8   Game-Like Learning

*An Example of Situated Learning and Implications
for Opportunity to Learn*

James Paul Gee

KNOWLEDGE: AS NOUN AND VERB

The theory of learning in many schools today is based on what I would call the "content fetish" (Gee 2004). The content fetish is the view that any academic area (whether physics, sociology, or history) is composed of a set of facts or a body of information and that the way learning should work is through teaching and testing such facts and information.

However, for some current learning theorists, "know" is a verb before it is a noun, "knowledge" (Barsalou 1999a, 1999b; Bereiter and Scardamalia 1993; Clark 1997; Glenberg 1997; Glenberg and Robertson 1999; Lave and Wenger 1991; Rogoff 1990). Any actual domain of knowledge, academic or not, is first and foremost a set of activities (special ways of acting and interacting so as to produce and use knowledge) and experiences (special ways of seeing, valuing, and being in the world). Physicists *do* physics. They *talk* physics. And when they are being physicists, they *see* and *value* the world in a different way than do non-physicists. The same applies for good anthropologists, linguists, urban planners, army officers, doctors, artists, literary critics, historians, and so on (diSessa 2000; Lave 1996; Ochs, Gonzales, and Jacoby 1996; Shaffer 2004).

Yet if much decontextualized, overt information and skill-and-drill on facts does not work as a theory of learning, neither does "anything goes," "just turn learners loose in rich environments," "no need for teachers" (Kirschner, Sweller, and Clark 2006). These are the progressive counterpart of the traditionalists' skill-and-drill, and they, too, are problematic as a theory of learning. Learners are novices, and leaving them to float among rich experiences with no guidance only triggers human beings' great penchant for finding creative but spurious patterns and generalizations that send them down

garden paths (Gee 1992, 2001). The fruitful patterns or generalizations in any domain are those that are best recognized by those who already know how to look at the domain and how the complex variables at play in the domain interrelate with each other. This is precisely what the learner does not yet know.

Here we reach a central paradox of all deep learning. It won't work to try and tell newcomers everything. We don't know how to put it all into words, because a domain of knowledge is first and foremost made up of ways of doing, being, and seeing, ways complex enough that they outrun our abilities to put them all into explicit formulations. When we do put what we know into explicit words, learners often can't retain them or even really understand them fully because they have not done the activities or had the experiences to which the words refer. This should worry advocates of overt instruction.

Yet as we have already said, simply turning learners loose to engage in the domain's activities won't work either, because newcomers don't know how to start, where to look for the best leverage, and which generalizations to draw or how long to pursue them before giving them up for alternatives. Of course, we can hardly expect learners to reinvent for themselves domains that took thousands of people and hundreds of years to develop. This should worry advocates of immersion.

This paradox has lead some educators, over the last few years, to search for what I would call "post-progressive pedagogies"; that is, pedagogies that combine immersion with well-designed guidance (e.g., Brown 1994; Lehrer 2003; Lehrer and Schauble 2005; Martin 1990). One area, perhaps surprisingly, where learning today works very much in this fashion, that is, by combining immersion and guidance in intelligent ways, is modern video games (Gee 2003a, 2004). Indeed, there has been much interest during the last few years in the role that good video games and related types of simulations can play in learning inside and outside schools (e.g., Barab et al. 2005; Barab et al. in press; Gee 2003a, 2005; Jenkins and Squire 2004; Shaffer 2007; Squire 2005, 2006; Steinkuehler 2004, 2006).

Below I will give some examples of the role game-like learning can play in post-progressive pedagogies and the ways such learning can speak to issues of equity and oppotunity to learn (OTL). Before I do so, I will point out that the dilemma we discussed earlier – between knowledge as information and knowledge as activity and experience – is related to another dilemma familiar from recent research on cognition: the dilemma between general, abstract, and verbal understandings, on the one hand, and situated understandings, on the other.

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GENERAL VERSUS SITUATED UNDERSTANDINGS

A situated understanding of a concept or word implies the ability to use
the word or understand the concept in ways that are customizable to differ-
ent specific situations of use (Brown, Collins, and Dugid 1989; Clark 1989,
1993, 1997; Gee 2004). A general or verbal understanding implies an ability to
explicate one's understanding in terms of other words or general principles
but not necessarily an ability to apply this knowledge to actual situations.
Thus, although verbal or general understandings may facilitate passing cer-
tain kinds of information-focused tests, they do not necessarily facilitate
actual problem solving. Research in cognitive science has shown, for exam-
ple, that it is perfectly possible to understand Newton's laws as formulas,
realizing their deductive capacities in a general way, but not be able to actu-
ally draw these deductions and apply them to a concrete case in actual practice
to solve a real-world problem (Chi, Feltovich, and Glaser 1981; Gardner 1991).

