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SITUATED MEANING AND LEARNING: WHAT SHOULD YOU DO AFTER YOU HAVE DESTROYED THE GLOBAL CONSPIRACY?

LEARNING AND EXPERIENCE

TRADITIONAL VIEWS OF LEARNING STRESS THE MIND AND NOT THE BODY. Learning is held to be a matter of generalizations, principles, rules, abstractions, and logical computations. This view treats the human mind as if it is like a digital computer. Digital computers operate by rules that tell them how to manipulate symbols, symbols that have no real meanings to the computer beyond the manipulations the computer carries out on them.

Another view of learning holds that human learning and thinking does not, in fact, always work this way and often does not work this way when humans are thinking at their best. This view holds that humans learn, think, and solve problems by reflecting on their previous experiences in the world. That is, humans have experiences, store these experiences, and make connections or associations among them.

Of course, humans don't just store experiences in their minds "as is." Rather, they edit them according to their interests, values, goals, and sociocultural memberships. This editing process helps them structure the ways in which they pay attention to their experiences, foregrounding some things in them and backgrounding others. Furthermore, it is the

connections or associations that people make among their experiences that are crucial to learning, thinking, and problem solving.

When people are faced with a new situation in the world, aspects of this situation remind them of aspects of experiences they have had in the past. They use these elements of past experience to think about the new situation. Sometimes they can just apply past experience pretty much as is to the new situation. Other times they have to adapt past experience, more or less, to apply it, in the process learning something new that can, in turn, be applied to future situations. In either case, past experiences serve as guides for how to proceed in new situations.

Studies of human languages are one source of rich evidence that human thinking is deeply rooted in embodied experience of the world. In all human languages abstract notions are encoded in words and phrases that constitute metaphors based on concrete, embodied experience of a material world. For example, consider how we talk about the mind and thinking. We say things like "Why can't you *get this into* your head," "Keep this *in mind*," or "I can't get the idea *out of* my head." In all the cases we treat the mind as a container that things can go in and out of.

For another example, consider how we talk about argumentation. We say things like "He *destroyed* your point," "She *defended* her own perspective," "She *marshaled* her arguments," or "You need to *challenge* his basic premises," where we treat argumentation as a form of fighting or combat. Or, for a final example, note how we talk about consciousness: "He *came back* to consciousness," "He *lost* consciousness," "He *went* unconscious," or "Try to bring the experience *back to* conscious awareness"; here we treat consciousness as a sort of place we can come to and leave.

There are, of course, a great many more such examples. The argument is that just as language builds abstractions on the basis of concrete images from embodied experience of a material world, so, too, does human learning and thinking. One good way to make people look stupid is to ask them to learn and think in terms of words and abstractions that they cannot connect in any useful way to images or situations in their embodied experiences in the world. Unfortunately, we regularly do this in schools.

In this chapter I discuss the ways in which video games encourage and recruit situated, experiential, and embodied forms of learning and thinking. In this respect good video games incorporate quite good perspectives on how learning, thinking, and problem solving work in the world and should work in schools. I base my discussion, for concreteness, around a particular game, the game *Deus Ex* (a sequel, *Deus Ex: Invisible War* came out in 2003).

DEUS EX

Deus Ex combines two different genres. It is a first-person shooter in which you fight a variety of enemies from a first-person perspective. It is also a role-playing game in which, like *Arcanum*, you have choices about how to build and develop your character. Before you start playing the game, you choose the name and look of your character. (Your character can be black or white, for instance.) Whatever real name you choose, your character's code name is "J. C. Denton." J. C. is a covert special operative for the United Nations Anti-Terrorist Coalition, UNATCO. Note that this game came out well before the events of September 11, 2001. In fact, the game raises interesting issues about who is and who is not a "terrorist" and under what circumstances.

J. C. Denton is an augmented human being. He and his brother, Paul, have been "augmented" via a technology that allows them to leverage advanced abilities through the use of "nanite organisms" placed in their blood. Nanites are robots so tiny that they can fit inside individual cells. (They have been said to be the future of robotics, tiny devices that could be used for things like cleaning out clogged arteries or performing other sorts of surgery inside the body—however, I have no idea how far such technology has gone, or will go, in the "real" world.) In this case, they give him (you) the capacity to gain superhuman powers of various sorts in the game world.

After choosing a real name and look for J. C. Denton, you get a certain number of points with which you can increase his skills. There are

11 skills (computers, electronics, environmental training, lock picking, medicine, swimming, and skills with weapons of different types, including demolition devices, heavy weapons, low-tech weapons, pistols, and rifles). Each of these skills has four levels of mastery (untrained, trained, advanced, and master). You begin the game with each skill at untrained level, except for skill with pistols, which begins at trained level. You use your initial points to increase J. C.'s training level in some of the other areas, though you only have enough initial points to increase a few skills a bit. As you play the game, you earn additional points with which you can further increase J. C.'s skills.

Enhancing certain skills and not others, at the beginning and throughout the game, directly affects how you play. For example, if you are at the expert level as a lock picker, then you can easily get into places you wouldn't be able to get into otherwise, unless you have found a key. If your demolition weapons skills are no good, then you are quite likely to die if you try to disarm a bomb. If your computer skills are good, you can hack more easily into the myriad of computational devices you find in the world of *Deus Ex*; otherwise you have to gain such information through other sources, if you can.

When I played the game, toward the end, at a point where I knew I was about to face a great many powerful robots and other enemies, I found in a dark corner of a military base a very large gun, quite suitable for blowing robots off the face of the earth. Alas, I did not have any great skill at heavy weapons, so stealth and more subtle fighting strategies were the order of the day. (Truth be told, I ultimately used the experience points I gained using these more subtle strategies to increase my heavy weapons training, went back and got the gun, and had great fun blasting robots with a single shot.)

But choosing J. C's skill levels is not the only way in which you can develop him. As I said above, he is "nano-augmented." In fact, he has slots for nano-augmentations distributed around his body. You begin the game with three nano-augmentations already installed: an Infolink that allows J. C. to receive real-time neural communications from commanders and allies; an Identification: Friend or Foe (IFF) system that analyzes people and tells J. C. whether they are hostile or not; and a light that runs off J. C.'s own biological system.

You can fill the unfilled slots as you find special augmentation canisters in the game world. Canisters contain blueprints for two special abilities, such as having the strength to lift a truck or the ability to see through concrete walls. When you install a canister into the appropriate slot on J. C.'s body, thereby releasing its nanite organisms into his bloodstream, you must choose one, and only one, of the two special abilities associated with that particular canister. Once you fill a slot, that augmentation is permanently installed, and the second option is gone forever. So you must choose wisely. The augmentations you select greatly affect how you develop in the game world and what strategies will be most advantageous against different foes and challenges. You can also find upgrade canisters that allow you to upgrade any augmentations you have already installed, thereby making them stronger or more efficient.

Besides developing J. C.'s skills and nano-augmentations, there are other ways in which the player's decisions affect how the game will unfold. In your role as J. C. Denton, you have conversations with a number of other characters. You can choose different things to say and different ways to respond. How you have carried out a conversation with a given character will affect what that character thinks of you, how he or she reacts to you, and what he or she will later do or not do for or against you. Furthermore, you face other sorts of consequential choices in the world of *Deus Ex*, and how you make such choices affects what happens later in the game.

When you start the game, you enter a futuristic world that has fallen on hard times. Crime, terrorism, and disease are out of all control. No single government or agency can react fast or efficiently enough to control the worldwide devastation. In particular, a horrible plague, known as the Grey Death, is sweeping through cities and countries around the world over, killing millions. There is only one known cure for the disease, a vaccine called Ambrosia, a product that is in short supply and manufactured by the U.S. corporation VersaLife.

