Reading, Language Development, Video Games, and Learning in the 21st Century

James Paul Gee
Mary Lou Fulton Presidential Professor of Literacy Studies
Arizona State University
james.gee@asu.edu

Reading: A Trajectory Approach

Consider the situation of a child learning to read. What should our goal for this child be? On the face of it, the goal would seem to be that the child learn to decode print and assign basic or literal meanings to that print. But the situation is not that simple. We know from the now well-studied phenomenon of the “fourth-grade slump” (the phenomenon whereby many children, especially poorer children, pass early reading tests, but cannot read well to learn academic content later on in school) that the goal of early reading instruction has to be more forward looking than simple decoding and literal comprehension (American Educator 2003; Chall, Jacobs, & Baldwin 1990; Gee 2008; Snow, Burns, & Griffin 1998). The goal has to be that children learn to read early on in such a way that this learning creates a successful trajectory throughout the school years and beyond. Such a trajectory is based, more than anything else, on the child’s being able to handle ever increasingly complex language, especially in the content areas (e.g., science and math), as school progresses. Children need to get ready for these increasing language demands as early as possible. It is as if school were more and more conducted in Greek as the grades increased: surely it would be better to be exposed to Greek as early as possible and not wait until school becomes the equivalent of advanced Greek.

Let’s call this a “trajectory approach” to early reading. Such an approach has to look not only forwards, but backwards, as well. Early phonemic awareness and early home-based practice with literacy are the most important correlates with success in first grade, especially success in learning to read in the “decode and literally comprehend” sense (Dickinson and Neuman 2006). However, the child’s early home-based oral vocabulary and early skills with complex oral language are the most important correlates for school success—not just in reading, but in the content areas—past the first grade, essentially for the rest of schooling (Dickinson and Neuman 2006; Gee 2004; Senechal, Ouellette, and Rodney 2006). Thus, a child's oral language development is key to a successful trajectory approach to reading, that is, an approach that seeks to make a long-term school-based reader of academic content (and that's what's in the high school biology textbook, for example). It is the key to avoiding, even eradicating, the fourth-grade slump.

However, we must pause here, for two reasons. First, I am aware that some people consider the sort of academic language that is in a biology textbook simply to be exclusionary jargon attempting to colonize people's everyday cultural identities in the name of a rationalist positivism. I am as interested as anyone in the politics of schooling and science (Gee 1990/1996/2007), but in this paper my concern is with the fate of children who get to high school and cannot cope with that textbook and related language practices. In my view, it does no good to rail against the language of the textbook, but, nonetheless, leave the textbook and other instances of academic language behind as the litmus test of school success—the "revolution" had better be total or children will suffer for adults' politics. For the record, while I fully concede that aspects of academic language have been used historically for little more than exclusion and the creation of status—and that textbooks should be replaced with texts more specially tied to activities and practices—by and large I believe that specialist varieties of language, when used appropriately, are critically and integrally tied to the functioning (workings) of specialist domains (whether this be an academic area or real-time-strategy video games) and access to these domains is severely limited without such language and related representational systems.

Second, I must pause because we are on the brink of what could be a major misunderstanding. Decades of research in linguistics has shown that every normal child's early language and language development are just fine (Chomsky 1986; Labov 1979; Pinker 1994). Every child, under normal conditions, develops a perfectly complex and adequate oral language, the child's "native language" (and, of course, sometimes children develop more than one native language). It never happens, under normal conditions—and normal here covers a very wide array of variation—that, in acquiring English, say, little Janie develops relative clauses, but little Johnnie just can't master them. That, is, of course, in a way, a surprising fact, showing that the acquisition of one's native language is not particularly a matter of ability or skill.

But, when I say, that children's early oral language—vocabulary and skills with complex language—are crucial correlates of success in school, correlates that show up especially after the child has learned to decode in first grade (one hopes)—I am not talking about children's everyday language, the sort of language that is equal for everyone. I am talking about their early preparation for language that is not "everyday", for language that is "technical" or "specialist" or "academic" (Gee 2004; Schleppegrell 2004). I will refer to people's "everyday" language—the way they speak when they are not speaking technically or as specialists of some sort—as their "vernacular style". I will refer to their language when they are speaking technically or as a specialist as a "specialist style" (people eventually can have a number of different specialist styles, connected to different technical, specialist, or academic concerns).

An Example

Let me give an example of what I am talking about, both in terms of specialist language and in terms of getting ready for later complex specialist language demands early on in life. Kevin Crowley has talked insightfully about quite young children developing what he calls "islands of expertise". Crowley and Jacobs (2002, p. 333) define an island of expertise as "any topic in which children happen to become interested and in which they develop relatively deep and rich knowledge." They provide several examples of such islands, including a boy who develops relatively deep content knowledge and a "sophisticated conversational space" (p. 335) about trains and related topics after he is given a Thomas the Tank Engine book.