Let me quickly point out that all human understandings are, in reality,
situated. What I am calling verbal understandings are, of course, situated
in terms of other words and, in a larger sense, the total linguistic, cultural,
and domain knowledge a person has (Gee 2006). Yet they are not necessarily
situated in terms of methods of applying these words to actual situations of
use and varying their applications across different contexts of use. Thus, I
will continue to contrast verbal understandings with situated ones, with the
latter implying the ability to do and not just say.

Situated understandings are the norm in everyday life. Even the most
mundane words take on different meanings in different contexts of use.
Indeed, people must be able to build these meanings on the spot in real time
as they construe the contexts around them. For instance, people construct
different meanings for a word like "coffee" when they hear something like
"The coffee spilled, get the mop" versus "The coffee spilled, get a broom"
versus "The coffee spilled, stack it again." Indeed, such examples have been
a staple of connectionist work on human understanding (Clark 1993).

Verbal and general understandings are top-down. They start with the
general; that is, with a definition-like understanding of a word or a general
principle associated with a concept. Less abstract meanings follow as special
cases of the definition or principle. Situated understandings generally work
in the other direction; understanding starts with a relatively concrete case
and gradually rises to higher levels of abstraction through the consideration
of additional cases.

The perspective I am developing here, one that stresses knowledge as activ-
ity and experience before knowledge as facts and information and situated as

opposed to verbal understandings, has many implications for the nature of learning and teaching, as well as for the assessment of learning and teaching. Recently, researchers in several different areas have raised the possibility that what we might call "game-like" learning through digital technologies can facilitate situated understandings in the context of activity and experience grounded in perception (Games-to-Teach Team 2003; Gee 2003a; McFarlane, Sparrowhawk, and Heald 2002; Squire 2003). I turn first to an application of what I consider game-like learning that uses no real game, then to a game made explicitly to enhance school-based learning, then to a commercial game that enhances deep learning in a crucially important way, and finally to a game-like simulation, built into an overall learning system, that uses many of the same learning principles as the commercial game. I will then conclude with some remarks on implications, especially for issues of assessment and OTL.

GAME-LIKE LEARNING: ANDY DISESSA

Andy diSessa's (2000) work is a good example, in science education, of building on and from specific cases to teach situated understandings. Further, diSessa's approach bears similarities to the game-like learning we will discuss in the next section. DiSessa has successfully taught children in sixth grade and beyond the algebra behind Galileo's principles of motion by teaching them a specific computer programming language called Boxer.

The students write into the computer a set of discrete steps in the programming language. For example, the first command in a little program meant to represent uniform motion might tell the computer to set the speed of a moving object at one meter per second. The second step might tell the computer to move the object. A third step might tell the computer to repeat the second step over and over again. Once the program starts running, the student will see a graphical object move one meter per second repeatedly, a form of uniform motion.

The student can elaborate the model in various ways. For example, the student might add a fourth step that tells the computer to add a value a to the speed of the moving object after each movement the object has taken (let us say, for convenience, that a adds one more meter per second at each step). Now, after the first movement on the screen (when the object has moved at the speed of one meter per second), the computer will set the speed of the object at two meters per second (adding one meter), and then, on the next movement, the object will move at the speed of two meters per second. After this, the computer will add another meter per second to the speed, and on the

next movement, the object will move at the speed of three meters per second. And so forth forever, unless the student has added a step that tells the computer when to stop repeating the movements. This process is obviously modeling the concept of acceleration. Of course, you can set a to be a negative number instead of a positive one and watch what happens to the moving object over time instead.

The student can keep elaborating the program and watch what happens at every stage. In this process, the student, with the guidance of a good teacher, can discover a good deal about Galileo's principles of motion through his or her actions in writing the program, watching what happens, and changing the program. What the student is doing here is seeing in an embodied way, tied to action, how a representational system that is less abstract than algebra or calculus (namely, the computer programming language, which is actually composed of a set of boxes) "cashes out" in terms of motion in a virtual world on the computer screen.

An algebraic representation of Galileo's principles is more general, basically a set of numbers and variables that do not directly tie to actions or movements as material things. As diSessa points out, algebra doesn't distinguish effectively "among motion ($d = rt$), converting meters to inches ($i = 39.37 \times m$), defining coordinates of a straight line ($y = mx$), or a host of other conceptually varied situations" (diSessa 2000, 32–33). They all just look alike. He goes on to point out that "[d]istinguishing these contexts is critical in learning, although it is probably nearly irrelevant in fluid, routine work for experts" (diSessa 2000, 33), who, of course, have already had many embodied experiences in using algebra for a variety of different purposes of their own.