One of UNATCO's duties is to administer this cure for the Grey Death. However, the general public does not know that the cure exists. It is kept a secret and given only to politicians, dignitaries, and billionaires to ensure that the world's economy does not crash. Or so the rich and powerful claim. Nothing is ever as it first seems in *Deus Ex*.

J. C. Denton's first mission takes place on Liberty Island, New York, site of the Statue of Liberty. Inside the statue, a terrorist group known as the National Secessionist Force (NSF) is holding an UNATCO agent hostage. You soon discovers that the NSF is aware of Ambrosia and intends to replicate it and release it to the public. This begins a wild adventure in which you move to various sites and cities across the world (all rendered in great futuristic detail, based on actual architectural maps), uncovering plots and conspiracies, solving a great many problems, and fighting enemies of all sorts.

Deus Ex involves a good many moral dilemmas. For example, you discover, fairly early on, that the NSF are not really the "bad guys" and you and your fellow UNATCO soldiers are not really the "good guys." Yet you have already killed a number of NSF soldiers. If you have been too enthusiastically gung ho in this enterprise, you are left with a very real sense of guilt. In fact, when I returned to the UNATCO base from one of my first missions and told the munitions officer, a seasoned veteran, how I had performed, he told me that I was not a real soldier, because I too readily killed the enemy rather than attempting to sneak past them when I could. He refused to give me more ammunition, telling me to use what I had left more carefully and humanely. Thus, when I discovered that the NSF troops were not really the terrorists UNATCO claimed, I felt all the more guilty.

Later in the game you are forced to choose whether to save your badly wounded brother, Paul, now fighting at your side against UNATCO, or to escape and let him die in order to go on fighting for your current cause. (Indeed, Paul urges you to go on and leave him to protect your retreat.) If you save your brother (and survive yourself, of course), he plays a role later in the story; if you don't, he doesn't, though you later see his body in

one of your enemies' bases. When I played *Deus Ex*, I let Paul die and have regretted it ever since. (At the time, I didn't feel I had the requisite game-playing skills to save him—but perhaps that was just a lame self-exonerating excuse.)

By the time *Deus Ex* ends, you know a great deal more than you did at the beginning. You have discovered that the world is, in fact, run by a small number of rich global elites, elites who hide behind and control forces like the U.S. government, many members of which don't themselves fully understand who is actually pulling the strings in the global world. These elites have helped bring on all the devastation in the world, and they benefit by it. At the conclusion of the game, three opposing figures (each of whom has been helping you) try to convince you to engage in a different set of specific final actions that will end the game in one of three different ways.

One figure tells you the world will always be run by a small elite, though the current ones are selfish, evil, and corrupt. He tells you that you and he and his allies should replace this ruling elite and that all of you will behave more humanely, because you are better people. If you do what he suggests, you will become one of the elite rulers of the world—and, indeed, you are a moral and incorruptible force, are you not?

Another figure tells you that the world will always be run by a small elite as long as there is a global world tied together through global networked communications. This figure encourages you to engage in actions that will destroy this global communication infrastructure, returning the world to small and technologically primitive villages that will not be closely connected to each other in any larger system. This, he claims, is the only moral and humane future.

The last figure agrees that the world will always be run by a small elite, especially if the world is globally interconnected into one big system, as it is. But this figure, who happens to be not a human but a massive and sophisticated artificial intelligence, tells you that the only moral and humane way forward is to have him—a completely dispassionate and rational being—run the world, not human beings, any of whom will

simply be corrupted by their passions and by power. Humans have failed, over all of history, to institute a nonviolent, humane world for everyone. Only a purely rational and logical being can make good decisions. The artificial intelligence device tells you to engage in actions that will allow it to rule.

You must choose which ending to bring on. Yourself as an incorruptible elite? Return to small villages? Rational rule by artificial intelligence? I must admit, I was thrilled at the end of *Deus Ex* as I ran from the ruins of the massive global communication infrastructure collapsing all around me and returned the world to a plethora of small villages. You might have decided otherwise.

Deus Ex (as does its sequel) has one feature that is characteristic of good video games, though the feature is stronger in this game than in many others: There are nearly always multiple solutions to any given problem. Players can choose strategies that fit with their style of learning, thinking, and acting. This, of course, is highly motivating both for learning and for playing the game and a rich source for reflecting on one's own styles of learning and problem solving (and, perhaps, experimenting with new ones).

STORYING AND LIVING IN THE VIRTUAL WORLD OF A VIDEO GAME

Deus Ex has a rich, ever-twisting and turning story line. However, story in *Deus Ex*, and other video games with rich stories, functions differently than it does in books or movies. A book or movie can tell its story from first episode to last or it can begin in the middle of the action and only later get to the initial events in the story. In either case, the reader or viewer knows someone else (the "author") has determined the order in which events in the story will be encountered. This "author" (which, of course, can be multiple people) also determines the sources through which the reader or viewer gains crucial information. For example, a crucial piece of information may be in a conversation between two lovers rather than in a hidden diary. In a video game, on the other hand, players can gain the same information from different sources.

In *Deus Ex*, the player uncovers the story bit by bit as he or she discovers documents, hacks into computers, overhears or engages in conversations, or sees things happen. Different players find different things and discover information relevant to the story line in a different order. Furthermore, the player him- or herself engages in actions that are themselves part of the story line and different players will engage in different actions or the same ones in a different order.

The story line in a video game is a mixture of four things:

1. The game designers' ("authors'") choices.
2. How you, the player, have caused these choices to unfold in your specific case by the order in which you have found things.
3. The actions you as one of the central characters in the story carry out (since in good video games there is a choice as to what to do, when to do it, and in what order to do it).
4. Your own imaginative projection about the characters, plot, and world of the story.

The first and fourth of these items are true of books and movies, as well, but items two and three are true of video games only.

Thus, in video games like *Deus Ex*, stories are embodied in the player's own choices and actions in a way they cannot be in books and movies. Let's just call them, for short, "embodied stories." When I use the term "embodied," I mean to include the mind as a part of the body. So "embodied" means, for me, "in the body" and "in the mind." When I talk about a person's embodied experiences in the world (virtual or real), I mean to cover perceptions, actions, choices, and mental simulations of action or dialogue.

This is not to say that stories in video games are better or worse than stories in books and movies. Each form has its own advantages and disadvantages. For example, since stories in video games are embodied in you

the player, you (i.e., the character you are playing) cannot die and stay dead (you can die, but then you start the game again from a saved point or from the beginning). Otherwise, the game would be over before its "ending." In a book or movie, you can get quite sad and upset when a character you empathize with dies (you know that the character probably won't be coming back from the dead, unless it's a supernatural story, and when characters we like do come back in books and movies in some supernatural way, we might still feel strong emotion (e.g., joy) since it is such a rare, unreal, and special event).

When the character you are playing dies in a video game (and it is always, of course, a main character), you can get sad and upset, but you also usually get "pissed" that you (the player) have failed. Perhaps you even feel that you have failed your character. And then you start again, usually from a saved game, motivated to do better. The emotional investments you have in a video-game story are different from the emotional investments you have in a book or movie.

There are all sorts of reasons why stories in video games cannot (yet?) be, in a sense, as deep or rich as stories in good books and movies. For example, a video game must work out different futures based on choices different players have made and different things they have done earlier in the game. This creates a computational problem that books and movies do not face, since in a book or movie the designer always knows what choices have been made earlier. (Although quite simple "choose your own adventure" books are available.) Furthermore, real conversation is beyond the current computational power of a video game, since human beings can make so many different responses to anything said to them. A game like *Deus Ex* carries out conversations by giving the player a choice among several different things to say. Again, creating flexible, unpredictable conversations is a computational problem that books and movies do not face, since they simply script specific set dialogue.

