GAMES AND LEARNING: ISSUES, PERILS, AND POTENTIALS: A REPORT TO THE SPENCER FOUNDATION*

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OVERVIEW OF THE REPORT

Section 1. Video Games and Learning: A New Field: Over the last few years a new field has emerged around video games and learning. This field is built around the premise that video games can engage players with deep and fruitful forms of learning in a highly motivating context.

Section 2. Video Gaming as a New Literacy: Video Gaming is a new "literacy." In gaming literacy, consumption ("reading") inherently involves certain forms of production ("writing") on the part of the play.

Section 3. Equity and Access Issues: It is possible that gaming literacy—together with related digital literacies—will create yet another equity gap as richer children attain productive stances toward design and tech-savvy identities to a greater degree than poorer ones.

Section 4. The Traditional Literacy Gap: For schooling after the earliest grades, the traditional literacy gap is due to children's early preparation for language that is "technical" or "specialist" or "academic," the sort of language that is tied to learning content (e.g., science) in school.

Section 5. Complex Language in Popular Culture: If complex, specialist ("hard") language is the problem in terms of the traditional literacy gap, it is an irony, perhaps, that popular culture today has gotten very complex and contains a great many practices that involve highly specialist styles of language.

Section 6. Real Understanding: Another Gap: Beyond the traditional literacy gap—the literacy divide between rich and poor—there is another gap in education. This is the gap between passing tests and really understanding. Lots of research has shown, for years now, that, in areas like science, a good many students, even those good grades and passing test scores, cannot actually use their knowledge to solve problems.

Section 7. Video Games and the Human Mind: Video games place language and learning in a setting that fits very well with how the human mind is built to learn and think according to contemporary research in the Learning Sciences.

Section 8. Distributed Intelligence and Cross-Functional Teams: Good video games have two other features that suit them to be good models for human thinking and learning externalized out in the world: 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.

Section 9. Games as Games: So far much of what we have said about good video games and learning doesn't have much to do with the fact that they are games *per se*. However, it is a leading question for research whether these features will work for learning well, or as well, if they are not embedded in video games that not only have these features but are good games, as well. What are the features that make a video game a game and a good game?

> **A. Interactivity:** In a video game, players make things happen; they don't just consume what the "author" (game designer) has placed before them.
>
> **B. Customization:** In some games, players are able to customize the game play to fit their learning and playing styles, for example through different difficulty levels or the choice of playing different characters with different skills
>
> **C. Strong Identities:** Good games offer players identities that trigger a deep investment on the part of the player.
>
> **D. Well-ordered problems:** Problems in good games are well ordered. In particular, early problems are designed to lead players to form good guesses about how to proceed when they face harder problems later on in the game.

E. Games are pleasantly frustrating: Good games adjust challenges and give feedback in such a way that different sorts of players feel the game is challenging but doable and that their effort is paying off.

F. Games are build around the cycle of expertise: Good games create and support what has been called in the Learning Sciences the "cycle of expertise.

G. "Deep" and "Fair": These terms of art in the gaming community should become evaluative terms of learning in and out of schools.

Section 10. Mentoring: The traditional dichotomy between overt instruction/guidance, on the one hand, and agentful immersion in experience is a false one. Good video games offer lots of guidance without taking away immersion or ownership

Section 11. Models and Modeling: If games are to be used in educational settings, there is another element beyond the role of mentors that needs to be stressed, namely the role of models and modeling in thinking, learning, and building knowledge. Models are basic to human play and science, as well as a great many other human activities.

Section 12. A New Crisis?: If we want to move games or game-like learning to school, will the structure of schooling have to change significantly or not? Can game-based learning speak to the looming crisis in American education that we are not producing enough innovation and creativity in school learning?

Section 13. Game Design and Education as a Design Science: Game design has another contribution to make to education: Game design as an enterprise is, at a deep level, similar to education seen as a "design science."

Section 14. Learning to Be: Deep learning—learning that can lead to real understanding, the ability to apply one's knowledge, and even to transform that knowledge for innovation—requires that we move beyond "learning about" and move to "learning to be." It requires that learning be not just about "belief" (what the facts are, where they came from, and who believes them) but also strongly about "design" (how, where, and why knowledge, including facts, are useful and adequate for specific purposes and goals

REFERENCES

APPENDIX: Short statements on specific issues.

1. Richard Halverson,
"Technologies to Understand and Teach Complex Practices"

2. Elisabeth Hayes,
"Girls, Gaming, and Trajectories of IT Experience"

3. Kurt Squire,
"*Civilization*, History, and Modeling"

4. David Shaffer,
"Epistemic Games: One Approach to the Issues, Perils, and Potentials of Computer Games"

1. Video Games and Learning: A New Field

Over the last few years a new field has emerged around video games and learning. This field is built around the premise that video games can engage players with deep and fruitful forms of learning in a highly motivating context. Good video games, it is argued, incorporate powerful learning principles—that is, that they incorporate fruitful learning methods—into their designs.[1] These principles are, by and large, strongly supported by current research in the Learning Sciences, even though such research rarely focuses on their implementation via games.[2]

This claim is more about the process of learning than the content of what is learned. But, questions do need to be asked about content: What is the content being learned in commercial video games? What sorts of additional content should commercial games engage with? Can we build engaging games that deal with content typically connected to school (e.g., science) or workplaces (e.g., collaboration)?

Before thinking about content more narrowly (e.g., science or math), we should realize that learning in and around games involves content in a broad sense. Video gaming has turned out—despite early predictions to the contrary—to be a deeply social enterprise. Even single-player gaming often involves young people in joint play, collaboration, competition, sharing, and a myriad of websites, chat rooms, and game guides, many of them produced by players themselves. But the social nature of gaming goes much further. Multiplayer gaming—games where small teams play against each other—is very popular among many young people. And massively-multiplayer games—games where thousands or millions of people play the same game—have recently (thanks, in part, to the tremendous success of *World of WarCraft*) become mainstream forms of social interaction across the globe. Such games are introducing new "states" or "communities" into the world. They are pioneering new forms of social capital, new forms of communities of practice, and new forms of social experimentation. In such games, people are learning new identities, new forms of social interaction, and even new values: a broad form of "content," indeed.[3]

There are, of course, different types of video games. And there are a number of different parameters along which games can be categorized. One such parameter is the distinction between so-called "casual games" like *Tetris* or *Bejeweled* and larger-scale games like *Half-Life* or *Rise of Nations*.[4] A better distinction here, perhaps, is between what we can call "problem games" and "world games," though the distinction is not air tight. Problem games focus on solving a given problem or class of problems (e.g. *Tetris*, *Diner Dash*), while world games simulate a wider world within which, of course, the player may solve many different sorts of problems (e.g., *Half-Life*, *Rise of Nations*). Classic early arcade games like *Super Mario* sit right at the border of this division. In either case, problem solving is crucial to gaming. In addition, in educational terms, we can think about chaining a series of problem games together to establish a larger curriculum. We will see below another way to think about different types of games in terms of the notion of "models" and "modeling".

Right at the outset, we face a choice about how to think about either learning in games or games in learning. Games—like any other technology—do not have effects, good or bad, all by themselves. Rather, they have different effects depending on the different uses we make of them, the different contexts in which we place them, and the different social systems that are built around them. When we are thinking about learning, what we must be concerned with is not just the game in the box, but the social and learning system that is built around the game. We might call the combination of the game in the box and the social and learning system built around it, the "Game" (the capital "G" or "big G" game).[5] Even children playing *Pokemon* on a *GameBoy* often are part of a social system in their communities, at school, and on the Web, a system that shares information, strategies, and cheats about the game and engages in co-play. When educators recruit games for leaning, they build distinctive social and learning systems (e.g., curricula, mentors, connections to other activities, social interactions, and so forth) around the games, and we need to assess the effectiveness of the whole system, not the game alone.