Once learners have experienced the meanings of Galileo's principles about motion in a situated and embodied way, they have understood one of the situated meanings for the algebraic equations that capture these principles at a more abstract level. Now these equations are beginning to take on a real meaning in terms of embodied understandings. As learners see algebra spelled out in more such specific material situations, they will come to master it in an active and critical way, not just as a set of symbols to be repeated in a passive and rote manner on tests. As diSessa puts it:

Programming turns analysis into experience and allows a connection between analytic forms and their experiential implications that algebra and even calculus can't touch. (diSessa 2000, 34)

DiSessa does not actually refer to his work with Boxer as game-like learning, though some people pushing the design of actual games for learning have been inspired, in part, by his approach to learning and science education

(Gee 2003a). Indeed, Boxer produces simulations that are, in many respects, game-like and that certainly can entice from learners the sort of flexible consideration of possibilities that play can inspire. However, I turn now to an actual game designed to enhance situated learning that goes beyond verbal understandings.

Supercharged!

Kurt Squire and his colleagues (Squire et al. 2004; see also Jenkins, Squire, and Tan 2003; Squire 2003) have worked on a computer game called *Supercharged!* to help students learn physics. *Supercharged!* is an electromagnetism simulation game developed in consultation with MIT physicist John Belcher by the Games-to-Teach project at MIT (run by Henry Jenkins; see www.educationarcade.org). Players use the game to explore electromagnetic mazes, placing charged particles and controlling a ship that navigates by altering its charge. The game play consists of two phases: planning and playing. Each time players encounter a new level, they are given a limited set of charges that they can place throughout the environment, enabling them to shape the trajectory of their ship.

Each level contains obstacles common to electromagnetism texts. These include points of charge, planes of charge, magnetic planes, solid magnets, and electric currents. Each of these obstacles affects the player's movement according to laws of electromagnetism. The goal of the game is to help learners build stronger *intuitions* for electromagnetic concepts based on perceptual and embodied experiences in a virtual world where these concepts are instantiated in a fairly concrete way.

Squire et al. (2004) report some results that are part of a larger design experiment examining the pedagogical potential of *Supercharged!* in three urban middle school science classrooms with a good deal of cultural diversity. In this study, the experimental group outperformed the control group on conceptual examination questions. Post-interviews revealed that both experimental and control students had improved their understanding of basic electrostatics. However, there were some qualitative differences between the two groups. The most striking differences were in students' descriptions of electric fields and the influence of distance on the forces that charges experience. For example, one girl, during her post-interview, described an electric field as:

The electric[ity] goes from the positive charge to the negative charge like this [drawing a curved line from a positive charge to a negative charge]. I know this because this is what it looked like in the game and it was hard to move away or toward it because the two charges are close together so they sort of cancel each other out. (p. 510)

In the control group, the students also performed well in drawing what an electric field looked like, although their reasons for their explanations revealed a different type of thinking:

INTERVIEWER: Ok, what do you think the electric field looks like around a positive charge?

ALEX: It has lines going outward from it like this [drawing lines with arrows pointing outward].

INTERVIEWER: Why do you think it looks like that?

ALEX: I don't know. The teacher said so and showed us a picture and that was what it looked like. (p. 510)

It appears that students in the experimental group were recalling experiences and challenges that were a part of the game play of *Supercharged!*, whereas students in the control group were relying more on their ability to memorize information. Playing *Supercharged!* enabled some students to confront their everyday (mis)conceptions of electrostatics as they played through levels that contradicted these conceptions. Students used representations of electric fields depicted in the game as tools for action.

Squire (2004) conclude that:

These initial findings suggest that the primary affordances of games as instructional tools may be their power for eliciting students' alternative misconceptions and then providing a context for thinking through problems. Adept game players appropriate game representations as tools for thinking, which, for some students such as Maria, were later taken up in solving other physics problems. (p. 510)

Yet Squire and his colleagues also acknowledge that the teachers came to realize that students were initially playing *Supercharged!* without a good deal of critical reflection on their play. The teachers then created log sheets for their students to record their actions and make predictions, which reinforced the purpose of the activity and encouraged students to detect patterns in their play. Later, the teachers provided even more structure, using the projector to display game levels, encouraging the class to interpret the events happening onscreen and make predictions about how they thought the simulation would behave. This additional structure added more focus to students' play and allowed the teacher to prompt deeper reflection on game play.

We see here, then, a good example of a post-progressive pedagogy, a well-integrated combination of embodied immersion in rich experience (the game wherein the learner virtually enters an electromagnetic field) and scaffolding and guidance, both through the design of the game itself as a learning resource

and through teachers making the game part of a larger coherent learning activity system. The argument is not for games in and of themselves but as part of a well-designed learning activity system.

Full Spectrum Warrior

There are a plethora of people today who want to make "serious games" for learning (for more information, see www.seriousgames.org or www.educationarcade.org). However, I believe we need to pay serious attention to how good commercial games deliver learning as part and parcel of enjoyable game play. Good commercial games are more or less forced to incorporate good principles of learning (Gee 2003a). Today's video games are long, complex, and hard – and avid players would not have it any other way. Game designers face the same sorts of challenge our schools do: how to get people to learn something and learn it well, even enjoy learning it, when it is long and difficult. Games that can't be learned, or games that don't motivate people to learn them, don't get played, and the companies that make them go broke.