Video games compensate for these limitations by creating what I have called embodied stories, stories that involve and motivate the player in a different way than do the stories in books and movies. One intriguing thing I have found about video-game stories, in my own play, is that I am so involved at the level of action—worrying about where I am, what's to be found there, what I am doing, what good or bad things might happen to me, what needs doing right now—that the larger story line often seems to float somewhat vaguely above me. I can't quite pull all the pieces together, since I'm too busy right now and, in any case, some of the pieces I discovered long ago are a bit hazy now. I can, of course, later (in a safe place) stop and try to put the pieces together, and I can then also usually look things up in notes games often keep for players.

Thus, although every once in a while in playing a game I do pause to consider the bigger picture—I certainly had to at the end of *Deus Ex* before I decided to send the world back to small villages—there is also a delicious feeling of being in the midst of things, looking at the world from the ground up and not from a God's-eye perspective. I suppose this is, again, part of what it means to call these stories "embodied stories." But it is also a whole lot like what "real" life is like. (Also, it is a lot like what it feels like to engage in an academic discipline when one does research and doesn't just study things after they have become all cut and dried.)

Again, video-game stories are not better or worse than stories in books and movies. They are different. They offer different pleasures and frustrations.

SITUATED AND EMBODIED MEANINGS

The embodied nature of video-game stories brings out a crucial feature. In video games, meaning (sense, significance) is itself situation specific and embodied. In chapter 2 I argued that this is how meaning operates when people actually know what they are doing in a domain and can do more than mindlessly repeat words and other symbols that they cannot situate inside any real practice. Video games are particularly good examples of how learning and thinking work in any semiotic domain when they are powerful and effective, not passive and inert.

In games like *Deus Ex*, the meaning of any event, object, artifact, conversation, written note, or any other potentially meaningful sign is up for grabs. You don't really know what it means unless and until you can give it a specific meaning in terms of the world through which you are moving as a character or the actual actions you carry out in that world. Furthermore, as that world and your actions in it change, the meanings of things you have seen or discovered can change as well. That is, meanings in video games are always specific to specific situations. They are always actively assembled (or changed) by the player, on the spot, in terms of images, materials, dialogue, and embodied actions in the virtual world being mutually created by the game and the player. In other words, meanings in video games are "situated meanings" or "situation-specific meanings," not just general ones.

Take something as simple as a numerical code—say five numbers—that you find on a desk or hack from a computer while playing *Deus Ex*. It's pretty clear that this code is nearly meaningless—not completely so, of course, since you know that it's a code of some sort. The code, at this point, just has a decontextualized, general meaning, the meaning "code of some sort." This code means nothing until you find something (e.g., a safe, a locked door, a computer) that it can be used on to some good effect. Then the numbers take on the situated, embodied, action-oriented meaning "key to this safe."

There is a wonderful moment in *Deus Ex* when a completely evil and powerful cyborg woman at the UNATCO command center, a creature who has threatened me throughout a large part of the game, is about to kill me when I have switched sides away from UNATCO. She expects an all-out fight that I am quite likely to lose badly. But I have found—unbeknownst to her—a code word in a computer that will cause her cyborgian mechanisms to self-destruct should I utter it in her presence. Those who have not found the code must fight her. I, on the other hand, utter the code word and experience a delicious moment of wonderfully embodied and situated meaning (much as I did when I first realized that fractal equations lead to marvelous patterns when you feed them into a computer or actually graph them on a piece of paper, rather than just learn to repeat them and verbally list their numerical properties).

What I have said about a set of numbers found on a discarded note in *Deus Ex* is true, too, of any written note or diary you find in the game. It's true of any words you hear as well. To make sense of them you must fit them into the emerging plot and virtual world you are discovering and helping to build. And you must do this actively, since you have choices about where to go and what to do. Every potentially meaningful sign in a game like *Deus Ex*—whether word, deed, artifact, or action—is a particular sort of *invitation to embodied action* (action actually carried out in the game world or simulated in your mind). And the nature of that invitation changes as you experience new situations and engage in new actions in the virtual world of the game.

Even something that seems to have a set and general meaning—a lock pick, for example—takes on different meanings in different situations. For example, at a certain point you may have but one lock pick left. Then that lock pick comes to mean something like: *try other ways into doors and use this lock pick as a last resort, because there may be more important doors coming up*. Notice that if you don't assemble some useful meaning for the lock pick, bad things can happen to you in the virtual world of the game. There is a price to be paid for not thinking at a situation-specific level and in terms of embodied actions in the game.

Of course, one might now say, "Well, that's just how meaning works in video games—it isn't and shouldn't be that way outside of games, say, in school." You already know from the discussion in chapter 2 that I disagree with this view. General, purely verbal meanings, meanings that a person has no ability to customize for specific situations and that offer the person no invitations for embodied actions in different situations, are useless (save for passing tests in school).

This theory of meaning as situated and embodied fits well with some current research on how comprehension of oral and written language works when it works effectively. For example, consider these remarks

from three separate works (see Bibliographical Note for sources):

> . . . comprehension is grounded in perceptual simulations that prepare agents for situated action.
>
> . . . to a particular person, the meaning of an object, event, or sentence is what that person can do with the object, event, or sentence.
>
> . . . higher intelligence is not a different kind of process from perceptual intelligence.

While video games actively encourage such situated and embodied thinking and doing, school often does not. In school, words and meanings usually float free of material conditions and embodied actions. They take on only general, so-called decontextualized meanings. Their meanings just amount to spelling out a word or phrase in terms of still other words and phrases, themselves with only general meanings. People (like the college physics students discussed in chapter 2) cannot actually *do* anything with these words. (They often cannot even simulate or carry out a conversation with these meanings, a conversation in which what they know is used flexibly and adapted differently to specific situations being discussed.)

Now someone's sure to say: "But we cannot teach children everything they need to learn in school, things like science and math, in ways that make sense in terms of situated meanings and embodied actions. There just isn't enough time, and, after all, they're not all going to become scientists." There is a sort of good common sense in this remark, but the problem is this: There really is *no other way to make sense*. If all you know—in any domain—are general meanings, then you really don't know anything that makes sense to you.

Of course, students in a science classroom do not need to know how to situate meanings in all the contexts a "real" scientist does. And they don't need to be experts at situating meanings in the sort of science they are studying. But they do need to know how *some* important and central situated meanings work in the semiotic domain—to have *some* embodied

feel for the matter. Otherwise they have, in reality, no idea how or why words and other sorts of signs in the domain make sense.

Imagine a person who claims to know what the word "democracy" means, because she can give you a dictionary definition of the word or a definition she has gotten out of a social studies textbook. However, faced with the following claim, she can make no intelligent response that speaks in any situated way to the situation the claim is about (i.e., the impact of wealth on elections in some countries):

> A country is not a democracy when candidates must take contributions from wealthy people in order to run for office, since then only wealthy people determine the slate of candidates.

The responder does not have to agree with this claim. But he or she surely has to see the sort of situated meaning being given to "democracy" in the claim. Further, he or she must then either accept that situated meaning or counter it with another situated meaning customized for (i.e., situationally relevant to) the situation the claim is dealing with. This is dialogue as engaged action. If you can't use "democracy" in a situation-specific way in such dialogues, then the word does not make sense to you, no matter how well you can repeat its dictionary definition.

Let me end this discussion of situated meaning with an example relevant to science education, an example that will take us away from words toward situated and embodied meanings for other sorts of symbols. The science educator Andrea diSessa has successfully taught children in sixth grade and beyond the algebra behind Galileo's principles of motion (principles related to Newton's laws) 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, 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.

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 understand 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 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 knows what good video games know, but schools often don't: Meaning is material, situated, and embodied if and when it is useful. Abstract systems originally got their meanings through such embodied experiences for those who really understand them. Abstraction rises gradually out of the ground of situated meaning and practice and returns there from time to time, or it is meaningless to most human beings.