Now consider a mother talking to her four-year-old son, who has an island of expertise around dinosaurs (the transcript below is adapted from Crowley and Jacobs 2002, pp. 343-344). The mother and child are looking at replica fossil dinosaur and a replica fossil dinosaur egg. The mother has a little card in front of that says:

- Replica of a Dinosaur **Egg**
- From the Oviraptor
- Cretaceous Period
- Approximately 65 to 135 million years ago
- The actual fossil, of which this is a replica, was found in the Gobi desert of Mongolia

In the transcript below, "M" stands for the mother's turns and "C" for the child's:

C: This looks like this is a **egg**.

M: Ok well this… That's exactly what it is! How did you know?

C: Because it looks like it.

M: That's what it says, see look ***egg***, ***egg***..….Replica of a dinosaur ***egg***. From the oviraptor.

M: Do you have a . . . You have an oviraptor on your game! You know the **egg** game on your computer? That's what it is, an oviraptor.

M: And that's from the Cretaceous period. And that was a really, really long time ago.

…

M: And this is . . . the hind claw. What's a hind claw? (pause) A claw from the back leg from a velociraptor. And you know what . . .

B: Hey! Hey! A velociraptor!! I had that one my [inaudible] dinosaur.

M: I know, I know and that was the little one. And remember they have those, remember in your book, it said something about the claws . . .

B No, I know, they, they…

M: Your dinosaur book, what they use them…

B: Have so great claws so they can eat and kill…

M: They use their claws to cut open their prey, right.

B: Yeah.

This is a language lesson, but not primarily a lesson on vernacular language, though, of course, it thoroughly mixes vernacular and specialist language. It is a lesson on specialist language. It is early preparation for the sorts of academic (school-based) language children see ever more increasingly, in talk and in texts, as they move on in school. It is also replete with "moves" that are successful language teaching strategies, though the mother is no expert on language development.

Let's look a some of the features this interaction has as an informal language lesson. First, it contains elements of non-vernacular, specialist language, for example: "**replica** of a dinosaur egg"; "from the **oviraptor**"; "from the **Cretaceous period**"; "the **hind claw**"; "their **prey**". The specialist elements here are largely vocabulary, though such interactions soon come to involve elements of syntax and discourse associated with specialist ways with words as well.

Second, the mother asks the child the basis of his knowledge: Mother: "How did you know? Child: Because it looks like it". Specialist domains are almost always "expert" domains that involve claims to know and evidence for such claims. They are in Shaffer's (2005) sense "epistemic games".

Third, the mother publicly displays reading of the technical text, even though the child cannot yet read: "That's what it says, see look ***egg, egg***……Replica of a dinosaur ***egg***. From the oviraptor." This reading also uses print to confirm the child's claim to know, showing one way this type of print (descriptive information on the card) can be used in an epistemic game of confirmation.

Fourth, the mother relates the current talk and text to other texts the child is familiar with: "You have an oviraptor on your game! You know the **egg** game on your computer? That's what it is, an oviraptor"; "And remember they have those, remember in your book, it said something about the claws". This sort of intertextulaity creates a network of texts and modalities (books, games, and computers), situating the child's new knowledge not just in a known background, but in a system the child is building in his head.

Fifth, the mother offers a technical-like definition: "And this is . . . the hind claw. What's a hind claw? (pause) A claw from the back leg from a velociraptor". This demonstrates a common language move in specialist domains, that is, giving relatively formal and explicit definitions (not just examples of use).

Sixth, the mother points to and explicates hard concepts: "And that's from the Cretaceous period. And that was a really, really long time ago". This signals to the child that "Cretaceous period" is a technical term and displays how to explicate such terms in the vernacular (this is a different move than offering a more formal definition).

Seventh, she offers technical vocabulary for a slot the child has left open: Child: "Have so great claws so they can eat and kill… Mother: They use their claws to cut open their **prey**, right". This slot and filler move co-constructs language with the child, allowing the child to use language "above his head" in ways in line with Vygotsky's concept of a "zone of proximal development" (Vygotsky 1978).

Informal Specialist-Language Lessons

So, let's be clear about two things. This is an informal language lesson. And such lessons involve more than language and language learning. They involve teaching and learning cognitive (knowledge) and interactional moves in specialist domains. Finally, they involve teaching and learning identities, the identity of being the sort of person who is comfortable with specialist, technical knowing, learning, and language. Of course, even formal language lessons—in learning a second language, for instance, in school—should involve language, knowledge, interaction, and identity. But this is not formal teaching, it is informal teaching, the teaching equivalent of informal learning. Let's call such informal language lessons, with the sorts of features I have just discussed, "informal specialist-language lessons" (ironically, they are informal formal-language lessons!).