I have argued that deep learning involves, first and foremost, activity and experience, not facts and information. Yet something interesting happens when one treats knowledge primarily as activity and experience, not facts and information: The facts come free. A large body of facts that resist out-of-context memorization and rote learning comes free of charge if learners are immersed in activities and experiences that use these facts for plans, goals, and purposes within a coherent knowledge domain (Shaffer 2004).

We also discussed a central paradox of all deep learning. It won't work to try and tell newcomers everything, but simply turning learners loose to engage in the domain's activities won't work either. I have already said that good commercial games would be out of business by now if they weren't good at getting themselves learned well, so game designers have already offered elegant solutions to this paradox. Unfortunately, our schools are still locked into endless and pointless battles between "traditionalism" and "progressivism," between overt teaching and immersive learning, between skill-and-drill and activities, as though these were the only two alternatives.

Because we don't have the space here to explicate the theory of learning behind each category of game, I will talk about just one such theory relevant to several categories and, perhaps, most relevant to those interested in making serious games. Many good commercial video games are based on a theory of learning I will call "distributed authentic professionalism," a theory that resolves our paradox quite nicely (see also Shaffer 2004, 2007). Let's

look at one such game: *Full Spectrum Warrior* (Pandemic Studios, for PC and Xbox).

Before I begin, let me hasten to say that I am well aware that this game is ideologically laden. It carries messages, beliefs, and values about war, warfare, terrorism, cultural differences, the U.S. military, and the role of the United States and its army in the modern, global world. I don't agree with some of these messages, beliefs, and values, but all that needs to be left to the side for now. It is not that these issues are not important. Right now, my only goal is to understand the game *Full Spectrum Warrior* as an example of a particular type of game recruiting a particular type of learning.

Full Spectrum Warrior has its origins in a U.S. Army training simulation, but the commercial game retains only about 15% of what was in the Army's simulation (Buchanan 2004, 150). *Full Spectrum Warrior* teaches the player (yes, it is a teacher) how to be a professional soldier. It demands that the player think, value, and act like one to "win" the game. You cannot bring just your game-playing skills, the skills you use in *Castlevania*, *Super Mario*, or *Sonic Adventure 2 Battle*, to this game. You do need these, but you need another set of skills as well. These additional skills are a version of the professional practice of modern soldiers – the professional skills of a soldier commanding a dismounted light infantry squad composed of two teams.

In *Full Spectrum Warrior*, the player uses the buttons on the controller to give orders to the soldiers, as well as to consult a GPS device, radio for support, and communicate with command. The instruction manual that comes with the game makes it clear from the outset that players must think, act, and value like a professional soldier to play the game successfully: "Everything about your squad . . . is the result of careful planning and years of experience on the battlefield. Respect that experience, soldier, since it's what will keep your soldiers alive" (p. 2).

Yet there is something else beyond values that is important here: The virtual characters in the game (the soldiers in the squads), on the one hand, and the real-world player, on the other hand, control different parts of the domain of professional military expertise. We get the whole domain only when we put their knowledge together. The knowledge is *distributed* between them. A human being (the player) shares knowledge with a virtual reality (the soldiers).

Full Spectrum Warrior is designed in such a way that certain sorts of knowledge and certain types of skill are built right into the virtual characters, the soldiers (and into the enemies, as well). Other sorts of related knowledge must be learned and used by the player:

The soldiers on your teams have been trained in movement formations, so your role is to select the best position for them on the field. They will automatically move to the formation selected and take up their scanning sectors, each man covering an arc of view. (p. 15)

Thus, the virtual characters (the soldiers) know part of what needs to be known (various movement formations), and you, the player, know another part (when and where to engage in such formations). Thus is true of every aspect of military knowledge in the game. Your soldiers know different things than you know, have mastered different bits of professional military practice than the bits you need to master to play the game. The game only works when the two different bits are put together – thought about and acted on – as a whole by the player who uses the virtual soldiers as smart tools or resources.

The player is immersed in activity, values, and ways of seeing, but the player is scaffolded by the knowledge built into the virtual characters and the weapons, equipment, and environments in the game. The player is also scaffolded by some quite explicit instruction given "just in time," when it can be understood in action and through experiences that make clear what the words really mean in context. The learner is not left to his or her own devices to rediscover the foundations of a professional practice that took hundreds of years to develop. Our paradox is solved.