THE PROBE, HYPOTHESIZE, REPROBE, RETHINK CYCLE

Because video games so nicely exemplify the nature of meaning as situated and embodied, they are also capable of capturing—and allowing players to practice—a process that is the hallmark of "reflective practice" in areas like law, medicine, teaching, art, or any other area where there are expert practitioners. Playing a good video game like *Deus Ex* well requires the

player to engage in the following four-step process:

1. The player must *probe* the virtual world (which involves looking around the current environment, clicking on something, or engaging in a certain action).
2. Based on reflection during and after probing, the player must form a *hypothesis* about what something (a text, object, artifact, event, or action) might mean in a usefully situated way.
3. The player *reprobes* the world with that hypothesis in mind, seeing what effect he or she gets.
4. The player treats this effect as feedback from the world and accepts or *rethinks* his or her original hypothesis.

In fact, if you don't engage in this four-step process, you won't get very far in a good video game. For example, in any standard shooter game (like, say, *Return to Castle Wolfenstein*, *Far Cry*, or *Doom 3*) you can run around shooting at things a bit without engaging in this process, but soon you will run out of ammo and health and die, probably in the wrong place, all too close to where you started. In a good video game you have to try lots of different things and then you have to think about the results you get and try to make sense of what they mean for you and your progress through the virtual world of the game. In fact, you can't get very far in any real-world practice either if you don't engage in this four-step process (say, in being a good teacher, musician, artist, architect, businessperson, or athlete).

Some consider this four-step process to be the basis of expert reflective practice in any complex semiotic domain. But it is also how children learn, even very young children, when they are not learning in school. It is how children initially build their minds and learn their cultures.

The human mind is a powerful *pattern recognizer*. In fact, humans are quite adept at finding patterns where none actually exists (witness astrology), a problem I will deal with in the next chapter. The young child does something (this is the probe)—for example, he or she tries to crush a soft

cloth book lying on the floor. The child, usually unconsciously, reflects on what he or she is doing while acting ("reflection-in-action") and after having acted ("reflection-on-action"). Such reflection involves listening to the world as it "talks back," giving you feedback about the success or failure of your action in terms of your own goals and desires.

Based on this feedback, the child forms a hypothesis (a guess) about a pattern that may exist (a set of relationships), say: "Books are soft, they squish, but don't break." His or her next action (the reprobe) is treated as a test of this pattern—do things really work this way or not? Perhaps the child now tries to crush a book made of paper and finds that it doesn't squish, but rips and tears. Based on this test, the child reflects again in and on action, accepting or re-forming his or her hypothesis about what the pattern is (say, now, hypothesizing, that cloth books squish and paper ones tear).

The child, through action and reflection, becomes a "self-teacher," "training" his or her own mental networks of associations (the patterns the mind stores). Here the network of associations is something like: book—cloth—squish, book—paper—tear, a larger pattern made up of two smaller subpatterns. Indeed, the child may already have another subpattern for books that is something like: book—cardboard—bends, doesn't break, exemplifying yet another category.

As the child forms more associations around the book (e.g., with concepts like fun, pictures, being read to by his or her parents, etc.), the child builds up an interlocking set of patterns (call this all the "book pattern") and subpatterns (elements like book—cloth—squish, or book—parent—being read to—feeling loved). Of course, subpatterns in the book pattern are also subpatterns in other larger patterns to which they are linked. For example, the subpattern book—cloth—squish is also a subpattern in the larger "squish pattern" (the pattern that captures how squishiness works in the world).

This forming of associations is crucial not just to the development of the child's mind. It also constitutes aspects of the child's emerging identity as a cultured being of a certain sort connected to a certain sort of family, social group, and community. For example, the six-year-old playing

Pikmin in chapter 2, when he was two, took his first hike in a forest. He saw a chipmunk on a fallen tree and said "Henry's forest," referring to a chipmunk in a Thomas the Tank Engine book he had at home, a book devoted to an animated railroad engine named Henry who is helping to reforest an area after it has burned in a forest fire.

What is happening here is that, as part and parcel of his embodied experience in the world, this child is creating a link (association) in his mental networks (patterns) between "real" chipmunks and "book" chipmunks, between the real world and the world of books. If such episodes continue (and they did, of course), the real world and books become integrally linked into the same sets of associations or patterns for such a child. Books and the real world don't stand apart or opposed.

Since the initial patterns we form in life are a basis on which we form all the rest of our later patterns (because they determine the hypotheses we originally make and revise, setting a certain trajectory to our mental development), children like this have links between the real world and books as a foundational part of who they are in mind, body, and culture. It is not surprising that they often orient to books and literacy when they go to school in powerfully different ways than do children who have formed quite different patterns of association and built their viewpoints on the world on that basis.

Of course, there is no simple deterministic story to be told here. People can transform their mental associations when sufficiently powerful learning experiences encourage them to do so. What I am referring to here is a certain "set" or "direction" given to a child's cognitive, social, and cultural development. Nonetheless, for some children, those who have failed to interlink literacy into their embodied experiences of the world and their social groups, powerful learning experiences may be required in school to set some new directions in respect to literacy. Unfortunately, such children are often the ones who get literacy in school completely detached from anything otherwise meaningful to them, as they are skilled-and-drilled to death.

As children build up their concepts—like their concept of books—as a set of complexly interlinked patterns and subpatterns, they use these

patterns to situate meanings that are appropriate to specific situations. They pull out the subpatterns that are appropriate (useful) for the situation they are in, adapting them to the current situation. If no such subpattern exists already, they cobble together a new subpattern from bits and pieces of existing ones and adapt this to the current situation.

For example, if a child wants something hard and flat to draw or color on, he or she will situate a meaning for *book* something like *hard flat surface good for supporting a piece of paper*, drawing on a pattern like "book—paper pages—hard covers—covers won't bend," and others, and adapting them to the current need. Of course, such adaptations, based on experiences in the world, in turn form new subpatterns in the child's mind. Our experiences in the world build patterns in our mind, and then the mind shapes our experience of the world (and the actions we take in it), which, in turn, reshapes our mind. Concepts are never set and finished. They are like a large tree that always seeks to rise higher (i.e., attain more generality) but that must always send into the ground deeper roots (i.e., return to embodied experience).

This view of the mind, as I pointed out earlier, is quite different from the traditional one psychology takes. In the traditional view, concepts are like general definitions in the mind (like definitions for words in dictionaries). In the traditional view, the mind thinks through stored "facts" and grand generalizations that are like statements in logic (like "All books have covers"). In the view I am developing here, the mind thinks and acts on the basis of something like stored images (simulations) of experience, images that are complexly interlinked with each other (thereby attaining some generality) but that are always adapted to new experiences in ways that keep them tied to the ground of embodied experience and action in the world.

These two viewpoints on the mind have different consequences for how people think schools should operate. If you believe the traditional view, you think schools should teach children to memorize facts and should overtly tell them important generalizations. If you believe the other view, you think schools must give children embodied experiences

in and through which they can form networks of associations that must continually be rechecked against the world. However, as I show in the next chapter, for this embodied view, children still need active teachers who are guiding (even with direct instruction) the hypotheses they make and the patterns they form from their embodied experience. Otherwise children, ever creative beings, may very well hit on wonderful patterns that, in the end, don't really work in the semiotic domains they are learning, causing them to go and stay too long down garden paths.

The four-stage probe/hypothesize/reprobe/rethink process that underlies the formation of the child's mind is not different in kind from the process by which expert practitioners operate. This four-stage process is, of course, basic to good science, whether carried out by children in a good science classrooms or "real" scientists in labs, since science is one important form of expert practice. Ironically, though, the process that is basic to young children's learning and to adult's expert practice is too often discounted and unused in school learning.

APPRECIATIVE SYSTEMS

So far I have argued that the probe/hypothesize/reprobe/rethink cycle is typical of how both young children and professional practitioners learn and think. But what differentiates the young child learning from the expert practitioner learning? What differentiates them, I believe, is how what I call their *appreciative systems* work.