The emerging field of video games and learning is built around a set of key questions, some of which we list below. In these questions, the term "learning" is used broadly to cover both processes of learning (how learning is happening) and the content of what is being learned. The term "content" is also used broadly to cover information, principles, forms of sociality, and values. Finally, remember when we talk about "games," in the end, we always must move on to talk about "Games" (game plus context, social system, and learning system):

1. What sorts of learning are connected to commercial video games?

2. How does this learning relate to learning in other aspects of people's lives?

3. How can so-called "serious games" enhance learning for schools, out-of-school programs (e.g., libraries), communities, and workplaces? Does learning through serious games (e.g., science) transfer to other learning activities where games are not used?

4. Can and should the types of learning (the models of learning or the learning principles) incorporated into good video games—commercial or serious—be implemented without using games, but, rather, by using other technological and non-technological devices and practices? How tightly tied to games as a vehicle are these learning principles?

5. Can games and game-based learning lead to new and better models of assessment?

6. How do games and game-based learning relate to demographic categories (e.g., race, class, and gender) and will games and gaming narrow or widen current equity gaps in learning and knowledge in schools and society? How can they be used to narrow such gaps?

7. What are the impacts of video games and gaming on our global society? What are their impacts on young people's lives, identities, and ways of learning and thinking? What future impacts can we expect from gaming?

2. Video Gaming as a New Literacy

Video Gaming is a new "literacy." By "literacy" we mean any technology that allows people to "decode" meanings and produce meanings by using symbols.[6] The alphabet is obviously such a technology, the one that gives rise to print literacy. The digital technologies by which games are made are another example of such a technology. Game design involves a "code"—a multi-modal one made up of images, actions, words, sounds, and movements—that communicates to players because players (conventionally) interpret aspects of that design to have certain meanings.[7] For example, players of real-time strategy games know that a "map" betokens a land mass that the player can build on in certain characteristic ways in competition with other builders.

Every literacy involves some set of relationships between consumption (reading) and production (writing). Gaming literacy is interesting in this respect, since consumption inherently involves certain forms of production on the part of the player. Gamers, of course, decode and comprehend ("consume") game design when they react effectively to that design in order to play the game. However, that game design doesn't really come into full existence until players make decisions and take actions in the game (otherwise the first screen of the game just sits there). If the game is open-ended enough, different players, by making different choices and taking different actions, produce somewhat different games. They enact the game designers' game design in different ways, in a sense, they design the game with the designers. Thus, production is inherently part of consumption in gaming, because gaming inherently involves taking action.[8]

This "productive" aspect of game consumption—the way in which players consume (read) games in part by producing (writing) them—goes further. Games are rule systems wherein players attempt to achieve goals, sometimes goals set by the game's designers and sometimes goals of their own, and sometimes a mixture of the two. To achieve these goals, gamers must reflect on the design of a game and how features of that design can serve to enhance or retard the achievement of those goals through specific strategies and actions. In this sense, at some level, to play a game successfully, gamers must think like game designers; they must at least think about how elements of game design work to help or hinder their goals as players. Questions like "Why is this virtual world (or this part of it) designed in this way?" and "What does this suggest about possible effective strategies?" are part and parcel of playing and winning a game (or achieving goals in games).

Thus, consuming and producing—reading and writing—are closely connected in gaming as a literacy. It is interesting to speculate on the question of how much of this is true also for print literacy. People have, of course, argued that reading, in the case of print literacy, involves thinking like a writer, reflecting on the design of the text from the writer's perspective, at least when people are reading "critically." This productive stance is pretty much forced, to some degree, for video games as a literacy, though we think this stance can and should be carried much further through good game design and good learning systems built around games. It can be carried further as a way of making learners deeply reflective about the design properties—the very design grammars—of the games they play.

But production in the case of gaming literacy—already caught up in the act of consumption—has another level, as well. Games often come with the software by which they are made, thereby allowing players to modify them in small or large ways. Players can build new maps, levels, and scenarios, and sometimes even change the rules of play. They can even design whole new games. Through such "modding" players become designers in their own right at an even higher level. Games like *Tony Hawk* allow players to build (design) many aspects of the game, from skate boards and skaters through skate board parks to the rules of play (e.g., the tricks and the points assigned to them).

Games, thus, inherently involve, at several different levels, a design stance even for their consumption. We believe this stance is a form of thinking that is important for the modern world.[9] The modern world is full of (sometimes risky) complexly patterned systems (e.g. government, markets, high-tech workplaces, environments, global flows of people and capital, and so forth). Such systems need to be understood as not just isolated elements, additively combined, but as complex wholes made up of sets of interacting relationships that take on the characteristics of a designed system, either thanks to the design work of people or the workings of physical or natural processes. We believe also that this stance can be taken further for a variety of educational goals by building good learning systems (mentoring and curricula) around good video games.

Video games are only one activity today where young people are stressing production and not just consumption. Indeed, modern digital technologies are leading us to an anytime, anywhere, anyone world of production. Young people today are producing their own websites, blogs, animation, machinima, music, fan fiction, video—and many other things—in massive amounts. Many of these activities—most certainly including modifying or redesigning or even designing games—involve art, technology, computation, and content in a very integrated fashion. Such production may be, for many young people, an important route for the acquisition of skills that are crucial for our modern, global, high-tech world. However, issues of equity arise here and it is to these we now turn.

3. Equity and Access Issues

Any literacy—traditional or otherwise—raises equity questions. Which groups in society have full access to it? Which groups master it? What is the social and economic payoff for different groups who use the literacy? Gaming literacy, even in the act of consumption, as we have seen, involves learning to think like a designer, to reflect on the ways in which the grammar of a game's design invites or retards the goals, choices, and actions one wants or needs to take. This is a stance that we believe is the heart and soul of being "media literate" for any medium, including print literacy.[10] When it is carried to its full extent, it is the heart and soul of "critical media literacy" for any medium: thinking like a designer, reflecting on design grammars for different media.

All games involve content: they build a virtual world of a certain sort. Media literacy in regard to a game's content means, then, being reflectively aware of how that content (world) is itself designed to facilitate or retard goals, choices, strategies, and actions. If that content, were, say, a branch of science—for example a certain type of biology—then the player would have to consider the content of biology not as a set of passive facts, but as a domain of facts, information, values, and practices that enhance or retard certain sorts of goals, choices, strategies, and actions, namely those of a certain type of scientist. This, then, would be science not as inert content, but as a "way of life," as a way of being in the world, one that leads to certain sorts of values, goals, and actions rooted in a body of facts, information, and practices.

So one contribution gaming literacy can make to young people is to help develop this productive reflective stance about design and how design works to facilitate or defacilitate actions, goals, and strategies and to do so from the perspective of certain sorts of values and ways of being in the world (virtual or real). We have argued that video games inherently encourage such a stance and that this stance can be taken much further through good game design and good learning systems built around games. This stance becomes also a productive and reflective stance towards the content (world) of the game and, thus, holds out rich potential for encouraging proactive and metacritical engagements with content like science or social studies.

But there is another contribution that gaming literacy can make to young people. Video games and their concomitant practices and ways of thinking are a gateway, for some young people, to the development of "tech-savvy" skills and identities. By "tech-savvy" we mean a mind-set in which people are comfortable and confident with modern digital technologies, as well as with technical languages and practices (e.g., computers, mathematics, programming, modeling, graphs, etc.).

If young people think like designers, mod the games they play, and extend their technological interests both socially—on the Internet, for instance—and cognitively to related technologies (e.g., machinama, graphic design, web sites, simulations, AI, level design, audio, computer science, etc.), they are developing particularly modern skill sets and mind sets. At the same time, video game technologies meld art and technology in ways that, for young people, make these areas much more closely related than they are for some older people. And, indeed, such a melding is another important modern skill.

So gaming literacy can lead—we believe—to both a productive reflective stance on design (including content) and to the formation of tech-savvy identities. We think both of these are particularly important for today's global, high tech world. But these things don't just happen all by themselves. They require guidance, in one form or another, from adults and more masterful peers.

We know that we face an equity crisis in the case of traditional literacy: poorer children do not learn to read and write as well as richer children. It is possible that gaming literacy—together with related digital literacies—will create yet another equity gap as richer children attain productive stances toward design and tech-savvy identities to a greater degree than poorer ones. This new equity gap will involve skills and identities that may be crucially tied to success in the contemporary world.