There are some caveats. I have used the word "professional," a word that unfortunately brings to mind high-status people who are paid well for specialist skills. Yet that is not what I mean. I am referring to what I will now call "authentic professionalism." Authentic professionals have special knowledge and distinctive values tied to specific skills gained through a good deal of effort and experience. They do what they do not for money, but because they are committed to an identity in which their skills and the knowledge that generates them are seen as valuable and significant. They don't operate just by well-practiced routines; they can think for themselves and innovate in their domains when they have to. Finally, professionals welcome challenges at the cutting edge of their expertise (Bereiter and Scardamalia 1993). Good carpenters, good skateboarders, and good musicians are authentic professionals just as much – and sometimes more so – as are good doctors, lawyers, and professors. Later, when I discuss the game *Madison 2020*, I will give a specific example of what it means to have even young children thinking and learning in professional domains (Shaffer 2007).

Many good video games involve the same formula as *Full Spectrum Warrior*. They distribute authentic professional expertise between the virtual

character(s) and the real-world player, something we can represent by the formula

Virtual Characters ← Authentic Professional Knowledge → Player.

For example, the game *Thief: Deadly Shadows* involves the professional identity of a master thief. Thieving expertise is distributed among the virtual character (Garrett) and the real-world player. *Tony Hawk's Underground* involves the professional identity of a skateboarder.

Many will object to *Full Spectrum Warrior* because of its ideology (values and worldview). Indeed, many will also object to the ideology of *Thief* and *Tony Hawk's Underground*. What all of these games exemplify, though, is that there is no real learning without some ideology. Adopting a certain set of values and a particular worldview is intimately connected to performing the activities and having the experiences that constitute any specific domain of knowledge. Physicists hold certain values and adopt a specific worldview because their knowledge making is based on seeing and valuing the world in certain ways. The values and worldview of astrologists comport badly with those of an astronomer; the values and worldview of a creationist comport badly with those of an evolutionary biologist. What we hope, of course, is that school exposes students to multiple and juxtaposed ideologies in a critically reflective context.

As one masters *Full Spectrum Warrior* through scaffolded activity based on distributed knowledge, facts – many of them – come free. All sorts of arcane words and information that would be hard to retain through rote drill become part of one's arsenal (tools), through which activity is accomplished and experience understood. For example, I now know what "bounding" means in military practice, how it is connected to military values, and what role it plays tactically to achieve military goals. If you knew only what it meant in terms of a verbal definition, your understanding could not begin to compete with mine.

Full Spectrum Warrior (and *Thief* and *Tony Hawk*) share knowledge and skill between a virtual character or characters (and objects and environments) and the player. In the act, by the end of the game, they allow the player to have experienced a "career," to have a story to tell about how his or her professional expertise grew and was put to tactical and strategic uses.

A good school-based learning experience that followed the *Full Spectrum Warrior* model would have to pick its domain of authentic professionalism well, intelligently select the skills and knowledge to be distributed, build in a related value system as integral to learning, and give explicit instruction only

"just in time" or "on demand." David Shaffer's "epistemic games," one of which we will discuss below, exemplify this approach.

AUGMENTED BY REALITY: *MADISON 2020*

In their *Madison 2020* project, David Shaffer and Kelly Beckett at the University of Wisconsin have developed, implemented, and assessed a game-like simulation that simulates some of the activities of professional urban planners (Beckett and Shaffer 2004; see also Shaffer et al. 2004). This game (and I will call it a game because it functions very much like a game in the learning environment in which it is used) and its learning environment incorporate many of the same deep learning principles that we have seen at play in *Full Spectrum Warrior.*

Shaffer and Beckett's game is not a stand-alone entity but is used as part of a larger learning system. Shaffer and Beckett call their approach to game-like learning "augmented by reality," because a virtual reality – that is, the game simulation – is augmented or supplemented by real-world activities; in this case, further activities of the sort in which urban planners engage. Minority high school students in a summer enrichment program engaged with Shaffer and Beckett's urban planning simulation game, and, as they did so, their problem-solving work in the game was guided by real-world tools and practices taken from the domain of professional urban planners.

As in the game *SimCity*, in Shaffer and Beckett's game, students make land-use decisions and consider the complex results of their decisions. However, unlike in *SimCity*, they use real-world data and authentic planning practices to inform those decisions. The game and the learning environment in which it is embedded is based on David Shaffer's theory of *pedagogical praxis*, a theory that argues that modeling learning environments on authentic professional practices – in this case, the practices of urban planners – enables young people to develop deeper understandings of important domains of inquiry (Shaffer 2004). The emphasis, however, is not on professions as vocations but as domains of expertise that recruit important ways of knowing and producing knowledge; thus, Shaffer calls his games "epistemic games" (Shaffer 2007).

Shaffer and Beckett argue that the environmental dependencies in urban areas have the potential to become a fruitful context for innovative learning in ecological education. Although ecology is, of course, a broader domain than the study of interdependent urban relationships, cities are examples of complex systems that students can view and with which they are familiar. Thus, concepts in ecology can be made tangible and relevant.

Cities are composed of simple components, but the interactions among those components are complex. Altering one variable affects all the others, reflecting the interdependent, ecological relationships present in any modern city. For example, consider the relationships among industrial sites, air pollution, and land property values: Increasing industrial sites can lead to pollution that, in turn, lowers property values, changing the dynamics of the city's neighborhoods in the process.