When the child probes the world and gets a result, on what basis does the child determine the "significance" and the "acceptability" of the result? The very form of this question makes it clear that children must *evaluate* the answer coming back from the world, must determine whether they "like" it or not, whether it is "good" or not from their perspective. Otherwise, why use the answer in their reflections and subsequent interactions with the world and, indeed, in their own minds as they build up their mental networks of associations?

Children can determine what they "like," what is a "good" result, only in terms of an *appreciative system*, that is, their set of goals, desires, feelings, and values in respect to the domain being engaged with. The appreciative system is where affect and cognition merge and come together. The children revise the hypotheses they have formed based on the goals, desires, feelings, and values encapsulated in their appreciative system. Young children who are thrilled by their power to destroy things will evaluate the tear of a book's brittle page as a good result and seek other brittle things to tear.

Expert practitioners in a given semiotic domain—whether teaching, science, law, business, architecture, art, or what have you—have to form an appreciative system relevant to that domain in terms of which they can evaluate action (probes) in the domain. That is, they must form the sorts of goals, desires, feelings, and values that "insiders" in that domain recognize as the sorts members of that domain (the affinity group associated with that domain) typically have. This process is much more specialized than the everyday learning a small child does. Furthermore, if learning in the domain is to be active and critical, the learning process and the appreciative system to which it gives rise must be open to a good deal more *conscious* reflection and critique than is typical of small children mastering their early worlds.

This is not to say that individuals do not merge and color these "social" goals, desires, feelings, and values (from the affinity group associated with the semiotic domain) with their own personal idiosyncratic goals, desires, feelings, and values. They most certainly do. They also merge and color them with those connected to other semiotic domains of which they are members and other identities, including cultural identities, that they have in the real world. The appreciative system, then, is not only the place where the affective and cognitive merge and come together, it is the place where the social, cultural, and personal merge and come together as well.

Nonetheless, the affinity group connected to the semiotic domain being learned determines what counts as an "acceptable" and "recognizable"

and "competent" appreciative system in the domain and what does not. The newcomer learns what counts as competent goals, desires, feelings, and values in the domain in terms of which he or she can properly evaluate the results of his or her probes within the world of the domain. In a sense, the learner is forming what we might call "taste" in the domain. This is why learning cannot be a private affair and the presence of others is essential.

In any domain—whether playing video games or learning some branch of science—the learner can learn in such a way that no real appreciative system is operative. In this case, the learner just does what he or she is told in a rote way. On the other hand, the learner can be actively involved in learning the domain in such a way that he or she forms an appreciative system that norms and guides his or her thought and action in the domain, but yet this system can remain largely unconscious and not reflected on in any very overt way. This is active but not yet critical learning.

In critical learning, the learner comes not just to form an appreciative system through practice and interaction with the affinity group associated with the domain but to reflect overtly on the goals, values, feelings, and desires that compose this system, to compare and contrast this appreciative system to others, and to make active and critical choices about the system. Of course, these choices must either remain within the confines of what the affinity group associated with the domain will recognize as acceptable or transform what the group finds acceptable. In either case, the learner is taking on a projective identity—actively, reflectively, and critically interfacing, at a metalevel, his or her real-world identities with the new identity being formed in the new semiotic domain.

When a player plays a video game like *Deus Ex* actively and critically, the player forms a viewpoint on what counts as playing well or not. It is not just a matter of getting through a crisis or solving a problem, of just surviving to get to the end of the game. The player cares about how his or her character (his or her virtual self) has fared. As I played more and more of *Deus Ex* and got better at the game, I found myself repeatedly replaying scenes to do them better—to have my character look better and to be able

myself to look back on the history of that character's interaction in the virtual world with a certain pride (pride that I could feel both in terms of my virtual identity as the character and my real identity as a player).

I was forming an appreciative system, one on which I could overtly reflect if and when I wished to. When I did engage in such overt reflection, asking myself why I cared about this or that outcome and what exactly my values in the game world were, I learned a good deal about myself, about the virtual world of the game, and about the design of this and other related games.

People do not usually form appreciative systems by themselves. Even in my case, where I was playing alone and not in a multiplayer game, I formed my appreciative system through multiple routes that went beyond my private play. As I got into the game (one of the first I played), I read about it on a variety of Internet sites. I looked at chat rooms devoted to the game and saw how others talked and felt about playing it and games like it. I eventually read magazines devoted to video games as well. I consulted several different walkthroughs of the game, intrigued both by how the writers had played through a given part and how they talked about such play.

And, of course, players who play with others, often on teams against other teams, and often using chat rooms to talk about their play, have their appreciative systems formed even more directly by the affinity group associated with the game. My appreciative system in regard to games like *Deus Ex* has changed and, I think, deepened, as I have played more such games and had more interactions with the affinity group associated with such games via the Internet, magazines, books, and face-to-face interactions.

As I play shooter games now—games like *Max Payne*, *Halo*, *Half-Life*, *Return to Castle Wolfenstein*, *Doom*, *Far Cry*, *Resistance: Fall of Man*, *Gears of War*, and their sequels—I find myself comparing and contrasting them. I find myself, however silently, critiquing elements of the game as "nothing new," and thinking "nice touch," "a nostalgic nod to *Half-Life*" (an earlier, vastly popular shooter), "brilliant integration of graphics and action," "problem well-integrated into the plot line, not just a puzzle," and a great

many more judgments (some expressed in language not printable here—especially in regard to the jumping in the first *Half-Life*). My appreciative system is tied in an important way to knowledge about and perspectives on shooter games as *designed entities* having their own sort of "design grammar." It is a "language" I am beginning to think and speak, even to think and speak creatively in the sense that I can critique such games and imagine new and different ones. In the end, then, while I don't have the skills to build a game, I think a good deal, while playing (reflection in action) and afterward (reflection on action), about what new and better games "ought to" look like.

It is my contention that active, critical learning in any domain should lead to learners becoming, in a sense, *designers*. Some, like the players who build their own extensions to games, will actually design new things. Others, like me, will design in thought and talk and let it inform their play. But there is no design and designing, in the sense I am talking about, without forming an appreciative system for a given semiotic domain.

Appreciative systems, design and designing, and reflection in and on embodied action in association with an affinity group are matters that hardly ever appear in discussions about school or in educational research. Perhaps that's one reason why so many young people learn to play complex video games so much faster and better than they learn anything comparably complex in school.

WRITTEN TEXTS

With all my talk of situating and embodying meanings, probing the world, and designing things, some will ask what has happened to good old-fashioned printed texts. Video games have, I believe, a great deal to teach us about how reading works when people actually understand what they are reading.

A game like *Deus Ex* has a great many texts inside the virtual world it creates, texts you find along the way, like notes, e-mail, diaries, and messages you have hacked from various computers. These texts help you not

only to piece together the ongoing story but to make decisions about actions you take. In some games, such as the underrated but wonderful game *Clive Barker's Undying*, the number of extended texts you find gets quite large and is a central part of playing (and enjoying) the game.

However, video games are deeply connected to written texts in a different way as well. They are surrounded by a great many written texts. For instance, there are a large number of reviews of games in magazines and on Internet sites. Furthermore, players often add their own reviews to the official review written for a particular Internet site (and they show no deference whatsoever to the official reviewers).

Games often come with manuals. They also sometimes come with a booklet, written as a diary, or notes, or otherwise set as part of the virtual world of the game, that gives the back story or background information for that virtual world. For example, *American McGee's Alice*, a game where Alice has gone insane and returned to a nightmarish Wonderland, comes with a booklet entitled "Rutledge Private Clinic and Asylum Casebook," which contains Alice's physician's daily notes on her treatment.