Along with all we know about "emergent literacy" at home (Dickinson and Neuman 2006; Emergent Literacy Project, n.d.; Gee 2004), informal specialist language lessons are crucial if one wants to take a trajectory view of reading development. They are pre-school pre-reading activities that lead to early reading instruction that avoids the fourth-grade slump. Of course, the reading instruction the child receives at school must continue these language lessons, informally and formally. It must place reading from the get go in the context of learning specialist styles of language, just as this mother has done. This, however, raises the issue of what happens for children who come to school without such informal specialist language teaching, and, often, too, without other important aspects of emergent literacy. My view is that this cannot be ignored. We cannot just move on to reading instruction of the "decode and literally comprehend" sort as if it just doesn't matter that these children have missed out on early specialist language learning. For these children language teaching needs to start, start with a vengeance, and sustain itself throughout the course of reading instruction. And, again, remember, this claim has nothing to do with teaching "standard" English or ESL, *per se*: it is a claim that even native speakers of vernacular standard English need language learning to prepare for specialist varieties of language.

Specialist Language in Popular Culture

There are other things, beyond such informal specialist-language lessons that can prepare children for the increasing language demands of school in the content areas. And we can see one of these if we look, oddly enough, at young people's popular culture today. Something very interesting has happened in children's popular culture. It has gotten very complex and it contains a great many practices that involve highly specialist styles of language (Gee 2004, 2007). Young children often engage with these practices socially with each other in informal peer learning groups. And, some parents recruit these practices to accelerate their children's specialist language skills (with their concomitant thinking and interactional skills).

For example, consider the text below, which appears on a *Yu-Gi-Oh* card. *Yu-Gi-Oh* is a card game involving quite complex rules. It is often played face-to-face with one or more other players, sometimes in formal competitions, more often informally, though it can be played as a video game, as well.

Armed Ninja

Card-Type: Effect Monster

Attribute: Earth | **Level:** 1

Type: Warrior

ATK: 300 | **DEF:** 300

Description: FLIP: Destroys 1 Magic Card on the field. If this card's target is face-down, flip it face-up. If the card is a Magic Card, it is destroyed. If not, it is returned to its face-down position. The flipped card is not activated.

Rarity: Rare

The "description" is really a rule. It states what moves in the game the card allows. This text has little specialist vocabulary (though it has some, e.g., "activated"), unlike the interaction we saw between mother and child above, but it contains complex specialist syntax. It contains, for instance, three straight conditional clauses (the "if" clauses). Note how complex this meaning is: First, if the target is face down, flip it over. Now check to see if it is a magic card. If it is, destroy it. If it isn't, return it to its face-down position. Finally, you are told that even though you flipped over your opponent's card, which in some circumstances would activate its powers, in this case, the card's powers are not activated. This is "logic talk", a matter, really, of multiple related "either-or", "if-then" propositions.

Note, too, that the card contains a bunch of classificatory information (e.g., type, attack power, defense power, rarity). All of these linguistic indicators lead the child to place the card in the whole network or system of *Yu-Gi-Oh* cards—and there are over 10, 000 of them—and the rule system of the game itself. This is complex system thinking with a vengeance.

Consider, also, the *Yu-Gi-Oh* card below:

Cyber Raider

Card-Type: Effect Monster

Attribute: Dark | **Level:** 4

Type: Machine

ATK: 1400 | **DEF:** 1000

Description: "When this card is Normal Summoned, Flip Summoned, or Special Summoned successfully, select and activate 1 of the following effects: Select 1 equipped Equip Spell Card and destroy it. Select 1 equipped Equip Spell Card and equip it to this card."

Rarity: Common

This card—and remember it is one of 10,000—contains nearly nothing but words and phrases that are technical, specialist terms in *Yu-Gi-Oh*. Few texts children see in school will be this saturated with such technical language.

I have watched seven year old children play *Yu-Gi-Oh* with great expertise. They must read each of the cards. They endlessly debate the powers of each card by constant contrast and comparison with other cards when they are trading them. They discuss and argue over the rules and, in doing so, use lots of specialist vocabulary, syntactic structures, and discourse features. They can go to web sites to learn more or to settle their disputes. If and when they do so, here is the sort of thing they will see:

> **8-CLAWS SCORPION** Even if "8-Claws Scorpion" is equipped with an Equip Spell Card, its ATK is 2400 when it attacks a face-down Defense Position monster.
>
> The effect of "8-Claws Scorpion" is a Trigger Effect that is applied if the condition is correct on activation ("8-Claws Scorpion" declared an attack against a face-down Defense Position monster.) The target monster does not have to be in face-down Defense Position when the effect of "8-Claws Scorpion" is resolved. So if "Final Attack Orders" is active, or "Ceasefire" flips the monster face-up, "8-Claws Scorpion" still gets its 2400 ATK.
>
> The ATK of "8-Claws Scorpion" becomes 2400 during damage calculation. You cannot chain "Rush Recklessly" or "Blast with Chain" to this effect. If these cards were activated before damage calculation, then the ATK of "8-Claws Scorpion" becomes 2400 during damage calculation so those cards have no effect on its ATK.
> http://www.upperdeckentertainment.com/yugioh/en/faq_card_rulings.aspx?first=A&last=C

I don't really think I have to say much about this text. It is, in every way, a specialist text. In fact, in complexity, it is far above the language many young children will see in their school books, until they get to middle school at best and, perhaps, even high school. But, seven year old children deal and deal well with this language (though *Yu-Gi-Oh* cards—and, thus, their language—are often banned at school).

Let's consider a moment what *Yu-Gi-Oh* involves. First and foremost it involves what I will call "lucidly functional language". What do I mean by this? The language on *Yu-Gi-Oh* cards, web sites, and in children's discussions and debates is quite complex, as we have seen, but it relates piece by piece to the rules of the game, to the specific moves or actions one takes in the domain. Here language—complex specialist language—is married closely to specific and connected actions. The relationship between language and meaning (where meaning here is the rules and the actions connected to them) is clear and lucid. The *Yu-Gi-Oh* company has designed such lucid functionality because it allows them to sell 10, 000 cards connected to a fully esoteric language and practice. It directly banks on children's love of mastery and expertise. Would that schools did the same. Would that the language of science in the early years of school was taught in this lucidly functional way. It rarely is.

So we can add "lucidly functional language" to our informal specialist-language lessons as another foundation for specialist language learning, one currently better represented in popular culture than in school. And, note, too, here that such lucidly functional language is practiced socially in groups of kids as they discuss, debate, and trade, with more advanced peers often play a major educative role. They learn to relate oral and written language of a specialist sort, a key skill for specialist domains, including academic ones at school. At the same time, many parents (usually, but not always, more privileged parents) have come to know how to use such lucidly functional language practices—like *Yu-Gi-Oh* or *Pokemon*, and, as well as we will see below, digital technologies like video games—to engage their children in informal specialist-language lessons.

My thirteen-year-old son Sam recently told me recently that he felt he had learned to read by playing *Pokemon*, another card and video game. He was referring to the games on the Nintendo Game Boy, games he played before he could read, when he was five. His mother or I sat with him and read for him—the game requires much reading. In a real sense, Sam did learn to read by playing *Pokemon*. But he learned to read, then, in a context that was also early preparation for dealing with complex specialist language, a type of language he would see later in school, though, for the most part, only after the first couple of grades. Of course, he learned other sorts of reading in other activities, as well. I am not arguing for early literacy that is focused on only specialist languages.

Of course, the sorts of lucidly functional language practices and informal specialist-language lessons that exist around *Yu-Gi-Oh* or *Pokemon* could exist in school—even as early as first grade—to teach school valued content. But they don't. Here the creativity of capitalist has far out run that of educators.

Situated Meaning and Video Games

So far we have talked about two underpinnings of a trajectory view of reading: informal (and later formal) specialized-language lessons and practices built around lucidly functional language. Why are these underpinnings for reading, in a trajectory sense? Because they place reading development in the context of specialized language development, which is the basis for being able to keep up with the ever increasing demands for learning content in school via complex technical and academic varieties of language (and, indeed, other sorts of technical representations used in areas like science and math).

Now we move to a third underpinning of a trajectory view of reading development. Lots of research has shown, for years now, that, in areas like science, a good many students with good grades and passing test scores cannot actually use their knowledge to solve problems (Gardner 1991). For example, many students who can write down for a test Newton's Laws of Motion cannot correctly say how many forces are acting on a coin when it is tossed into the air and at the top of its trajectory—and, ironically, this is something that can be deduced from Newton's Laws (Chi, Feltovich, & Glaser 1981). They cannot apply their knowledge, because they don't see how it applies—they don't see the physical world and the language of physics (which includes mathematics) in such a way that it is clear to them how that language applies to that world.

There are two ways to understand words. I will call one way "verbal" and the other way "situated" (Gee 2004, 2007). 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 1997; Gee 2004, 2007). 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.

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

Situated understandings are, of course, the norm in everyday life and in vernacular language. 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 tied to activity and experiences in the world before knowledge as facts and information and knowledge as 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 (Gee 2003a). 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 2003b, 2005; McFarlane, Sparrowhawk & Heald 2002; Squire 2003).