Shaffer and Beckett's *Madison 2020* project situated student experience at a micro level by focusing on a single street in their own city (Madison, Wisconsin):

Instead of the fast-paced action required to plan and maintain virtual urban environments such as *SimCity*, this project focused only on an initial planning stage, which involved the development of a land use plan for this one street. And instead of using only a technological simulation [i.e., the game, JPG], the learning environment here was orchestrated by authentic urban planning practices. These professional practices situated the planning tool in a realistic context and provided a framework within which students constructed solutions to the problem (Beckett and Shaffer 2004, 11–12).

The high school students Shaffer and Beckett worked with had volunteered for a ten-hour workshop (run over two weekend days) focused on city planning and community service. At the beginning of the workshop, the students were given an urban planning challenge: They were asked to create a detailed redesign plan for State Street, a major pedestrian thoroughfare in Madison, a street quite familiar to all of the students in the workshop. Professional urban planners must formulate plans that meet the social, economic, and physical needs of their communities. To align with this practice, students received an informational packet addressed to them as city planners. The packet contained a project directive from the mayor, a city budget plan, and letters from concerned citizens providing input about how they wished to see the city redesigned. The directive asked the student city planners to develop a plan that would, in the end, have to be presented to a representative from the planning department at the end of the workshop.

Students then watched a video about State Street, featuring interviews with people who expressed concerns about the street's redevelopment aligned with the issues in the informational packet (e.g., affordable housing). During the planning phase, students walked to State Street and conducted a site assessment. Following the walk, they worked in teams to develop a land-use plan using a custom-designed, interactive geographic information system

(GIS) called MadMod. MadMod is a model built using Excel and ArcMap (Environmental System Research Institute 2003) that lets students assess the ramification of proposed land use changes.

MadMod – the "game" in the learning system – allows students to see a virtual representation of State Street. It has two components, a decision space and a constraint table. The decision space displays address and zoning information about State Street using official two- or three-letter zoning codes to designate changes in land use for property parcels on the street. As students made decisions about changes they wished to make, they received immediate feedback about the consequences of changes in the constraint table. The constraint table showed the effects of changes on six planning issues raised in the original information packet and the video: crime, revenue, jobs, waste, car trips, and housing. Following the professional practices of urban planners, in the final phrase of the workshop, students presented their plans to a representative from the city planning office.

MadMod functions in Shaffer and Beckett's curriculum like a game much in the way *SimCity* does. In my view, video games are simulations that have "win states" in terms of goals players have set for themselves. In this case, the students have certain goals, and the game lets them see how close or far they are from attaining those goals. At the same time, the game is embedded in a learning system that ensures those goals and the procedures used to reach them are instantiations of the professional practices and ways of knowing of urban planners.

Shaffer and Beckett show, through a pre-/post-interview design, that students in the workshop were able to provide more extensive and explicit definitions of the term "ecology" after the workshop than before it. The students' explanations of ecological issues in the post-interview were more specific about how ecological issues are interdependent or interconnected than in the pre-interview. Concept maps that the students drew showed an increased awareness of the complexities present in an urban ecosystem. Thus, students appear to have developed a richer understanding of urban ecology through their work in the project.

One hundred percent of the students said the workshop changed the way they thought about cities, and most said the experience changed the things they paid attention to when walking down a city street in their neighborhoods. Better yet, perhaps, Shaffer and Beckett were able to show transfer: Students' responses to novel, hypothetical urban planning problems showed increased awareness of the interconnections among urban ecological issues. All these effects suggest, as Shaffer and Beckett argue, "that

students were able to mobilize understanding developed in the context of the redesign of one local street to think more deeply about novel urban ecological issues" (p. 21).

ASSESSMENT: A GAME EXAMPLE

Let me begin to relate my remarks above more directly to assessment issues by using another commercial game as an example. It involves people playing real-time strategy video games like *Rise of Nations*, *Age of Empires*, or *Age of Mythology* (Gee 2003a, 2004), which are arguably the most complicated videogames made.

In real-time strategy games (so-called "RTS" games), a player takes a given civilization (e.g., in *Rise of Nations*, the Russians, Chinese, British, Indians, Incas, etc.) from its earliest days as a simple village to the rise of modern cities through a variety of ages (e.g., in *Rise of Nations*, the Classical Age, the Medieval Age, the Gunpowder Age, the Industrial Age, the Modern Age, and the Information Age). Players must build many different types of buildings and cities; discover and collect resources like timber, gold, minerals, and oil; build different types of soldiers, armies, and military apparatuses, as well as priests and scholars; establish new territories through movement (across land and sea), war, or diplomacy; set and collect taxes and engage in trade; establish religious and educational institutions; and build wonders and monuments. As a player builds up resources, knowledge, and achievements, he or she can choose to move into ever more modern ages, upgrading all buildings, soldiers, and apparatus. Of course, a player can also choose to stay in an earlier age, build up massively in that age in certain respects, and defeat civilizations that are more "modern."