Evidence is already building that this new gap is, indeed, being created.[11] This evidence is beginning to show that just giving young people access to technologies is not enough. They need—just as they do for books—adult mentoring and rich learning systems built around the technologies, otherwise the full potential of these technologies is not realized for these children.

At the same time, a crucial question arises: Can we speak to the new gap (the tech-savvy gap) in such a way that we also address the old gap, the gap in regard to traditional print-based literacy? Since this is a crucial question, let's discuss, for a moment, the nature of the traditional literacy gap.

4. The Traditional Literacy Gap

We have known for some decades now about the phenomenon known as "the fourth-grade slump."[12] This is a phenomenon whereby many children, especially poorer children, pass early reading tests, but cannot later on in school read well to learn academic content. They learn early on to read, but don't know how to read to learn when they face more complex language and content as school progresses.

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 decode print.[13] However, the child's early home-based oral vocabulary and early oral skills with the sorts of complex language associated with books and school are the most important correlates for school success—not just for reading, but for learning in the content areas—past the first grade, essentially for the rest of schooling.[14]

Decades of research in linguistics has shown that every normal child's early language development of their native language is just fine.[15] But when we say that children's early oral language—vocabulary and skills with complex language—are crucial correlates of success in school, we are not talking about children's everyday language. We are talking about their early preparation for language that is not "everyday," but for language that is "technical" or "specialist" or "academic."[16]

Let us give an example of what it means to get children ready for later complex language demands early on in life. Kevin Crowley has talked insightfully about quite young children developing what he calls "islands of expertise," which he defines as "any topic in which children happen to become interested and in which they develop relatively deep and rich knowledge."[17] Consider, then, a mother talking to her four-year-old son, who has an island of expertise around dinosaurs.[18] 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 ("everyday") 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.

What are some of these "moves"? First, the mother uses 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**"). Second, she asks the child the basis of his knowledge ("How did you know?). Third, she 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"). Fourth, her reading of the text also uses print to confirm the child's claim to know, showing one way this type of print can be used in an epistemic game of confirmation.

Fifth, 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"). Sixth, she 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"). Seventh, she 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).

Eighth, the mother 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."[19]

All of these moves on the part of the mother are a good example of what we mean by building a learning system—with adult mentoring—around a child's activities. Here the learning system is informal and built in the service of getting the child prepared for the complex language demands of books and school. It is just the sort of interaction that we believe it is crucial to build around not only texts but other technologies, including video games, as well.

5. Complex Language in Popular Culture

If complex, specialist ("hard") language is the problem in terms of the traditional literacy gap, it is an irony, perhaps, that popular culture today speaks to just this issue in an interesting and important way. Something quite fascinating 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.[20] 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—played either via physical cards or as a video game—involving quite complex rules:

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

This "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. We should point out, as well, that as complex as the language is on this card—a card borrowed from a seven year old—the language on *Yu-Gi-Oh* web sites devoted to the game's rules is yet much more dense and complex. Here is but one example:

> **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

Let's consider for a moment what *Yu-Gi-Oh* involves. First and foremost it involves what we can call "lucidly functional language." 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 the company 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.

And, note, too, here that such lucidly functional language is practiced socially in groups of kids as they discuss, debate, and trade cards, where interactions with more advanced peers often plays 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*, or, as we will see below, video games—to engage their children in informal specialist-language lessons.

6. Real Understanding: Another Gap

Beyond the traditional literacy gap—the literacy divide between rich and poor—there is another gap in education, one that implicates even the understandings of more privileged children in school. This is the gap between passing tests and really understanding. Lots of research has shown, for years now, that, in areas like science, a good many students, even those good grades and passing test scores, cannot actually use their knowledge to solve problems.[21]

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.[22] They cannot apply their knowledge, because they don't *see* how it applies. They don't see the physical world and the symbol system of physics (which includes language and mathematics) in such a way that it is clear to them how that system applies to that world. While the poor may do less well in school, even the well off seem not to understand what they learn all that deeply.

This lack of understandings is connected to language and other symbols. There are two ways to understand words. We will call one way "verbal" and the other way "situated."[23] A situated understanding of a concept or word implies the ability to associate the word with specific images, actions, experiences, or dialogue in such a way that one knows how to apply the word in specific contexts to solve problems or accomplish goals.[24] 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.

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."[25] Of course, to assign such situated meanings to "coffee" here, one must have had experiences with coffee in different forms and contexts.

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.

Before discussing situated meanings in more depth, let us 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's take the small booklet that comes with the innovative 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. 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. 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 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 suggests that some of this information is on one screen and some on the other. But 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”?

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.

But if you play the game for a while first and then read the book, then you can spell out such information in situation-specific terms and the relationships of this information to the other hundreds of pieces of information in the booklet becomes 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 attach a situated meaning—images, actions, experiences, or pieces of dialogue from the game—to each word in the text. *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. You can read it to enable problem solving,

So now we would make just the same claim about any school content domain as we 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, if you ever do. This is not harmful for kids who have already played the game at home, but it is disastrous for those who have not.

Good video games don't just support situated meanings for the written materials associated with them in manuals and on fan web sites—and these are copious—but also for all the 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 our claim: what we will call "game-like learning" leads to situated and not just verbal meanings. "Game-like learning" need not involve an actual game—it simply requires learners to live and have (guided) experiences in the world from the perspective of the area being learned, for example, a particular branch of science. But actual video games hold out great potential to enhance and deepen this process—to offer learners a myriad of new experiences that can allow them to learn situated meanings and not just verbal definitions.

7. Video Games and the Human Mind

Just as children today often see complex specialist language in their popular culture activities like *Yu-Gi-Oh*, they also see 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. Let us explicate what we mean.

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.[26] 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.[27] 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 we are concerned with—games like *Half-Life 2*, *Rise of Nations*, *Full Spectrum Warrior*, *Morrowinds: The Elder Scrolls*, and *World of WarCraft*—are what we could call "action-and-goal-directed preparations for, and simulations of, embodied experience." A mouthful, indeed, but an important one.

To make clear what we 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 us first briefly summarize some recent research in cognitive science.[28] 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[29]
>
> **…** to a particular person, the meaning of an object, event, or sentence is what that person can do with the object, event, or sentence[30]
>
> … higher intelligence is not a different kind of process from perceptual intelligence[31]

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.[32]

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 us now turn to a characterization of video games and then we will put our remarks about the mind and games together.

Video games usually involve a visual and auditory virtual world in which the player has micro-control (small scale control) over the movements of elements in the world (e.g., a virtual character in *Half-Life*, units in *Rise of Nations*, or shapes in *Tetris*). 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."[33] 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 massively 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.[34] 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 we have sketched, in fact, argues, as far as we are 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.[35] 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. Winning would mean just what it does to a scientist: feeling a sense of accomplishment through the production of knowledge to solve deep problems.

We 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.

8. Distributed Intelligence and Cross-Functional Teams

Good video 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.[36] 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" (p. 2).

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[37]—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 us turn to the creation of a form of collaboration we can call "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, Paladin, 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 we 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.[38] People specialize, but integrate and share, organized around a primary affiliation to their common goals and endeavors, and use 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 leveraging experiences to build simulations (in the mind and outside it), distributed intelligence, and cross-functional collaboration—are all ones that need not to be restricted to military games. They are key to deep understanding in any specialist domain, whether in school or at work.

9. Games as Games

So far much of what we have said about good video games and learning doesn't have much to do with the fact that they are games *per se*. The features we have looked at don't speak directly to video games as games and, indeed, these features all seem to be somewhat removed from the pleasures that games as games give us humans. However, it is certainly a leading question for research whether these features will work for learning well, or as well, if they are not embedded in video games that not only have these features but are good games, as well. What are the features that make a video game a game and a good game? What are the sources of the pleasures people draw from video games as games of a certain sort? How do these features relate to learning?