Before I discuss game-like learning in some depth, let me point out a phenomenon that all gamers are well aware of. This phenomenon gets to the heart and soul of what situated meaning are and why they are important: Written texts associated with video games are not very meaningful, certainly not very lucid, unless and until one has played the game. Let me take the small booklet that comes with the innovative shooter game *Deus Ex* to use as an example of what I mean by saying this. In the twenty pages of this booklet, there are 199 bolded references that represent headings and sub-headings (to take one small randomly chosen stretch of headings and subheadings that appears at the end of page 5 and the beginning of page 6: **Passive Readouts**, **Damage Monitor**, **Active Augmentation & 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 gives 53 keys on the computer keyboard an assignment to some function in the game, and these 53 keys are mentioned 82 times in the booklet in relation to the information contained in the 199 headings and subheadings. So, though the booklet is small, it is just packed with concise and 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 (p. 5).

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 the information in this passage to the hundreds of other important details in the booklet.

Such literal understandings are precisely what children who fuel the fourth-grade slump have. 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, 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 screen? 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—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 and so forth—20 pages is beginning to seem like a lot—remember there are 199 different headings under which information like this is given a brisk pace through the booklet.

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 backwards and forwards. 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 poorly, just like, in fact, any of a myriad of school-based texts in the content areas. It is, outside the practices in the domain from which it comes, just as meaningless, however much one could garner literal meanings from it with which to verbally repeat things or pass tests.

And, of course, too, you can utter something like "Oh, yea, you click on F1 (function key 1) 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, you very often 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 can't really 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 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 at that time I had played only one other shooter game before, a very different one)—yes, I, an overly academic baby-boomer, made the mistake of trying to read the book first, despite my own theories about reading—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 in the booklet. But none of it was well-enough understood to be found easily without continually re-searching for the same information. In the end, you have to just actively play the game and explore and try everything. Then, at last, the booklet makes good sense, but, then too, you don't need it all that much any more.

So now I would make just the same claim about any school content domain as I have just said about the video game *Deus Ex*: specialist language in any domain—games or science—has no situated meaning—thus no lucid or applicable meaning—unless and until one has "played the game", in this case the game of science, or, better put, a specific game connected to a specific science. Such "games"("science games") involve seeing the language and representations associated with some part of science in terms of activities I have done, experiences I have had, images I have formed from these, and interactional dialogue I have heard from and had with peers and mentors outside and inside the science activities. School is too often about reading the manual before you get to play the game, of you ever do. This is not harmful for kids who have already played the game at home, but is disastrous for those who have not.

Good video games don’t just supported situated meanings for the written materials associated with them in manuals and on fan web sites—and these are copious—but also for all language within the game. The meaning of such language is always associated with actions, experiences, images, and dialogue. Furthermore, players get verbal information “just in time”, when they can apply it or see it apply, or “on demand”, when they feel the need for it and are ready for it—and then, in some cases, games will give the player walls of print (e.g., in *Civilization IV*).

So my claim: what I will call “game-like learning” leads to situated and not just verbal meanings. In turn, situated meanings make specialist language lucid, easy, and useful. In order to demonstrate what I am talking about—and what I mean by “game-like learning”—I will turn first to an application of what I consider game-like learning that uses no real game, then to a game made explicitly to enhance school-based learning, then to a game-like simulation, built into an overall learning system.

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. 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 than what diSessa's students have been exposed to, basically it is 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.

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 2003b). 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; Squire 2003, Squire 2006, 2007) have worked on a computer game called "*Supercharged!*" to help students learn physics. 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.

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).

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 relied 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.

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 what I would call a "post-progressive pedagogy" (Gee 2004), 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.

Augmented by Reality: Madison 2020

In their Madison 2020 project, David Shaffer and Kelly Beckett at the University of Wisconsin have developed, implemented, and assessed a game-like simulation that simulates some of the activities of professional urban planners (Beckett & Shaffer 2004; see also Shaffer, Squire, Halverson, & Gee 2005; see Shaffer 2006 for a definitive discussion of his "epistemic games"). I call this a "game" because learners are using a simulation and role-playing new identities, but, of course, it is not a "game" in any traditional sense.

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

As in the game *SimCity*, in Shaffer and Beckett's game, students make land use decisions and consider the complex results of their decisions. However, unlike in *SimCity*, they use real-world data and authentic planning practices to inform those decisions. The game and the learning environment in which it is embedded is based on David Shaffer's theory of *pedagogical praxis*, a theory that argues that modeling learning environments on authentic professional practices—in this case, the practices of urban planners—enables young people to develop deeper understandings of important domains of inquiry (Shaffer 2004).