The player must do all this in competition with other civilizations (as many as five or six) played by the computer or other real people. There is a premium on time, because everyone operates in real time; each person acts while all of the other players are acting, so speed can be one strategy for victory (although one can also choose to "turtle"; that is, build more slowly but secure one's territory through fortifications or diplomacy). Players can establish different conditions for victory – for example, most territory gained, defeat and colonization of other civilizations, diplomatic conditions, or the success of a civilization on grounds other than military (e.g., economy or wonders built).

Such a game, although complex, is certainly no more complicated than math or science in school when learners are playing it as an actual enterprise (practice) and not just as memorizing facts. In fact, as I go through this

discussion, I would like the reader to imagine replacing my example – I will use the game *Rise of Nations* – with something like "doing experimental science" (e.g., with fast-growing plants) or "reading and researching a topic with others – for example, using the jigsaw method – well enough to teach it to peers," activities that might well go on in elementary school. I want the reader to ask, "Why shouldn't learning school subjects be more like playing *Rise of Nations*? Why shouldn't assessment work in school the way it does in *Rise of Nations*?" I am not saying necessarily that it should; I am saying we should ask why it shouldn't.

Let's say now we wanted to assess Janie on her playing of *Rise of Nations*. At one level, there is no need to view assessment as in any way separate from playing the game. If Janie has managed to get to a new age, we know for sure that she can play the game; if she can get to later and later ages, we know she can play it well; if she can hold her own against other players, we know she is very good indeed (of course, we have to be sure she doesn't cheat, although with video games, what is called "cheating" often involves a good deal of knowledge about the game and forms of collaboration that we might very well approve of, but that is a topic for another day; see Consalvo 2007). If we are picky and demand to know whether Janie is "proficient," then the game can be set to various difficulty levels, making the computer opponents harder and harder to beat – if Janie still holds her own, we know she is "proficient" – in fact, very good. So does she.

Why, then, would we need any assessment apart from the game itself? One reason – indeed, a reason Janie herself would – is that Janie might want to know, at a somewhat more abstract level than moment-by-moment play, how she is doing and how she can do better. She might want to know which features of her activities and strategies in the game are indicative of progress or success and which are not. Of course, the game is very complex, so this won't be any particular score or grade. What Janie needs is a formative or developmental assessment that can let her theorize her play and change it for the better, and this is what the game gives her.

At the end of any play session in *Rise of Nations*, the player does not just get the message "you win" or "you lose," but rather a dozen charts and graphs detailing a myriad of aspects of her activities and strategies across the whole time span of her play (and her civilization's life). This gives Janie a more abstract view of her play; it models her play session and gets her to see her play session as one "type" of game, one way to play the game against other ways. It gives her a meta-representation of the game and her game play in terms of which she can become a theoretician of her own play and learning. From this information, she does not learn just to be faster or "better"; she

learns how to think strategically about the game in ways that allow her to transform old strategies and try out new ones. She comes to see the game as a system of interconnected relationships.

Here are the charts and graphs Janie will see after each session of play. Janie will see herself compared, at each stage of the game play, with the other players (real people or the computer) in each chart and graph:

1. Achievements: Games (shows victory type [conditions under which victory was achieved], high score [total points of the winner, points are summarized over all the features in the charts and graphs below], map type [terrain chosen, some are harder than others], and game time [how long the session lasted]);

2. Achievements: Score (shows total score and scores for army, combat, territory, cities, economy, research, wonders);

3. Achievements: Military (shows largest army, number of units built, units killed, units lost, buildings built, buildings lost, cities built, cities captured, cities lost);

4. Achievements: Economy (shows food collected, timber collected, wealth collected, metal collected, oil collected, rare resources, ruins bonuses, resources sent, resources received);

5. Achievements: Research (shows when Classical Age, Medieval Age, Gunpowder Age, Industrial Age, Modern Age, Information Age each achieved, library research, miscellaneous research, unit upgrades);

6. Achievements: Glory (shows most citizens, most caravans, most scholars, most cities, most territory, most wonders held, forts built, units bribes, survival to finish);

7. Achievements: Player speed (shows player speed, hotkeys pressed, mouse clicks, clicks in map, clicks in interface, time zoomed in, time zoomed out, control groups formed, control groups activated);

8. Achievements: Score graph (graphs scores with historical age on the Y axis and game time on the X axis);

9. Achievements: Military graph (graphs scores with historical age on the Y axis and game time on the X axis);

10. Achievements: Territory graph (graphs scores with historical age on the Y axis and game time on the X axis);

11. Achievements: Resource graph (graphs scores with historical age on the Y axis and game time on the X axis);

12. Achievements: Technology graph (graphs scores with historical age on the Y axis and game time on the X axis); and

13. Achievements: Time line (each age correlated with game time when it was achieved by a straight line graph).

Janie uses these charts and graphs – they are part of the game play, part of the fun of the game – to understand where things went right and where they went wrong, where things can be improved and where no change is needed. She is now prepared to do even better next time. She can even look at the charts and graphs and conclude, not that there were weaknesses in her performance, but that she won by a certain style and would like now to try another one. This is formative or developmental assessment at its best.