Hardly anyone has failed to notice how profoundly motivating video games are for players. Players focus intently on game play for hours at a time, solving complex problems all along. In an "attentional economy," where diverse products and messages, not to mention school subjects, compete for people's limited attention, video games draw attention in a deep way. It is clearly a profoundly important subject for research to understand the source or sources of this motivation. Such motivation is clearly foundational for learning.

Oddly enough, one hypothesis here is that it is problem solving and learning, as well as the display of mastery, that are themselves a key source of motivation in good video games. If this is true, then, we need to know why learning and mastery is so motivating in this context and not always as motivating in school. Here another hypothesis would be that learning and mastery are motivating in good video games precisely because they use the sorts of deep learning principles we have just discussed above, as well as others.

But, of course, we need to know, as well, whether, when the content of a video game is based on more academic or specialized learning goals, the same sorts of effects can occur. Some people assume that things like science can never be made as enticing as fighting fictional wars in *America's Army* or running a family in *The Sims*, for example. At the same time, we know of few good scientists who do not find science, as a form of being in and seeing the world, motivating, entertaining, and life enhancing.

There are certainly features connected to video games as games that help explain both the motivation they recruit and the learning they enable. First, the role of failure is very different in video games than it is in school. In good games, the price of failure is lowered—when players fail they can, for example, start over at their last saved game. Furthermore, failure—for example, a failure to kill a boss—is often seen as a way to learn the underlying pattern and eventually to win. These features of failure in games allow players to take risks and try out hypotheses that might be too costly in places where the cost of failure is higher or where no learning stems from failure.

Every gamer and game scholar knows that a great many gamers, including young ones, enjoy competition with other players in games, either one-on-one or team-based. It is striking that many young gamers see competition as pleasurable and motivating in video games, but not in school. Why this is so ought to be a leading question for research on games and learning. One thing seems evident, namely that competition in video games is seen by gamers as social and is often organized in ways that allow people to compete with people at their own level or as part and parcel of a social relationship that is as much about gaming as it is about winning and losing. Furthermore, gamers highly value collaborative play, for example, two people playing *Halo* together to beat the game or the grouping in massive multiplayer games like *World of WarCraft*. Indeed, collaboration and competition seem often to be closely related and integrated in gaming, though not in school.

Beyond issues of motivation, failure, competition, and collaboration, the very ways in which games are designed as games seem to give them features that both enhance learning and a sense of mastery. This is a hypothesis that needs testing. Nonetheless, there are some features of the very design of video games that appear to be closely associated with well-known principles of learning. We list some of these design features below:

A. Interactivity: In a video game, players make things happen; they don't just consume what the "author" (game designer) has placed before them. In good games, players feel that their actions and decisions—and not just the designers' actions and decisions—are co-creating the world they are in and the experiences they are having. What the player does matters and each player, based on his or her own style, decisions, and actions, takes a somewhat different trajectory through the game world. The more open-ended a game is the more true this is, though in a more limited sense it is true of all games, since players must play them and play is, as we have seen above, a form of simultaneous "reading" (interpreting) and "writing" (producing).

All deep learning involves learners feeling a strong sense of ownership and agency, as well as the ability to produce and not just passively consume knowledge.

B. Customization: In some games, players are able to customize the game play to fit their learning and playing styles, for example through different difficulty levels or the choice of playing different characters with different skills. In others, the game is designed to allow different styles of learning and playing to work (e.g., there are multiple ways to solve the problems in the game), for example, in the *Deus Ex* games and role playing games like *Arcanum*. Customization, in the sense of catering to different learning styles and multiple routes to success, is an important learning principle in many different areas.

C. Strong Identities: Good games offer players identities that trigger a deep investment on the part of the player. This identity is often connected to a specific virtual character, though sometimes it is attached to a whole "civilization" (as in *Civilization* or *Rise of Nations*). When gamers are playing characters, strong identities are achieved in one of two ways: Some games offer a character so intriguing that players want to inhabit the character and can readily project their own fantasies, desires, and pleasures onto the character (e.g., Solid Snake in the *Metal Gear Solid* games). Other games offer a relatively empty character whose traits the player must determine, but in such a way that the player can create a deep and consequential life history in the game world for the character (e.g., in role playing games like *The Elder Scrolls III: Morrowind*). Furthermore, in games, the identity of the character one plays is very clearly associated with the sorts of functions, skills, and goals one has to carry out in the virtual world. Many people have argued that identity (e.g., "being-doing a scientist" in order to learn science) is crucial for deep learning (see last section, as well, on this issue).[39]

D. Well-ordered problems: Problems in good games are well ordered. In particular, early problems are designed to lead players to form good guesses about how to proceed when they face harder problems later on in the game. In this sense, earlier parts of a good game are always looking forward to later parts. This is part of what good level design is all about. Work on the mind and learning which takes a connectionist approach has argued that such ordering is crucial for effective learning in complex domains.[40]

E. Games are pleasantly frustrating: Good games adjust challenges and give feedback in such a way that different sorts of players feel the game is challenging but doable and that their effort is paying off. Players get feedback that indicates whether they are on the right road for success later on and at the end of the game. When players lose to a boss, perhaps multiple times, they get feedback about the sort of progress they are making so that at least they know if and how they are moving in the right direction towards success. Andy diSessa[41] has argued that such pleasant frustration is an optimal state for learning things like science.

F. Games are build around the cycle of expertise: Good games create and support what has been called in the Learning Sciences the "cycle of expertise,"[42] with repeated cycles of extended practice, tests of mastery of that practice, then a new challenge that leads to new practice and new mastery at a higher level. This is, in fact, part of what constitutes good pacing in a game.

G. "Deep" and "Fair": These are terms of art in the gaming community. A game is "fair" when it is challenging, but set up in a way that leads to success and does not design in features that virtually ensure failure over which the player has little or not control. A game is "deep" when game play elements (e.g., a fighting system in a turn-taking game) that initially seem simple, and, thus, easy to learn and use, become more and more complex the more one comes to master and understand them. Such terms, it would seem, would make good terms of art in the Learning Sciences, as well.

These are all basic features of the way many games are designed. They also appear to be important features for effective learning. Thus, they raise the question as to whether the sorts of features we discussed earlier—the ones less connected to games as games *per se*—are rendered more effective when in the presence of these more directly game-like features.

10. Mentoring

Some enthusiasts for games and learning see games as a way to remove teachers from learning. They stress—as have many others in one branch of the progressivist tradition—immersion, experiential learning, inquiry, and learners' setting their own agendas and goals. Similarly, some people in the field of artificial tutoring, as well, have held out the possibility that such tutors could replace human teachers.

On the other hand, Kirschner, Sweller, and Clark have recently published an attention grabbing paper—"Why Minimal Guidance during Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching"[43]—that argues:

> While unguided or minimally-guided instructional approaches are very popular and intuitively appealing, the point is made that these approaches ignore both the structures that constitute human cognitive architecture and evidence from empirical studies over the past half century that consistently indicate that minimally-guided instruction is less effective and less efficient than instructional approaches that place a strong emphasis on guidance of the student learning process. The advantage of guidance begins to recede only when learners have sufficiently high prior knowledge to provide 'internal' guidance. Recent developments in instructional research and instructional design models that support guidance during instruction are briefly described. (Abstract)

It is clear from our example above of the mother and her four-year-old talking about dinosaurs—an example we took from Kevin Crowley's work—that in the sorts of effective home-based learning that prepares kids for school, the role of the adult is crucial. In this case the adult scaffolds a particular type of talk—talk that orientates towards school-based or academic language—and engages in what we might well refer to as informal language lessons, a form of overt—yes, even controlling—guidance. At the same time the child is immersed in an activity over which, as an "expert," he feels ownership and agency.

The dichotomy between overt instruction/guidance, on the one hand, and agentful immersion in experience is a false one. Good video games offer lots of guidance without taking away immersion or ownership: the game design structures the player's experience, setting up goals, constraining the problem space, and ordering the problems (level design); overt verbal information is offered—and often lots of it—"just in time" (when it is needed and can be used) or "on demand" (when the player is ready for it and knows why it is needed); tutorials, assessments, feedback, and practice abound in video games. Furthermore, gamers are most often members of social groups, communities of practice, where more advanced peers share information, guidance, modeling, and critique.