For most games, publishers offer highly colorful and detailed strategy guides that tell players all about the game (its characters, maps and geography of the world, weapons, enemies, objects to be found, fruitful strategies to follow, etc.). Such guides also give a complete walkthrough for the game. A number of Internet sites offer (usually free) a variety of different walkthroughs ("faqs") written by players themselves. These sites also offer hints from players and "cheats" for the games. (Cheats are ways to manipulate the game's programming to do things like give yourself extra life or more ammunition.)

These texts are all integrated into the appreciative systems associated with the affinity groups connected to video games. Different players and groups have different views about whether, when, and how to use these texts. For example, consider walkthroughs on a site like gamefaqs.com. These documents often run to 70 or more single-spaced pages and are written according to a tight set of rules about what they should contain and look like (including a list of each date on which the walkthrough was

revised). Some players shun walkthroughs entirely, though they may write them. Others argue that walkthroughs can and should be used, but only to get a hint when one is thoroughly stuck. Indeed, the writers of the walkthroughs themselves often recommend that players use them this way. (Imagine producing a 70-page, single-spaced document and advising people to look at it only when they are stuck.)

Of course, if children had walkthroughs in school when they studied things like science, we would call it "cheating" (let alone if they had "cheat codes"). But, then, imagine what a science classroom would look like where learners wrote extensive walkthroughs according to strict norms and debated when and how to use them, debates that became part and parcel of the learners' growing appreciative systems about what it means to "do science (well)." And, indeed, in a sense, real scientists do have walkthroughs. They know (through talk with others and through texts) the case histories of how relevant related discoveries in their field were made. They also have opinions about how closely one should consult or follow these histories.

It is now a piece of folk wisdom that "young people" don't read things like manuals but just start playing games, often looking at the manual or other guides later. Yet I would argue that these young people are using print in the way it should be used when people actually understand what they read in a useful and situated way. Baby boomers—perhaps too influenced by traditional schooling—often try to do otherwise to their regret and frustration, when they insist on reading a manual before they have any embodied understanding of what the manual is about (i.e., the game).

The problem with the texts associated with video games—the instruction booklets, walkthroughs, and strategy guides—is that they do not make a lot of sense unless one has already experienced and lived in the game world for a while. Of course, this lack of lucidity can be made up for if the player has read similar texts before, but at some point these texts originally made sense because the player had an embodied world of experience with games in terms of which to situate and spell out their meanings.

The same thing is most certainly true of the sorts of texts that show up in learning content areas like science, math, or social studies in school. A biology textbook does not make a lot of sense unless and until one has experienced and lived in the world of biology as practice for a while. And again, this lack of lucidity is mitigated if the student has already read a good many similar texts. However, at some point these texts also originally make sense because the student has an embodied world of experience (in reality or, at least, simulated in his or her mind) in terms of which to situate and spell out their meanings.

When I give talks on video games to teachers, I often show them a manual or strategy guide and ask them how much they understand. Very often they are frustrated. They have no experience in which to situate the words and phrases of the texts. All they get is verbal information, which they understand at some literal level, but which does not really hang together. They cannot visualize this verbal information in any way that makes sense or makes them want to read on. I tell them that that is how their students feel when confronted with a text or textbook in science or some other academic area if they have had no experiences in terms of which they can situate the meanings of the words and phrases. It's all "just words," words the "good" students can repeat on tests and the "bad" ones can't.

When you have played a video game for a while, something magical happens to the texts associated with it. All of sudden they seem lucid and clear and readable. You can't even recall how confusing they seemed in the first place. At that point, players can use the text in a great variety of ways for different purposes. For instance, they can look up details that enhance their play. (For example, I looked up information on the different guns in *Return to Castle Wolfenstein* and discovered I was using a less accurate one than I could have been using, and I also got a crucial hint on how to keep the better gun from overheating.) Or such guides can fill out players' knowledge of the places, creatures, and things in the virtual world in which they are living. Players can troubleshoot problems they are having in the game, with the game, or with their computer. They can get hints or compare their play to how others have done.

Let me take the booklet that comes with *Deus Ex* as an example of what I mean by saying that texts associated with video games are not lucid unless and until one has some embodied game experience in which to "cash out" the meanings of the text. The book contains 20 small pages, printed in double columns on each page. In these pages, there are 199 bolded references that represent headings and subheadings. One small randomly chosen stretch of headings and subheadings that appears at the end of page five and the beginning of page six says: *Passive Readouts, Damage Monitor, Active Augmentation and Device Icons, Items-at-Hand, Information Screens, Note, Inventory, Inventory Management, Stacks, Nanokey ring, Ammunition*. Each of these 199 headings and subheadings is followed by text that gives information relevant to the topic and relates it to other information throughout the booklet. In addition, the booklet assigns 53 keys on the computer keyboard to some function in the game, and these 53 keys are mentioned 82 times in relation to the information contained in the 199 headings and subheadings. So, although small, the booklet is packed with relatively technical information.

Here is a typical piece of language from this booklet:

> Your internal nano-processors keep a very detailed record of your condition, equipment and recent history. You can access this data at any time during play by hitting F1 to get to the Inventory screen or F2 to get to the Goals/Notes screen. Once you have accessed your information screens, you can move between the screens by clicking on the tabs at the top of the screen. You can map other information screens to hotkeys using Settings, Keyboard/Mouse.

This makes perfect sense at a literal level, but that just goes to show how worthless the literal level is. When you understand this sort of passage at only a literal level, you have only an illusion of understanding, one that quickly disappears as you try to relate this information to the hundreds of other important details in the booklet. First of all, this passage means nothing real to you if you have no situated idea about what

"nano-processors," "condition," "equipment," "history," "F1," "Inventory screen," "F2," "Goals/Notes screen" (and, of course, "Goals" and "Notes"), "information screens," "clicking," "tabs," "map," "hotkeys," and "Settings, Keyboard/Mouse" mean in and for playing games like *Deus Ex*.

Second, though you know literally what each sentence means, together they raise a plethora of questions if you have no situated understandings of this game or games like it. For instance: Is the same data (condition, equipment, and history) on both the Inventory screen and the Goals/Notes screen? If so, why is it on two different screens? If not, which type of information is on which screen and why? The fact that I can move between the screens by clicking on the tabs (but what do these tabs look like; will I recognize them?) suggests that some of this information is on one screen and some on the other. But, then, is my "condition" part of my Inventory or my Goals/Notes—it doesn't seem to be either, but, then, what is my "condition" anyway? If I can map other information screens (and what are these?) to hotkeys using "Setting, Keyboard/Mouse," does this mean there is no other way to access them? How will I access them in the first place to assign them to my own chosen hotkeys? Can I click between them and the Inventory screen and the Goals/Notes screens by pressing on "tabs"? And so on—20 pages is beginning to seem like a lot; remember, there are 199 different headings under which information like this is given.

Of course, all these terms and questions can be defined and answered if you closely check and cross-check information over and over again through the little booklet. You can constantly turn the pages backward and forward. But once you have one set of links relating various items and actions in mind, another drops out just as you need it and you're back to turning pages. Is the booklet poorly written? Not at all. It is written just as well or as poorly as—just like, in fact—any of a myriad of school-based texts in the content areas. It is, outside the practices in the semiotic domain from which it comes, just as meaningless, no matter how much one could garner literal meanings from it with which to verbally repeat things or pass tests.

Of course, you can say, "Oh, yeah, you click on F1 to get to the Inventory screen and F2 to get to the Goals/Notes screen" and sound like you know something. The trouble is this: In the actual game, you can click on F2 and meditate on the screen you see at your leisure. Nothing bad will happen to you. However, very often you have to click on F1 and do something quickly in the midst of a heated battle. There's no "at your leisure" here. The two commands really don't function the same way in the game—they actually mean different things in terms of embodied and situated action—and they never really *just* mean "click F1, get screen." That's their general meaning, the one with which you really can't do anything useful until you know how to spell it out further in situation-specific terms in the game.

