# GAME-LIKE LEARNING: AN EXAMPLE OF SITUATED LEARNING AND IMPLICATIONS FOR OPPORTUNITY TO LEARN

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**Knowledge: As Noun and Verb**

The theory of learning in many of our 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, b; Bereiter & Scardamalia 1993; Clark 1997; Glenberg 1997; Glenberg & Robertson 1999; Lave & 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 goes for good anthropologists, linguists, urban planners, army officers, doctors, artists, literary critics, historians, and on and on (diSessa 2000; Lave 1996; Ochs, Gonzales, & Jacoby 1996; Shaffer, in press).

But if lots of 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". These are the progressive counterpart of the traditionalists' skill-and-drill and, they, too, are problematic as a theory of learning. Learners are novices, leaving them to float amidst rich experiences with no guidance only triggers human beings' great penchant for finding creative but spurious patterns and generalizations that send learners down garden paths (Gee 1992, 2001). The fruitful patterns or generalizations in any domain are the ones 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 inter-relate with each other. And this is precisely what the learner does not yet know.

And 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, since 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 and can't even really understand them fully because they have not done the activities or had the experiences in and to which the words refer. So this needs to worry advocates of overt instruction.

But simply turning learners loose to engage in the domain's activities won't work either, since 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. And, of course, we can hardly expect learners to reinvent for themselves domains that took thousands of people and hundreds of years to develop. So this needs to 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, R., & Schauble, in press; 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 in modern video games (Gee 2003a). And, indeed, there has been much interest over the last few years in the role good video games and related sorts of simulations can play in learning inside and outside schools.

Below I will give some examples of the role game-like learning can play in post-progressive pedagogies and the ways in which such learning can speak to issues of equity and opportunity to learn. But before I do so, let me point out that the dilemma we discussed above, between knowledge as information and knowledge as activity and experience, is a 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.

## 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 different specific situations of use (Brown, Collins, & Dugid 1989; Clark 1989, 1993, 1997; Gee, to appear). 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, while verbal or general understandings may facilitate passing certain sorts of information-focused tests, they do not necessarily facilitate actual problem solving. Research in cognitive science has shown, for example, 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 actually draw these deductions and apply them to a concrete case in actual practice to solve a real-world problem (Chi, Feltovich, & Glaser 1981; Gardner 1991).

Situated understandings are, of course, 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 activity 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 2003; Gee 2003a; McFarlane, Sparrowhawk & Heald 2002; Squire 2003). I turn now to two quite different examples and then a discussion of a commercial video game that can give us some insight into what the future might hold for using video games for learning. I will then conclude with some remarks on implications, especially for issues of assessment and opportunity to learn.

**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. And 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 each second repeatedly, a form of uniform motion.

Now 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 just say, for convenience, that *a* adds one more meter per second at each step). So 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. And, 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". 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," 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 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). And, indeed, Boxer produces simulations that are, in many respects, game like and certainly can entice from learners the sort of flexible consideration of possibilities that play can inspire.

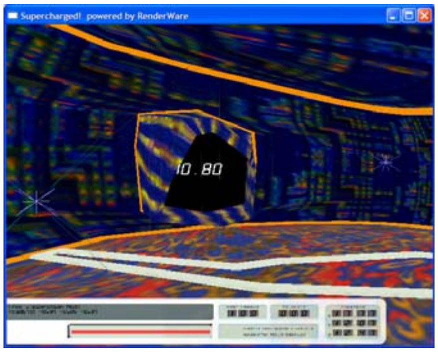
However, I turn now to an actual game designed to enhance situated learning that goes beyond verbal understandings.

**Supercharged!**

Kurt Squire and his colleagues (Squire, Barnett, Grant, & Higginbotham 2004; see also Jenkins, Squire, & Tan, in press; 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 which 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. Figure 1 shows a screenshot from the game.

Figure 1: Screenshot of a SuperCharged!



Squire, Barnett, Grant, and Higginbotham (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 exam 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 live 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 though 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 was 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, Barnett, Grant, and Higginbotham (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).

But 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 on screen and make predictions about how they thought the simulation would behave. This added structure added more focus to students' play and allowed the teacher to prompt deeper reflection on game play.

So 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 and parcel 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 will not have it any other way. So game designers face the same sort of challenge our schools do: how to get people to learn something, and learn it well, even to enjoy learning it, when it is long and hard. Games that can't be learned, or where the learning is not motivating, don't get played and the companies that make them go broke.

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

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 if these were the only two alternatives.

Since we don't have the space here to explicate the theory of learning behind each category of game, let me just talk about 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 which resolves our paradox quite nicely (see also

Shaffer 2004a and his important notion of “pedagogical praxis”). So, let's look at one such game: *Full Spectrum Warrior* (Pandemic Studios, for PC and Xbox).

Before I begin, however, let me hasten to say that I am well aware that this game is ideologically laden. I am well aware that it carries messages, beliefs, and values about war, warfare, terrorism, cultural differences, the U.S. military, and the role of the U.S. and its army in the modern, global world. I myself 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. However, 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 is a game and retains only about 15% of what was in the Army’s simulation (Buchanan 2004, p. 150). *Full Spectrum Warrior* teaches the player (yes, it is a teacher) how to be a professional soldier. It demands that the player thinks, values, and acts 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, specifically, in this game, 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).

But there is something else, beyond values, important here, as well, and this is the fact that 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 (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 knowing (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 scaffolded, as well, 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.

Now some caveats. I have used the word "professional", a word that unfortunately brings to mind high status people who get paid well for specialist skills. But that is not what I mean. What I mean is 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 & Scardamalia 1993). Good carpenters, good skate boarders, good musicians are authentic professionals just as much—and sometimes more so—than good doctors, lawyers, and professors.

Lots of 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. The *Chronicles of Riddick: Escape from Butcher Bay* involves the professional identity of a "tough guy prison escapee". *Tony Hawk's Underground* involves the professional identity of a skate boarder.

Many will object to *Full Spectrum Warrior* because of it ideology (values and world view). Indeed, many will object, as well, to the ideology of *Thief*, *Riddick*, and *Tony Hawk*. What all these games exemplify, though, is that there is no real learning without some ideology. Adopting a certain set of values and a particular world view is intimately connected to doing the activities and having the experiences that constitute any specific domain of knowledge. Physicists hold certain values and adopt a specific world view because their knowledge making is based on seeing and valuing the world in certain ways. The values and world view of astrologists comport badly with those of an astronomer; the values and world view 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—lots and lots 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*, *Riddick*, and *Tony Hawk*) share out 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" .

**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 implications for testing and assessment, as well as for any deep notion of opportunity to learn (Gee 2003b, 2004). If an assessment is testing conceptual knowledge and the ability for students to apply (to situate) their learning, then it clearly seems to be the case that students exposed to the sorts 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 sorts of technical knowledge is important, how it really works, and will have sensed their own real capacity to fully understand and use that knowledge. Thus, if deep conceptual learning is our goal, then it may be that such game-like learning as we have discussed here will become one of the sorts of resources we would demand for all students if assessments of their learning are to be fair, based on true opportunity to learn at a conceptual level and in a situated way.

But what about tests and assessments based on verbal information and facts—the sorts that so 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, Schaffer, in press). 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 and parcel of their own activity-based purposes and goals—when they are, we might say, part and parcel 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 sorts of information and fact-centered tests. Their situated understandings allow them to do better on conceptual tests, but to still understand the words and verbal formulations on traditional tests better, since these sorts 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 when 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, as well.

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