We stressed above that our focus ought be, not on the game in the box, but on what we called "the big 'G' game," that is, the combination of the game in the box and the social and learning system built around the game. This learning system most certainly includes forms of overt guidance, instruction, and scaffolding, though these can take a variety of different forms.

One way to get at this issue is to return to our remarks about the human mind in Section 7. There we argued that people's embodied experiences in the world (experiences of action, interaction, and talk) are the foundations of their thinking and problem solving:

> 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.

People form their simulations based on experiences they have had. But to do this successfully they have to have processed these experiences in certain ways.[44] They have to learn to interrogate their experiences (and they have to have the language capacities, in given domains, to do this). Interrogating one's experiences means, among other things, the following[45]:

> 1. In order to learn from and use their experiences for future problem solving, learners need to interpret their experiences. As we have seen, human experience works best for learning when it is goal-driven. Interpreting one's experience means thinking—both while in practice and later on after practice—about how one's goals relate to one's reasoning in the situation and it means pulling out lessons learned and anticipating when and where those lessons might be useful.
>
> 2. Learners can learn best when they get immediate feedback in practice so they can recognize and assess their errors and situations where their expectations have failed and when they are encouraged to explain why their errors and expectation failures happened and what they could have done differently.
>
> 3. Learners need ample opportunities to apply their previous experiences—as interpreted—to new similar situations, so they can "debug" and improve their interpretations of these experiences, gradually generalizing them beyond specific situations.
>
> 4. Learners can and need to learn from the interpreted experiences and explanations of other people, most certainly including more expert people. This is best done through modeling and discussion.

When these four steps are carried out, learners' experiences become well articulated "cases"[46] with which and from which they can reason. These four steps obviously require the design of a learning system around a game (or other set of activities generating experiences) that recruit very distinctive forms of individual action, interaction, participation, modeling, and discourse.

This framework also suggests a variety of roles for teachers or other adults in young people's learning. Like game designers, teachers need to be designers of learning systems that cause learners to process their goal-driven experiences in the ways discussed in these four steps. They need to do this while still allowing a sense of agency and ownership on the part of the learners. Teachers must offer overt information, modeling, worked examples, guidance at the appropriate level, often "just in time" and "on demand." They may very well need to offer more such overt information, modeling, and guidance for beginners, just as good games and good game tutorials do. Finally, teachers build and resource "communities of practice" where each learner can use the resources of good tools and technologies and other learners at different levels of expertise.[47] In such communities, knowledge is distributed (spread across multiple people and their smart tools and technologies) and dispersed (exists on site and off site with links).

One key thing teachers need to do is to build and resources certain forms of talk, patterns of participation, and interaction.[48] This is so because (a) distinctive forms of content are connected (hopefully in lucidly functional ways) with distinctive forms of language, connections rendered public in talk, (b) learners need to learn to interpret, analyze, debug, and explain their experiences (and the connections between goals and reasoning within experience)—and, again, all these can be rendered public through talk, c) learners need to learn from the interpreted experiences of others, their peers and more expert people in the domain, and (d) communities of practice are, in part, formed through the sorts of talk that allows for public sharing and joint modeling, building and problem solving.

Too often, though, people have celebrated learners talking and discussing without worrying enough about the type of talk in which they are engaged and the cognitive foundations that give that talk situated meanings for (hopefully) everyone in the group. The *Yu-Gi-Oh* example above makes two things crystal clear. First, learning *Yu-Gi-Oh* requires a very specific form of talk—a specific register or social language[49]—a form that is deeply tied to the functions, meanings, and purpose of *Yu-Gi-Oh* as an activity. Second, each young *Yu-Gi-Oh* player can discuss and debate with others in this language on common ground not because they have done nothing but talk, but because they have played the game and that play has given them embodied, situated meanings for the language.

The same is true of science in the classroom: its language needs to be lucidly functional, kids need to get embodied, situated meanings of its words and concepts, and they need to use that language (not just the vernacular) in ways that are functional to "play the game" and accomplish meaningful goals (like winning in *Yu-Gi-Oh* or carrying out and defending a successful experiment). They hopefully do all these in the framework of the four points above. But note, crucially, *Yu-Gi-Oh* language goes hand in hand with certain forms of interactive participation (there are ways people relate to each other to play the game)—not just any old forms and certainly not "everyday" forms modeled on informal conversations. Those forms are related to the nature of the game and the requirements for being successful at it. The same is true of any type of science being taught in school.

If you actually study kids acquiring *Yu-Gi-Oh*, they are most certainly immersed in a rich set of multi-model experiences and activities (books, movies, TV shows, cards, games, trading, etc.), but they also usually have lots of overt teaching and modeling. In fact, the television show directly (through dramatically) models how to play—and think about—the game. More advanced players—in the local community and at tournaments—offer lots of overt advice and guidance, sometimes gently, sometimes not. There is, in the end, no necessary opposition between guidance and immersion—we need lots of both, balanced differently at different points in the learners trajectory—just as happens in any good video game.

11. Models and Modeling

If games are to be used in educational settings, there is another element beyond the role of mentors that needs to be discussed, namely the role of models and modeling in thinking, learning, and building knowledge. Models have not played an essential role in much of the mainstream educational literature, but they play a major role in current work in the Learning Sciences and in games.[50]

Specialist domains—like science and mathematics in academics or *Yu-Gi-Oh* or *Dungeons and Dragons* in popular culture—create tools and new ways with language in order to construct new worlds or new ways of looking at the real world. For science and math this involves looking at, talking about, and knowing the everyday world in new ways, ways that are often different from our everyday non-specialist ways. For the popular cultural activities like *Yu-Gi-Oh* and *Dungeons and Dragons* this involves constructing fantasy worlds with complex correspondences to the real world (though science and mathematics sometimes do this sort of thing as well)—e.g., by combining elements of the human, animal, natural, and textual-mythological domains. One of the key devices through which both science and popular culture construct new worlds, or new ways of looking at and acting on the real world, is the use of models.

I will be using the word "model" here in a somewhat extended sense from its everyday usage, so let's start with familiar territory. Consider a child's model air plane. Real planes are big, complex, and dangerous. A child can safely play with the model plane, trying out things, imagining things, and learning about planes. Of course, models are always simpler than the thing they model and, thus, different types of models capture different properties of the thing being modeled and allow different sorts of things to be tried out and learned. Even a child's toy plane may be more or less detailed, and a piece of folded paper can do in a pinch as a model of an airplane.

Model planes can, of course, be used by engineers and scientists, as well. They can use the model plane in a wind tunnel, for example, to test things that are too dangerous or too expensive to do with real planes. They can make predictions based on the model and see if they hold true for the real thing in real life (e.g., planes crash under certain conditions). They can use the model to make plans about how to build a better real plane. They can use it, as well, to test theories about planes and flight, to build explanatory ideas about new planes or not yet well-understood aspects of mechanical flight. They can even use the model to better understand, after the fact, problems like crashes that have already occurred in reality. The model plane is a tool for thought, learning, and action.

Models are just depictions of a real thing (like planes, cars, or buildings) or a system (like atomic structure, weather patterns, traffic flow, eco-systems, social systems, and so forth) that are simpler than the real thing, stressing some properties of the thing and not others. They are used for imaginative thought, learning, and action when the real thing is too large, too complex, too expensive, or too dangerous to deal with directly. It is also clear from our example of the model plane that models are embedded in distinctive sorts of activities (e.g., putting the model plane in a wind tunnel) that we can call "modeling".

A model plane closely resembles the thing it is modeling (a real plane). But models can be ranged on a continua of how closely they resemble the thing they are modeling. They can be, in this sense, more or less "abstract". One model plane may have lots of details, right down to little decals designating the decorations on the plane. Another may be a simple balsa-wood wings and frame construction, no frills, meant to strip plane flight to its fundamentals. A folded piece of paper goes further away from a close resemblance to a real plane. Even more abstractly, the blue print of the plane, on a piece of paper, is still a model, useful for some purposes (e.g., planning and building) and not others. It is a model that resembles the plane very little, but still corresponds to the real plane in a patterned way. It's an abstract picture.