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

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

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

> Instead of the fast-paced action requires to plan and maintain virtual urban environments such as *SimCity*, this project focused only on an initial planning

> stage, which involved the development of a land use plan for this one street. And instead of using only a technological simulation [i.e., the game, JPG], the learning environment here was orchestrated by authentic urban planning practices. These professional practices situated the planning tool in a realistic context and provided a framework within which students constructed solutions to the problem. (pp. 11-12).

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

Students then watched a video about State Street, featuring interviews with people who expressed concerns about the street's redevelopment aligned with the issues in the informational packet (e.g., affordable housing). During the planning phase, students walked to State Street and conducted a site assessment. Following the walk, they worked in teams to develop a land use plan using a custom-designed interactive geographic information system (GIS) called MadMod. MadMod is a model built using Excel and ArcMap (ESRL 2003) that lets students assess the ramification of proposed land use changes.

MadMod—which is the "game" in the learning system—allows students to see a virtual representation of State Street. It has two components, a decision space and a constraint table. The decision space displays address and zoning information about State Street using official 2- or 3-letter zoning codes to designate changes in land use for property parcels on the street. As students made decisions about changes they wished to make, they received immediate feedback about the consequences of changes in the constraint table. The constraint table showed the effects of changes on six planning issues raised in the original information packet and the video: crime, revenue, jobs, waste, car trips, and housing. Following the professional practices of urban planners, in the final phrase of the workshop, students presented their plans to a representative from the city planning office.

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

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

100% of the students said the workshop changed the way they thought about cities and most said the experience changed the things they paid attention to when walking down a city street in their neighborhood. Better yet, perhaps, Shaffer and Beckett were able to show transfer: Students' responses to novel, hypothetical urban planning problems showed increased awareness of the interconnections among urban ecological issues. All these effects suggest, as Shaffer and Beckett argue, "that students were able to mobilize understanding developed in the context of the redesign of one local street to think more deeply about novel urban ecological issues" (p. 21).

Video Games and Situated Learning

Just as children today often see complex specialist language in their popular culture activities like *Yu-Gi-Oh*, they also complex and deep learning in their commercial video games. Modern video games set up a learning situation that is situated in the sense that meanings are situated, as we have just seen, and in the sense that skills and concepts are learned in an embodied way that leads to real understanding. There is a reason for this: games place language and learning in a setting that fits very well with how the human mind is built to learn and think. Schools sometimes do not. This is why I have stressed game-like learning above in my discussions of diSessa's work, *Supercharged!*, and *Madison 2200*. Let me explicate what I mean.

Video games are a relatively new technology replete with important, and not yet fully understood, implications (Gee 2003b). Scholars have often viewed the human mind through the lens of a technology they thought worked like the mind. Locke and Hume, for example, argued that the mind was like a blank slate on which experience wrote ideas, taking the technology of literacy as their guide. Much later, modern cognitive scientists argued that the mind worked like a digital computer, calculating generalizations and deductions via a logic-like rule system (Newell & Simon 1972). More recently, some cognitive scientists, inspired by distributed parallel-processing computers and complex adaptive networks, have argued that the mind works by storing records of actual experiences and constructing intricate patterns of connections among them (Clark 1989; Gee 1992). So we get different pictures of the mind: mind as a slate waiting to be written on, mind as software, mind as a network of connections.

Human societies get better through history at building technologies that more closely capture some of what the human mind can do and getting these technologies to do mental work publicly. Writing, digital computers, and networks each allow us to externalize some functions of the mind. Though they are not commonly thought of in these terms, video games are a new technology in this same line. They are a new tool with which to think about the mind and through which we can externalize some of its functions. Video games of the sort I am concerned with—games like *Half-Life 2, Rise of Nations, Full Spectrum Warrior*, *Morrowinds: The Elder Scrolls*, and *World of WarCraft*—are what I would call "action-and-goal-directed preparations for, and simulations of, embodied experience". A mouthful, indeed, but an important one.

To make clear what I mean by the claim that games act like the human mind and are a good place to study and produce human thinking and learning, let me first briefly summarize some recent research in cognitive science, (Bransford, Brown, & Cocking 2000). Consider, for instance, the remarks below [in the quotes below, the word "comprehension" means "understanding words, actions, events, or things"]:

> … comprehension is grounded in perceptual simulations that prepare agents for situated action (Barsalou, 1999a: p. 77)

> **…** to a particular person, the meaning of an object, event, or sentence is what that person can do with the object, event, or sentence (Glenberg, 1997: p. 3)

What these remarks mean is this: human understanding is not primarily a matter of storing general concepts in the head or applying abstract rules to experience. Rather, humans think and understand best when they can imagine (simulate) an experience in such a way that the simulation prepares them for actions they need and want to take in order to accomplish their goals (Barsalou 1999b; Clark 1997; Glenberg & Robertson 1999).