When you can spell out such information in situation-specific terms in the game, then the relationships of this information to the other hundreds of pieces of information in the booklet become clear and meaningful. And, of course, it is these relationships that are what really count if you are to understand the game as a system and, thus, play it at all well. *Now* you can read the book if you need to piece in missing bits of information, check on your understandings, or solve a particular problem or answer a particular question you have.

When I first read this booklet before playing *Deus Ex* (and having played only one other shooter game, a very different one), I was sorely tempted to put the game on a shelf and forget about it. I was simply overwhelmed with details, questions, and confusions. When I started the game, I kept trying to look up stuff. But I understood none of it well enough to find things easily without searching for the same information over and over again. In the end, you just have to actively play the game and explore and try everything. Then, at last, the booklet makes good sense, but by then you don't need it all that much.

There is much discussion these days about how many children fail in school—especially children from poor homes—because they have not been taught phonics well or correctly in their early years. But the truth of the matter is that a great many more children fail in school because, while

they can decode print, they cannot handle the progressively more complex demands school language makes on them as they move up in the grades and on to high school.

School requires, in respect to both oral and written language, forms or styles of language that are different from and, in some respects, more complex than everyday oral language used in informal face-to-face conversations. The forms of language used in texts and discussions in science, math, social studies classes, and other content areas go by the general name of "academic language," though different varieties of academic language are associated with different content areas in school.

Academic language, like the language in the *Deus Ex* booklet, is not really lucid or meaningful if one has no embodied experiences within which to situate its meanings in specific ways. For example, consider this academic-language quote from a high school science textbook:

> The destruction of a land surface by the combined effects of abrasion and removal of weathered material by transporting agents is called erosion. . . . The production of rock waste by mechanical processes and chemical changes is called weathering.

Again, one can certainly understand this at some literal word-by-word, sentence-by-sentence way. However, this is not "everyday" language. No one speaks this way at home around the table or at a bar having drinks with friends. But this language is filled with all the same problems the language of the *Deus Ex* booklet held for me when I had not lived through any experiences in terms of which I could situate its meanings. Without embodied experiences with which to cash out its meanings, all the above academic text will do—as the *Deus Ex* booklet did to me initially—is fill one with questions, confusion, and, perhaps, anger.

For example: I have no idea what the difference is between "abrasion" and "removal of weathered material by transporting agents," which I would have thought was one form of abrasion. What's a "transporting agent"? What's a "mechanical process"? I am not really clear on the

difference between "mechanical processes," especially in regard to weather, and "chemical changes." And what chemicals are we talking about here—stuff in rain?

Since the first sentence is about "erosion" and the second about "weathering," I suppose these two things are connected in some important way—but how? They must be two forms of "destruction of a land surface," given that this is the subject of the first sentence. But, then, I would have thought that producing "rock waste" was a way of building, not just destroying, land, since rock waste eventually turns into dirt (doesn't it?) and thus, I would have supposed, eventually into potentially fertile land. But this is a geology text, and they don't care about fertile land (or do they?). The word "land" here has a different range of possible situated meanings than I am familiar with.

Of course, I can turn the pages of the book back and forth clarifying all these points. After all, these two sentences are meant to be definitions—not of the words "erosion" and "weathering" in everyday terms but in specialist terms in a particular semiotic domain. And, of course, I do need to know that they *are* definitions, and I may not even know that if I have had little experience of specialists trying to define terms in explicit and operational ways so as to lessen the sort of ambiguity and vagueness that is more typical of everyday talk. Since they are definitions, they are linked and cross-linked to a myriad of other terms, descriptions, and explanations throughout the book, and I can follow this tangled trail across the pages, back and forth, losing bits of the connections just as I need them and page turning yet again.

However, once I have experienced the sorts of embodied images, actions, and tasks that engage geologists—including their ways of talking and debating, their reasons for doing so, their interests, norms, and values—then the text is lucid and useful. Confusion, frustration, and anger disappear. Given such understanding, everybody would pass the test and we couldn't fail half the class and reward a small set of "winners"—people who can repeat back verbal details they remember well when they don't fully understand them in any practical way.

In the end, my claim is that people have situated meanings for words when they can associate these words with images, actions, experiences, or dialogue in a real or imagined world. Otherwise they have, at best, only verbal meanings (words for words, as in a dictionary). Situated meanings lead to real understanding and the ability to apply what one knows in action. Verbal meanings do not (though they do sometimes lead to the ability to pass paper and pencil tests). This is why so many school children, even ones who are good at school, can pass tests but still cannot apply their knowledge to real problem solving.

MORE LEARNING PRINCIPLES

Let me conclude this discussion by listing further learning principles that our discussion of learning and thinking in video games in this chapter has implicated. Once again, in this list, I intend each principle to be relevant both to learning in video games and learning in content areas in classrooms. After listing principles we have already discussed pretty thoroughly, I discuss a few others that are related to them.

15. **Probing Principle**
    Learning is a cycle of probing the world (doing something); reflecting in and on this action and, on this basis, forming a hypothesis; reprobing the world to test this hypothesis; and then accepting or rethinking the hypothesis.
16. **Multiple Routes Principle**
    There are multiple ways to make progress or move ahead. This allows learners to make choices, rely on their own strengths and styles of learning and problem solving, while also exploring alternative styles.
17. **Situated Meaning Principle**
    The meanings of signs (words, actions, objects, artifacts, symbols, texts, etc.) are situated in embodied experience. Meanings are not general or decontextulized. Whatever generality meanings come to have is discovered bottom up via embodied experiences.

18. Text Principle

Texts are not understood purely verbally (i.e., only in terms of the definitions of the words in the text and their text-internal relationships to each other) but are understood in terms of embodied experiences. Learners move back and forth between texts and embodied experiences. More purely verbal understanding (reading texts apart from embodied action) comes only when learners have had enough embodied experience in the domain and ample experiences with similar texts.

Now let us turn to four related learning principles that are implicated in the discussion of video games and learning in this chapter, although they are not discussed directly. The intertextual principle is concerned with the fact that after players have dealt a good bit with certain types or genres of video games and the texts associated with them, they can begin to see these texts themselves as a family or genre of related texts. They understand any one such text (say a strategy guide for a fantasy role-playing game) intertextually in relationship to other related texts they have read connected to such games. Now they are "cashing out" texts not just in terms of embodied action in the games they have played (they are most certainly doing that as well) but also in terms of other texts they have read in the family or genre. Reading "new" texts becomes easy.

The multimodal principle is concerned with the fact—clear in all of the discussions about video games in this book so far—that, in video games, meaning, thinking, and learning are linked to multiple modalities (words, images, actions, sounds, etc.) and not just to words. Sometimes, at a particular point in a game, multiple modalities support each other to communicate similar meanings (e.g., "go in this direction"); sometimes they communicate different meanings, each of which fits together to form a bigger, more meaningful and satisfying whole (e.g., "I have just entered an evil place, better be real careful").

The "material intelligence" principle is really a subpart of the multimodal principle. In a video game, objects and artifacts store some of the

thinking and knowledge a player gains. So, in fact, does the environment the player moves through. For example, in *Deus Ex* if you haven't got a lock pick, you may have to think a great deal to get into a given door. If you have a lock pick, the lock pick stores your knowledge of how to get in the door, and you don't need to store the knowledge yourself. You can devote your thinking and problem-solving skills to other matters, thereby powerfully extending the amount of overall thinking and problem solving that is being accomplished, since the lock pick is doing some of it, along with lots of other "potent" material items. In a great game like *SWAT4*, a good deal of the experience of playing the game is learning how to use the knowledge stored in your other team mates (Non-Playing Characters, known as "NPCs," who in *SWAT4* are virtual characters, controlled by the computer, with lots of Artifical Intelligence) and the many tools and technologies you use to enter and pacify rooms safely.