We can go even further and consider a model of the plane that it is chart with all the plane's different parts listed down a set of rows and a set of numbers ranged along the top in columns. The intersection of a part and number would stand for the amount of stress each part is under in flight. For each part we can trace along the row and see a number representing how much stress this part is under in flight. No resemblance, really, left here, but the chart still corresponds to the plane. We can still map from pieces of the chart to pieces of the plane. The chart still represents some properties of the plane, though this is a very abstract picture of the plane, indeed, and one useful for a narrow purpose.

However, this type of model—at the very abstract end of the continuum of resemblance—shows us another important feature of models and modeling. It captures an invisible, relatively "deep" (that is, not so readily apparent) property of the plane, namely how parts interact with stress. Of course, we could imagine a much more user-friendly picture (model) of this property, perhaps a model plane all of whose parts are color coded (say in degrees of red) for how much stress they must bear in flight. This is more user-friendly and it makes clear the mixture of what is readily apparent (the plane and its parts) and what is a deep (less apparent) property, namely stress on parts.

But, of course, the list-like model can probably lists lots more parts than we can easily build into a small toy-like model plane, and it can give more accurate information through the use of numbers, rather than color shadings. As with all models, there are always trade offs in terms of what you want to know, learn, or represent, how user-friendly the model will be, and what the model will look like. In fact, one of the key intellectually interesting thing about models and modeling is that it forces us to reflect on, explain, and defend such choices for specific purposes and goals.

These are very basic matters. Models and modeling are basic to human play. They are basic to a great many human enterprises, for example, science (a diagram of a cell), architecture (model buildings), engineering (model bridges), art (the clay figure the sculptor makes before making the real statue), video and film (e.g., story boards), writing (e.g., outlines), cooking (recipes), travel (maps), and many more. In fact, models and modeling are so basic to thought, learning, and action outside of school that it is odd children in school do not usually get a lot of time building, manipulating, transforming, thinking with, and discussing models as a way to understand things like science and society and to produce, and not just consume, knowledge.

Models are basic to video games, as well, and are another point where game design and the learning sciences intersect. However, thinking about models also keys us into two different large categories of commercial video games. Video games are simulations in which the player is inside the simulation. All simulations are models of what they are simulating. So *World of WarCraft* simulates (models) a world of mountains, lakes, roads, buildings, creatures, and so forth, that, while fantasy, is meant to resemble aspects of the real world. However, players for the most part pay very little attention to this modeling aspect of *World of WarCraft*, because it usually plays no important role in the game play. Rather, players concentrate on the embodied experiences of play, problem solving, and socialization that *World of WarCraft* offers them. By and large, the fact that it models environments does not matter all that much to the game play.

However, sometimes in *World of WarCraft* this is not true; sometimes the modeling aspect comes to the fore. For example, when I get stuck trying to walk up the inclines and crevices of a mountain in *World of WarCraft*, I begin to think about how the game's mountain is representing (modeling) gravity and resistance in the real world, sometimes with anger, because I realize that it did not model them well enough to ensure that I can get up an incline that in the real world I could, but in the game I can't.

However, there are other games in which the modeling aspect of the simulation is crucial. Players in these games are having experiences, just as they are in *World of WarCraft* or *Half-Life*, but the modeling aspect is also crucial at nearly all points, not just intermittently. In a game like *Civilization*, for instance, the depictions of landscapes, cities, and armies are not very realistic, not nearly as realistic as in *World of WarCraft*. For example, in *Civilization*, a small set of soldiers stands for a whole army and the landscape looks like a colorful map. However, given the nature of game play in *Civilization*, these are clearly meant to be models of the real things stressing only some of their properties. They are clearly meant to be used for quite specific purposes in the game, for example, modeling large scale military interactions across time and space and modeling the role of geographical features in the historical development of different civilizations. Models and modeling is integral to game play in *Civilization*—it's the point of the game, in one sense. Since a game like *Civilization* stresses modeling, it is not surprising that it is played with a top-down god's eye view, rather than the first person, world-internal view of *Half-Life*.

However, not all games that stress modeling as integral to game play have such a top down view, though other model-intensive games do, games like *Zoo Tycoon*, *Rise of Nations*, and *the Sims*. A game like *S.W.A.T.4* is played with a first person, world-internal view, but still modeling is crucial to the game. The player is very well aware that it matters how and why the designers modeled the S.W.A.T. team members, their equipment, and the sorts of environments with which and in which they interact.

So we can distinguish between video games that stress player experiences, but not modeling, and other games that, while offering experiences, stress modeling, as well. However, even games where, at the big picture level, modeling is not integral to game play in terms of their overall virtual worlds—games like *World of WarCraft* or *Half-Life*—very often models appear ubiquitously inside the game to aid the player's problem solving. For example, most games have maps that model the terrain (and maps are pretty abstract models) and allow players to navigate and plan. The bottom of *World of WarCraft*'s screen is an abstract model of the player's abilities and skills. Lots of games allow players to turn on and off a myriad of screens that display charts, lists, and graphs depicting various aspects of game play, equipment, abilities, skills, accomplishments, and other things. In a first-person shooter, the screen that shows all the guns a player has, their firing types, and their ammunition is a model of the game's weapon system, an abstract picture of it made for certain planning, strategizing, predicting, and problem-solving uses.

Models inside games go further, much further. Players and player communities often build modifications of games that are models used to solve certain sorts of problems. For example, *World of WarCraft* player's can download a mod that displays a chart (during actual fighting) that lists each player's class (e.g., Druid, Priest, Warrior, Mage, Paladin, etc.) and the amount of damage they are doing in a group raid inside a dungeon. This chart can be used to check—publicly—that each player is holding up his end of the group task (so Warriors better being lots of damage and healing priests better not be—they had better be concentrating on healing rather than attacking). This is one of several tools, almost all of them made by players, that help players solve a very real-world problem, namely the problem of individuals attempting to take a free ride in a group or attempting to hide their lack of skill.

Models and modeling reach a new pitch in games like *Tony Hawk*. In these skating board games, first, the whole game is a model of the practices and culture of skateboarders. Within that larger model, there are a myriad of models of boards, dress styles, tricks, and parks. However, players can readily design their own skaters, clothes, boards, tricks, points for tricks, and skate parks. That is, they can build their own models. When they build a model skate park, they interact with a set of more abstract models of environments (screens made up of grids and rotatable objects) that help them build the more specific and realistic looking model skate park they want (like a toy plane). Furthermore, they can share their new skate parks with other players—who can even skate their parks—and thereby get feedback and critique, in turn revising their models, based on things like fidelity to skater culture, practices, and values; real-world properties like gravity; and player opinions about identity, fun, engagement, and the nature of skateboarding as a real activity and as gaming activity. Indeed, as skating in the real world changes, the models in the game and those made by players change, each time trying to capture things that are seen as important or essential, all the while balancing a variety or criteria about fidelity to different things and systems. This is modeling with a vengeance. Here modeling is integral to game play at all levels.

So, why, in the end, are models and modeling important to learning—say, learning things like science or social science? Because, while people learn from their interpreted experiences—as we have argued above—models and modeling allow specific aspects of experience to interrogated and used for problem solving in ways that lead from concreteness to abstraction. This is not the only way abstraction grows—it can grow, as well, from comparing and contrasting multiple experiences. But modeling is an important way to interrogate and abstract experience. This is readily apparent in a game like *Tony Hawk*. Surely, players of this game, if they have made skate parks and shared them, have both an embodied experiential understanding of skating (as least as an in game simulated activity) and a more abstract take on properties and features of skating and skate parks. Indeed, these two forms of understanding can constantly interact with and feed off each other. Indeed, there resides a real power for learning and innovation.