Video games turn out to be the perfect metaphor for what this view of the mind amounts to, just as slates and computers were good metaphors for earlier views of the mind. To see this, let me now turn to a characterization of video games and then I will put my remarks about the mind and games together.

Video games usually involve a visual and auditory world in which the player manipulates a virtual character (or characters). They often come with editors or other sorts of software with which the player can make changes to the game world or even build a new game world. The player can make a new landscape, a new set of buildings, or new characters. The player can set up the world so that certain sorts of actions are allowed or disallowed. The player is building a new world, but is doing so by using and modifying the original visual images (really the code for them) that came with the game. One simple example of this is the way in which players can build new skateboard parks in a game like *Tony Hawk Pro Skater*. The player must place ramps, trees, grass, poles, and other things in space in such a way that players can manipulate their virtual characters to skate the park in a fun and challenging way.

Even when players are not modifying games, they play them with goals in mind, the achievement of which counts as their “win state” (and it’s the existence of such win states that, in part, distinguishes games from simulations) These goals are set by the player, but, of course, in collaboration with the world the game designers have created (and, at least in more open-ended games, players don't just accept developer's goals, they make real choices of their own). Players must carefully consider the design of the world and consider how it will or will not facilitate specific actions they want to take to accomplish their goals.

One technical way that psychologists have talked about this sort of situation is through the notion of "affordances" (Gibson 1979). An "affordance" is a feature of the world (real or virtual) that will allow for a certain action to be taken, but only if it is matched by an ability in an actor who has the wherewithal to carry out such an action. For example, in the massive multiplayer game *World of WarCraft* stags can be killed and skinned (for making leather), but only by characters that have learned the Skinning skill. So a stag is an affordance for skinning for such a player, but not for one who has no such skill. The large spiders in the game are not an affordance for skinning for any players, since they cannot be skinned at all. Affordances are relationships between the world and actors.

Playing *World of WarCraft*, or any other video game, is all about such affordances. The player must learn to **see** the game world—designed by the developers, but set in motion in particular directions by the players, and, thus, co-designed by them—in terms of such affordances (Gee 2005). Broadly speaking, players must think in terms of "What are the features of this world that can enable the actions I am capable of carrying out and that I want to carry out in order to achieve my goals?"

So now, after our brief bit about the mind and about games, let's put the two together. The view of the mind I have sketched, in fact, argues, as far as I am concerned, that the mind works rather like a video game. For humans, effective thinking is more like running a simulation than it is about forming abstract generalizations cut off from experiential realities. Effective thinking is about perceiving the world such that the human actor sees how the world, at a specific time and place (as it is given, but also modifiable), can afford the opportunity for actions that will lead to a successful accomplishment of the actor's goals. Generalizations are formed, when they are, bottom up from experience and imagination of experience. Video games externalize the search for affordances, for a match between character (actor) and world, but this is just the heart and soul of effective human thinking and learning in any situation.

As a game player you learn to see the world of each different game you play in a quite different way. But in each case you see the world in terms of how it will afford the sorts of embodied actions you (and your virtual character, your surrogate body in the game) need to take to accomplish your goals (to win in the short and long run). For example, you see the world in *Full Spectrum Warrior* as routes (for your squad) between cover (e.g., corner to corner, house to house) because this prepares you for the actions you need to take, namely attacking without being vulnerable to attack yourself. You see the world of *Thief* in terms of light and dark, illumination and shadows, because this prepares you for the different actions you need to take in this world, namely hiding, disappearing into the shadows, sneaking, and otherwise moving unseen to your goal.

When we sense such a match, in a virtual world or the real world, between our way of seeing the world, at a particular time and place, and our action goals—and we have the skills to carry these actions out—then we feel great power and satisfaction. Things click, the world looks as if it were made for us. While commercial games often stress a match between worlds and characters like soldiers or thieves, there is no reason why other games could not let players experience such a match between the world and the way a particular type of scientist, for instance, sees and acts on the world (Gee 2004). Such games would involve facing the sorts of problems and challenges that type of scientist does and living and playing by the rules that type of scientist uses. Wining would mean just what it does to a scientist: feeling a sense of accomplishment through the production of knowledge to solve deep problems.

I have argued for the importance of video games as "action-and-goal-directed preparations for, and simulations of, embodied experience." They are the new technological arena—just as were literacy and computers earlier—around which we can study the mind and externalize some of its most important features to improve human thinking and learning. But games have two other features that suit them to be good models for human thinking and learning externalized out in the world. These two additional features are: a) they distribute intelligence via the creation of smart tools, and b) they allow for the creation of "cross functional affiliation," a particularly important form of collaboration in the modern world.