In video games players soon learn how to "read" the physical environments they are in to gain clues about how to proceed through them. The shapes and contours of the physical environment, and the objects lying around, come to guide the player (of course, one can be fooled from time to time) in making good guesses about how to proceed. For instance, at one point in *American McGee's Alice*, you (playing as Alice) are lost among rocks and wild streams. However, you can see far off at the top of a mountain a bit of a mansion. Furthermore, the environment contains some contours of rocks and hills that suggest ways up. And finally, shining on a few rocks ahead of you are red jewels that you have already learned give you more health if you pick them up. Their placement clearly suggests moving toward them. The whole layout of the environment, then, helps you guess intelligently about how to proceed.

It is certainly good you get this help from the material environment and objects in it—good that the material environment and objects in it are part of your intelligence—because all along the way you have more than enough to do, thinking about how to fight Wonderland's now-deranged characters who want to stop your progress (and about how to solve a good many other problems).

Of course, in good classroom science instruction, children should come to see that, in science, too, objects, artifacts, and the ways in which the environment is set up can store knowledge and power. This, in turn, can allow them to think about other things and solve other problems that, when combined with the knowledge and power stored in tools, technologies, objects, and the environment, truly extends their reach. Indeed, good teachers set up scientific environments that guide learners and surround them with empowering tools that extend their individual efforts.

For example, just staring at and playing with pendulums in the real world is not actually a good way to "discover" the laws of the pendulum's movement. Galileo actually discovered these laws not by staring at a swinging chandelier, as the myth has it, but by using geometry and drawing, on paper, arcs and circles and paths of movement along them and figuring our their geometrical properties. Geometry is a powerful tool that stores much knowledge and skill that the learner does not have to invent for him- or herself. So, too, is the computer program diSessa uses to teach students Galileo's theorems about motion. Of course, we often expect children to learn science without the tools, artifacts, and material guidance that actual scientists have and have gained from the history of their science. There is real intelligence built into geometry and diSessa's Boxer program, as there is intelligence (knowledge, guidance) built into the objects and environments in *American McGee's Alice*, *SWAT4*, or *Half-Life 2*.

Finally, the intuitive (tacit) knowledge principle is concerned with the fact that video games honor not just the explicit and verbal knowledge players have about how to play but also the intuitive or tacit knowledge—built into their movements, bodies, and unconscious ways of thinking—they have built up through repeated practice with a family or genre of games. It is common today for research on modern workplaces to point out that in today's high-tech and fast-changing world, the most valuable knowledge a business has is the tacit knowledge its workers gain through continually working with others in a "community of practice" that adapts to specific situations and changes "on the ground" as they happen. Such

knowledge cannot always be verbalized. Even when it can be verbalized and placed in a training manual, by that time it is often out of date.

Of course, conscious knowledge is important for critical learning, as I have pointed out several times already. But, too often, unlike video games and good workplaces, schools do not honor the tacit and embodied knowledge people build up through practice and adaptation to change "on the spot" as it happens amid practice (and not in pure speculation). Yet such knowledge is crucial in a great many domains and is a large part of why learners feel competent in a domain and feel as if they share real membership with the affinity group associated with a domain. The child learning science who has built up no tacit knowledge—no "craft knowledge"—cannot really feel competent either. But the child who has built up such knowledge is liable to be turned off by school when such knowledge is not valued and mindlessly repeating facts and numbers that one understands in no embodied way gains one an A.

I once helped run an after-school science club for middle-school students who were quite unaffiliated with school and school-based learning and literacy. We taught these children how to do science and how to talk about what they were doing and discovering with each other. We taught them to act and talk like knowers, not just passive observers. When we checked up on one of the young boys who had flourished in our club (had even won a prize in his school's science fair), his high school teacher told us something quite interesting: "It's funny, he is really good at actually doing the science when we run an experiment or do other things, but he has a bad grade, because he keeps failing my multiple-choice tests" (much like, alas, Mendel, who failed his test to become a high school biology teacher but discovered modern genetics in his garden). This teacher did not value how much science this child knew in a tacit way tied to practice. The teacher could hardly leverage this knowledge—and bring some of it to conscious and critical awareness—if he did not honor it. When profit is on the line, good businesses no longer make this mistake; they have learned to draw on the tacit knowledge their workers develop in actual practice to introduce new work practices, rather than to rely solely on

managers innovating everything top-down without such "hands on" knowledge.

Next I list the principles we have just discussed.

19. Intertextual Principle

The learner understands texts as a family ("genre") of related texts and understands any one such text in relation to others in the family, but only after having achieved embodied understandings of some texts. Understanding a group of texts as a family (genre) of texts is a large part of what helps the learner make sense of such texts.

20. Multimodal Principle

Meaning and knowledge are built up through various modalities (images, words, symbols, interactions, abstract designs, sounds, etc.), not just words.

21. "Material Intelligence" Principle

Thinking, problem solving, and knowledge are "stored" in tools, technologies, material objects, and the environment. This frees learners to engage their minds with other things while combining the results of their own thinking with the knowledge stored in these tools, technologies, material objects, and the environment to achieve yet more powerful effects.

22. Intuitive Knowledge Principle

Intuitive or tacit knowledge built up in repeated practice and experience, often in association with an affinity group, counts a great deal and is honored. Not just verbal and conscious knowledge is rewarded.

BIBLIOGRAPHICAL NOTE

The discussion in this chapter about thinking as founded in pattern recognition from our embodied experiences of the world draws broadly on so-called connectionist views of the mind. See P. M. Churchland 1989; P. S. Churchland 1986; P. S. Churchland and Sejnowski 1992; Clark 1989, 1993, 1997; Margolis 1987, 1993; Rumelhart, McClelland, and the PDP Research Group 1986. For related work that has deeply influenced me, see Barsalou 1999a, b; Glenberg 1997; Glenberg, Gutierrez, Levin, Japuntich, and Kaschak 2004; Glenberg and Robertson 1999; Hutchins 1995; Nolan 1994. The quote about comprehension being grounded in perceptual simulations is from Barsalou 1999a, p. 77. The quote about meaning being about what a person can do is from Glenberg 1997, p. 3. The quote about close ties between thinking and perception is from Hawkins 2004, p. 96. Hawkins (2004) is a popular account. For a more academic account of spatial representations and imagery in regard to learning, see: Schwartz and Heiser 2006. On the idea that humans learn by storing and using their previous experiences and for the conditions under which experience leads to the best learning, see Kolodner 1993, 1997, 2006; Schank 1982, 1999.

For the idea that abstract notions are rooted in metaphors for embodied experience, see Lakoff 1987; Lakoff and Johnson 1980. On situated and embodied meanings, see Brooks 2002; Brown, Collins, and Dugid 1989; Clancey 1997; Clark 1997; Gee 1996, 1999b, 2004; Lave 1988; Lave and Wenger 1991; Rogoff 1990; and Tomasello 1999.

For Galileo's use of geometry to solve the problem of pendulums and how children are asked to engage in an actually harder task when they must solve the same problem without geometry, see Edwards and Mercer 1987. For diSessa's work and a discussion of Boxer, see diSessa 2000, quotes are from pp. 32–33, 33, 34. The probe, hypothesize, reprobe, rethink cycle is deeply related to Donald Schon's work, see Schon 1987; see also Gee 1997. The discussion of "appreciative systems" (a term Schon uses) was inspired by Schon's work. On the idea that learners ought to be designers, see New London Group 1996. The quote about the destruction of land surfaces is taken from a textbook quoted in Martin 1990, p. 93.

Intertextuality is a major theme in Bakhtin's influential work; see especially Bakhtin 1986. Material relevant to the material intelligence principle and the intuitive knowledge principle is discussed in diSessa 2000; the intuitive knowledge principle is also much discussed in terms of how knowledge functions in modern workplaces; see Gee, Hull, and Lankshear 1996. For multimodality, see Kress 1996, Kress and van Leeuwen 1996, 2001.