So, then, second, why are models and modeling important to game design? Because, in-game models are tools to facilitate, enrich, and deepen the problem solving the game designer is building. And because games like *Civilization*, *S.W.A.T.4*, *The Sims*, and *Tony Hawk*, games that stress modeling even at the larger level of the game-play experience, allow for a quite deep form of play—often connected in complicated ways with the real world—though this is not to say, of course, that such games are more “fun” than other games. They are, however, probably the key route to the making of so-called “serious games” (though, of course, models and modeling can readily be built into games whose overall game play does not stress modeling).

It may well be that when educators recruit games for learning in areas like science or social science that the role of models and modeling will be a critical aspect. The fact that video games can give players rich experiences, allow them to interpret and reflect on these experiences, and, at the same time, get them to interact with models at various levels of abstraction as part and parcel of those experiences, both at the level of the game as a whole and within the game, may eventually be seen as one of the promising aspects of games in learning. It will be a crucial place at which mentors (teachers) will be able to guide and deepen learners’ interactions with the game and with other people around the game.

12. A New Crisis?

Our discussion thus far leads to one of the deepest and most important issues in the field of games and learning. If we want to move games or game-like learning to school, will the structure of schooling have to change significantly or not? Can games or game-like learning adapt to schooling or will they demand major innovations and changes? It has been argued for some time that schooling as we know it is an antiquated institution, appropriate for an industrialized capitalism that is now passing in the developed world. Schools are out of kilter, it is argued, with our current fast-changing, information rich, knowledge intensives, high-tech, global world.[51]

Some have argued recently that the United States faces a new looming crisis in education.[52] The crisis, it is argued, resides in the fact that far too many young people in the United States today are being prepared—in school and at home—for standard jobs in a world that will very soon, in countries like the United States, reward people who can do "innovation work" and punish people fit only for standard jobs.[53] A standard job is a job—whether it be a call-center operator or a computer scientist, whether it be low or high status—that can be done more cheaply and just as efficiently, thanks to technologies like computers and the Internet, in low cost centers, often outside of the United States. Such jobs involve standardized skills that can now be trained efficiently almost anywhere.

Today, a country like India, to take just one salient example, has call-center operators, engineers, and computer scientists as well or better trained as those in the U.S., people able and willing to work for less, all the while staying in India. And in a connected world, it often does not matter where people are. In actual effect, time differences are an advantage, e.g., Indian radiologists can read American X-rays while American doctors and patients sleep at night and have them ready by morning in America.

Our government and our schools have made an effort to "leave no child behind" through the use of standardized testing and accountability. But standardized testing—and the regime we have put in place to raise test scores—produce standardized skills, skills that are now common across the world, even in counties like China that have massive numbers of poor people, but still, nonetheless, also have massive numbers of middle-class people, more, in fact, than the entire population of the United States.

Mastery of the complex technical languages (whether this be the language of chemistry or graphic design), complex symbol systems (whether this be non-linear mathematics or neural networks), and complex practices (whether this be socially engineering new workplaces or new eco-systems) that will be the basis for innovation in the coming world does not start in college. Such mastery starts in kindergarten and before—consider the discussion of young children's "islands of expertise" above.[54] Just as it is best to start learning a foreign language early—better to start learning Russian as a second language at home and school early on in life if you are to really master it—so too, today's technical languages, symbol systems, and practices are best based on learning that begins early in life and is sustained over the long haul.

A number of economically well off people in the United States and elsewhere across the globe already realize this. They use modern technologies and a bevy of language and literacy practices in their homes to introduce their children early on to technical languages, skills, and knowledge. They create and support, as we have seen, "islands of expertise" in their children. These islands may be rooted in dinosaurs, mythology, computers, science, art, or video games, but their real import is the preparation they give these children for life-long learning as they face the every increasing demands of complex language, symbols, and practices at higher and higher levels of schooling.

We have argued above that some aspects of children's popular culture today are more complex than ever before, in the sense of demanding complex thinking, language, and problem solving. Indeed, the language on a *Yu-Gi-Oh* card or web site is often more complex—more technical—than the language children using the cards see in their school books or hear in their classrooms these days. Or consider the complex problem-solving and decision-making required to play a video game like *Age of Mythology*, a real-time strategy game with over 300 commands, a game played successfully by seven-year-olds (though not always by their parents).

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

But what about the children who do not have these opportunities, ones now readily available to and sometimes put to good use by privileged families? Can they get this sort of modern learning system, directed towards preparation for future innovative work, in school? Today's popular culture, indeed, has great potential to be recruited into such high value learning systems. But this doesn't happen all by itself. Popular culture may be much less good for those children who do not have opportunities to have it actively leveraged for their long-term growth into complex thinking, complex language, complex content, and innovative work.

We believe that a new and massive equity gap is growing in just these terms—one not mitigated by and maybe even enhanced by today's technologically impoverished schools.[55] The solution to the looming crisis cannot reside in our schools alone. We must transform learning in and out of schools for children and adults. We need wholesale change. And the change we need is neither liberal nor conservatives.

Liberals have too often advocated pedagogies that immerse children in rich activities and focus on the learners' own goals and backgrounds. This is empowering, but for many children it hides the "rules of the game," the skills, values, and assessments, not to mention the massive effort, that learners must overtly recognize if they are to succeed in a world that no long rewards commodity jobs.[56] Some children, often from privileged homes, pick up the requisite understanding of the rules of the game at home and use liberal schooling as fruitful and empowering practice ground.

Conservatives have too often advocated pedagogies that stress overtly telling learners what they need to know and skilling-and-drilling them on factual knowledge, the sorts of knowledge standardized test usually test. Decades of research have shown that while such learners can often pass paper and pencil tests, they cannot apply their knowledge—for example, their knowledge of Newton's Laws of Motion—to any real-world problem.[57] This is hardly a recipe for building expertise and innovation.

But liberal or conservative pedagogies are not our only choices. What we will call "post-progressive pedagogies" are neither liberal nor conservative.[58] As we discussed in the preceding section, such pedagogies stress immersion in practice (doing) supported by lots of structure, structure built into the design of learning systems meant to lead to expertise, higher-order skills, and the ability to innovate. These learning systems involve the sorts of immersion with guidance that one finds in good game design. Let us turn now to a consideration of what we can learn from game design about the design of learning in and out of classrooms.

13. Game Design and Education as a Design Science

We have talked thus far about how getting players to be reflective about their game play can lead to "media literacy" in the form of thinking like a designer, that is, becoming overtly aware of the design grammar by which effects are achieved and relationships established through digital game technologies. We have talked, as well, about how, if games were made around "academic" content—e.g., a branch of science—this process would allow learners to be reflective not just about the design grammar of a game, but of science as an active thinking-valuing-doing process itself.

But game design has another—much less remarked—contribution to make to education. Game design as an enterprise is, at a deep level, similar to education seen as a "design science."[59] How good game designers think about game design, we believe, has much to teach us about how educators ought to think about the design of learning in and out of classrooms. To see what this point amounts to, let's look at just one classic paper in the field of game design, Doug Church's "Formal Abstract Design Tools."[60]

Church starts by pointing out that a "modern computer game … fuses a technical base with a vision for the player's experience." So, too, with the design of classroom learning systems or learning systems outside classrooms: the educator—often a reflective teacher, sometimes a researcher—must fuse technical knowledge about learning as a social and cognitive process with a vision of the learner's experience.

Church believes that the "primary inhibitor of design evolution is the lack of a common design vocabulary." And, indeed, this is a core problem in education as a design science, as well. In fact, game designers are more acutely aware of the problem than are educators. Church's notion of "Formal Abstract Design Tools" is an attempt to create a framework for such a vocabulary. Educators have something important to learn by watching how he goes about this task. But they have a great deal to learn, as well, from the outcome of Church's enterprise, due to the fact that both games and learning systems are ways of sociotechnically engineering people's social and cognitive experiences.