Consider first how good games distribute intelligence (Brown, Collins, & Dugid 1989). In *Full Spectrum Warrior*, the player uses the buttons on the controller to give orders to two squads of soldiers. The instruction manual that comes with the game makes it clear from the outset that players, in order to play the game successfully, must take on the values, identities, and ways of thinking of a professional soldier: “Everything about your squad,” the manual explains, “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”. In the game, that experience—the skills and knowledge of professional military expertise—is distributed between the virtual soldiers and the real-world player. The soldiers in the player’s squads have been trained in movement formations; the role of the player is to select the best position for them on the field. The virtual characters (the soldiers) know part of the task (various movement formations) and the player must come to know another part (when and where to engage in such formations). This kind of distribution holds for every aspect of military knowledge in the game.

By distributing knowledge and skills this way—between the virtual characters (smart tools) and the real-world player—the player is guided and supported by the knowledge built into the virtual soldiers. This offloads some of the cognitive burden from the learner, placing it in smart tools that can do more than the learner is currently capable of doing by him or herself. It allows the player to begin to act, with some degree of effectiveness, before being really competent—“performance before competence.” The player thereby eventually comes to gain competence through trial, error, and feedback, not by wading through a lot of text before being able to engage in activity. Such distribution also allows players to internalize not only the knowledge and skills of a professional (a professional soldier in this case), but also the concomitant values (“doctrine” as the military says) that shape and explain how and why that knowledge is developed and applied in the world. There is no reason why other professions—scientists, doctors, government officials, urban planners (Shaffer 2004)—could not be modeled and distributed in this fashion as a deep form of value-laden learning (and, in turn, learners could compare and contrast different value systems as they play different games).

Finally, let me turn to the creation of "cross-functional affiliation." Consider a small group partying (hunting and questing) together in a massive multiplayer game like *World of WarCraft*. The group might well be composed of a Hunter, Warrior, Druid, and Priest. Each of these types of characters has quite different skills and plays the game in a different way. Each group member (player) must learn to be good at his or her special skills and also learn to integrate these skills as a team member within the group as a whole. Each team member must also share some common knowledge about the game and game play with all the other members of the group—including some understanding of the specialist skills of other player types—in order to achieve a successful integration. So each member of the group must have specialist knowledge (intensive knowledge) and general common knowledge (extensive knowledge), including knowledge of the other member's functions.

Players—who are interacting with each other, in the game and via a chat system—orient to each other not in terms of their real-world race, class, culture, or gender (these may very well be unknown or if communicated made up as fictions). They must orient to each other, first and foremost, through their identities as game players and players of *World of WarCraft* in particular. They can, in turn, use their real-world race, class, culture, and gender as strategic resources if and when they please, and the group can draw on the differential real-world resources of each player, but in ways that do not force anyone into pre-set racial, gender, cultural, or class categories.

This form of affiliation—what I will call cross-functional affiliation—has been argued to be crucial for the workplace teams in modern "new capitalist" workplaces, as well as in modern forms of social activism (Beck 1999; Gee 2004; Gee, Hull, & Lankshear 1996). People specialize, but integrate and share, organized around a primary affiliation to their common goals and using their cultural and social differences as strategic resources, not as barriers.

So video games, though a part of popular culture, are, like literacy and computers, sites where we can study and exercise the human mind in ways that may give us deeper insights into human thinking and learning, as well as new ways to engage learners in deep and engaged learning. What we see here—and it's the same message we saw with *Yu-Gi-Oh* and *Pokemon* before—is that areas of popular culture are beginning to organize thinking and learning in efficacious ways. The practices they recruit—lucidly functional language, situated meanings, and embodied understandings leveraging experiences to build simulations (in the mind and outside it), distributed intelligence, and cross-functional collaboration—are all ones that don't need to be restricted to military games. They are key to deep understanding in any specialist domain, whether in school or at work.

Conclusions

I have argued that learning to read, if a child is not to be a victim of the fourth-grade slump, must involve early preparation for specialist, technical, and academic forms of language, forms that will be seen more and more both in speech and, most characteristically, in writing as school progresses. I have discussed some of the underpinnings of effective early preparation for such styles of language. These underpinnings have included "informal specialist-language lessons", "lucidly functional language" practices, and practices which facilitate "situated meanings". These practices are common in certain homes and in some of the popular cultural practices of children. They are, perhaps, less common in the early years of schooling. More generally, I have argued that a game-like approach to learning—by which I mean, not "having fun", but thinking inside of and with simulations in a situated and embodied way, an approach well represented even in commercial video games—holds out a good deal of potential as a foundation for learning that leads to problem solving and not just paper and pencil test passing.

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