our schools surrender to the challenge of preparing children for innovative work, the burden will fall disproportionately on the poor. If our body politic will not invest the energy, resources, and creativity in rebuilding our educational system to prepare students to be innovators, then well-off parents will surely make up the difference for their kids, and the withering of public education—on which democratic citizenship rests—will be all but complete.

The alternative is to mobilize the power of new technologies to change the way we think about education. The same technologies that outsource commodity jobs create a rich and innovative popular culture. The same technologies that place a premium on innovative practices make those practices accessible to students as never before. The same technologies that make the industrial practices of industrial schools largely irrelevant in preparing students for productive and satisfying economic and cultural lives make it possible to invent a new way of organizing our educational system.

Epistemic games of all kinds make it possible for students of all ages to learn by working as innovators. In playing epistemic games, students learn basic skills, to be sure. They learn the facts and content that we currently reward. But in epistemic games, students learn facts and content in the context of innovative ways of thinking and working. They learn in a way that sticks, because they learn in the process of doing things that matter.

Epistemic games thus give educators an opportunity to move beyond disciplines derived from medieval scholarship constituted within schools developed in the industrial revolution—to a new model of learning for a digital culture and a global economy.

And the sad irony is that if Johnny can't learn to innovate, it will be because *we* weren't willing to innovate. It will be because we were not willing to reinvest in Johnny's education by thinking about learning in new ways.

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