Yet what if we wanted to evaluate Janie – to grade her, not just develop her? This is, of course, the classic summative assessment question. This sort of assessment would still be the best record of what she has done and can do (if we set certain conditions for her play). We have to be careful here, though. You will note that in charts 1 and 2, the player gets a "total score." However, this total score (which reflects different things as different victory conditions are set) is a composite of all of the other features dealt with in the charts and graphs. By itself it is pretty meaningless, because one needs to know which of many features is made for the high score in different cases, and these will be different for different players, play sessions, styles of play, and conditions of victory. If this total score floated away from all of these other features, it would be almost totally meaningless (e.g., someone you thought was really good because he or she had a high score could lose to someone you thought less highly of because the "lesser" player engaged in a strategy that focused only on where the "better" player was weak; that is, the "lesser" player would have understood the game as a set of complex features, not one "score").

What if we wanted to help high-level policy makers set standards for real-time strategy game play, just like school superintendents and state and federal educational officials try to do for reading, math, or science? Even these "high-level" folks need to see the total score as one take on a multidimensional feature space. In fact, just as Janie needed these charts and graphs to model her game play so she could theorize it, these officials would need not a score for each Janie, but a model to help them theorize the complex system that constitutes the game *Rise of Nations* and real-time strategy games as a category (itself a complex system – a system of systems made up of different specific games). It is hard to believe that the situation is any simpler for reading, science, or math, unless, of course, one radically simplifies what one means by reading, science, or math – and it is to this issue that I now turn.

IMPLICATIONS

Both the perspective on learning developed here (a situated one) and the examples of game-like learning within well-designed learning activity

systems have a number of further implications for testing and assessment, as well as for any deep notion of OTL (Gee 2003b, 2004). If an assessment is testing conceptual knowledge and the ability for students to apply (situate) their learning, then it clearly seems to be the case that students exposed to the kinds of game-like learning we have discussed here have an advantage. They are able to form understandings based on activity and experience, understandings customizable to specific contexts of use. From this basis they can eventually generalize their knowledge without losing the grounding of that knowledge in specific applications.

Even if students exposed to such learning never achieve the full range and generality of an expert (after all, experts have had years of experience), they will know why specific kinds of technical knowledge are important, how they really work, and they will have sensed their own real capacity to fully understand and use that knowledge. Thus, if deep conceptual learning is our goal, it may be that such game-like learning as we have discussed here will become one of the resources we will demand for all students if assessments of their learning are to be fair and based on true OTL at a conceptual level and in a situated way.

Of course, "fair" may not be the right word here, as Pullin has pointed out to me (personal communication). As she points out, "things can be fair; that is, equitably distributed, but offered at a very low level." She prefers the term "meaningful opportunity to learn" rather than "fair opportunity to learn." I agree but want also to point out that, in another sense of the word, it is not "fair" even when we have a low-level test, but some children, and not others, have had the opportunity to learn the material at a deeper level – in my view, they will, in many cases, not only do better on higher-level tests but on such lower-level ones as well.

What about tests and assessments based on verbal information and facts, which dominate our schools and even our legal conceptions of testing and fairness in testing? One hypothesis that a number of people have entertained is that when students engage in situated learning of the sort discussed here, facts and information eventually "come free" (e.g., Gee 2003a; Shaffer 2007). Information and facts that are hard to retain when they are drilled out of any meaningful context come to be learned much more effortlessly when learners are acquiring them as part of their own activity-based purposes and goals – when they are part of "playing the game" the learner wants to play.

If this is true, then such learners have an advantage over other learners even on more traditional information and fact-centered tests. Their situated understandings allow them to perform better on conceptual tests but to still have a better understanding of the words and verbal formulations on

traditional tests, because these kinds of words have been integral to the game they have played and the activities they have accomplished. These words have situated, contextually sensitive meanings for these learners. In this case, students exposed only to a verbal information and fact-based curriculum – much less only to skill-and-drill – have not had the same opportunity to learn and to pass even the traditional tests as have more privileged learners.

This problem becomes all the more acute when we realize that many children from privileged homes attain more and more activity- and experience-based situated learning at home, while poorer children do not get it at home or at school. To the extent that digital technologies come to enhance such learning, they may create a yet greater equity divide in terms of higher-order forms of understanding and even in the distribution of traditional test scores, especially in the content areas.

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