In Church's phrase "Formal Abstract Design Tools," he is using the term "formal" to mean precise definitions and the ability to explain them to someone else. "Abstract" is meant to focus on underlying ideas, not specific constructs specific to only one genre (e.g., role playing games as against real-time strategy games). This use of "abstract" would demand, in the educational sphere, that we focus first on core ideas about learning that hold across content areas, not just ones specific to a given area like math or literature. Church cautions, however, that abstract tools "are not bricks to build a game out of." He points out that "[y]ou don't build a house out of tools; you build it with tools."

Before he offers examples of "Formal Abstract Design Tools" in his paper, Church offers an analysis of some the game play features of the classic game *Mario 64*. Here is some of what he has to say about this game:

> *Mario 64* blends (apparent) open-ended exploration with continual and clear direction along most paths. Players always have lots to do but are given a lot of choice about which parts of the world they work on and which extra stars they go for. The game also avoids a lot of the super-linear, what's-on-the-next-screen feel of side-scrolling games and gives players a sense of control. In *Mario*, players spend most of their time deciding what they want to do next, not trying to get unstuck, or finding something to do.
>
> A major decision made in the design was to have multiple goals in each of the worlds. The first time players arrive in a world, they mostly explore the paths and directions available. Often the first star (typically the easiest to get in each world) has been set up to encourage players to see most of the area. So even while getting that first star, players often see things they know they will need to use in a later trip. They notice inaccessible red coins, hat boxes, strange contraptions, and so on, while they work on the early goals in a world. When they return to that world for later goals, players already know their way around and have in their heads some idea about how their goals might be achieved, since they have already visited the world and seen many of its elements.
>
> These simple, consistent controls, coupled with the very predictable physics (accurate for a *Mario* world), allow players to make good guesses about what will happen should they try something. Monsters and environments increase in complexity, but new and special elements are introduced slowly and usually build on an existing interaction principle. This makes game situations very discernable — it's easy for the players to plan for action.

> If players see a high ledge, a monster across the way, or a chest under water, they can start thinking about how they want to approach it.
>
> This allows players to engage in a pretty sophisticated planning process. They have been presented (usually implicitly) with knowledge of how the world works, how they can move and interact with it, and what obstacle they must overcome. Then, often subconsciously, they evolve a plan for getting to where they want to go. While playing, players make thousands of these little plans, some of which work and some of which don't. The key is that when the plan doesn't succeed, players understand why. The world is so consistent that it's immediately obvious why a plan didn't work.
>
> This involves players in the game, since they have some control over what they want to do and how they want to do it. Players rarely feel cheated, or like they wanted to try something the game didn't support.

This sounds a lot like an insightful analysis of a curriculum or a pedagogy. It is, in fact, as much an analysis of a learning situation as it is of a game. Church is talking about how design decisions impact the players' experience and how these design decisions "push the player toward deeper involvement in the game world." After offering this analysis, Church moves to abstract out some tools and define them well enough to apply them to other games, including games in other genres.

Church's analysis of *Mario* has made it clear that the game offers players many ways in which to form their own goals and act on them. Players "know what to expect from the world and thus are made to feel in control of the situation":

> Goals and control can be provided and created at multiple scales, from quick, low-level goals such as "get over the bridge in front of you" to long-term, higher-level goals such as "get all the red coins in the world." Often players work on several goals, at different levels, and on different time scales.

Church argues that this process of accumulating goals, understanding the world, making a plan and then acting on it, is "a powerful means to get the player invested and involved." He calls this "intention," because in essence it allows and encourages "players to do things intentionally." Intention in this sense can operate at each level, from a quick plan to cross a river to a multi-step plan to solve a huge mystery. This leads Church to his first Formal Abstract Design Tool:

> **INTENTION:** *Making an implementable plan of one's own creation in response to the current situation in the game world and one's understanding of the game play options.*

A second tool arises from Church's recognition that the "simplicity and solidity of *Mario's* world makes players feel more connected to, or responsible for, their actions. In particular, when players attempt to do something and it goes wrong, they are likely to realize why it went wrong." This tool he calls "perceivable consequence." The key here is that not only does the game react to the player; its reaction is also apparent: "Any action you undertake results in direct, visible feedback":

PERCEIVABLE CONSEQUENCE: *A clear reaction from the game world to the action of the player.*

Church goes on to note how *Mario* uses these tools in conjunction: "[A]s players create and undertake a plan, they then see the results of the plan, and know (or can intuit) why these results occurred." Church then moves on to show how the tools of intention and perceivable consequence can be applied to other types of games and how they work out somewhat differently in different types of games.

While these are basic principles, what is striking is how centrally connected to efficacious learning they are. All of us would—at least if we accepted any remotely modern theory of learning supported by current research—applaud a science curriculum that was built not just by using the Intention tool and the Perceivable Consequence tool, but by deftly combining them. We would also applaud a design science of learning that carried out Church's task of building a common vocabulary around a set of shared and basic principles, principles that are abstract and yet are able to be practically implemented.

We believe that the deep compatibility of Church's game design enterprise and a design science of learning (implemented by researchers or teachers themselves) lies in the fact that games are learning systems (games draw some of their deepest pleasures from learning and mastery) and classrooms are, at their best, social/cognitive games played according to understandable and discoverable rules (otherwise learners are just lost, as they are in bad video games). In the end, then—though we are just at the bare beginnings of this enterprise—we believe that there can be very fruitful communication and learning between game design and educational design science (again, where we think of both researchers and teachers as designers).

14. Learning to Be

For years now we have attempted to speak to the literacy gap in our schools—the fact that poorer children lead to read less quickly and less well than more well off children. But modern digital technologies are open up possibilities for new gaps on top of this old one, gaps in knowledge and in access to tech-savvy skills and identities. This is happening at the same time as our country—along with other developed countries—faces a looming creativity/innovation crisis, especially in technical areas. At the same time, fewer and fewer Americans are choosing to become scientists, engineers, or computer scientists.[61]

Deep learning—learning that can lead to real understanding, the ability to apply one's knowledge, and even to transform that knowledge for innovation—requires that we move beyond "learning about" and move to "learning to be."[62] It requires that learning be not just about "belief" (what the facts are, where they came from, and who believes them) but also strongly about "design" (how, where, and why knowledge, including facts, are useful and adequate for specific purposes and goals).[63]

Deep learning requires the learner being willing and able to take on a new identity in the world, to see the world and act on it in new ways. Learning a new domain, whether physics or furniture making, requires learners to see and value work and the world in new ways, in the ways in which physicists or furniture makers do. One deep reason this is so is because, in any domain, if knowledge is to be used, the learner must probe the world (act on it with a goal) and then evaluate the result. It is "good" or "bad," "adequate" or "inadequate," "useful" or "not," "improvable" or "not"?

Learners can only do this if they have developed a value system—what Donald Schon calls an "appreciative system"[63]—in terms of which such judgments can be made. Such value systems are embedded in the identities, tools, technologies, and worldviews of distinctive groups of people—who share, sustain, and transform then—groups like doctors, carpenters, physicists, graphic artists, teachers, and so and so forth through an nearly endless list. A game like *S.W.A.T.4* is all about such identities and values. In playing the game, the player comes to realize that S.W.A.T. team members look at and act on the world in quite distinctive ways because of their values and goals and that these values and goals are supported by and integrally expressed through distinctive tools, technologies, skills, and knowledge. So, too, with any type of science, for instance.

Good video games can offer people new experiences which can be interrogated inside good learning systems. They can offer problem sets integrated, worked, modeled, and ordered in intelligent ways. They can offer identities—new shoes to stand in from which to view the world, ready for action, in distinctive ways—connected to powerful tools, knowledge, and technologies. They can create new forms of collaboration and communities of practice. They can create new roles and enrich old ones for teachers. They can create new gaps and make old ones worse, or they can be one tool among many for us to close old gaps and forestall new ones.

Notes

1. Gee (2003, 2004, 2005); Shaffer, D. W., Squire, K., Halverson, R., & Gee, J. P (2005); Squire & Jenkins (2004).

2. Gee (2003, 2004, 2005).

3. Brown & Thomas (2006); Castranova (2006); Steinkuehler (2005, in press); Taylor (2006)

4. Juul (2005).

5 Shaffer (2007), Gee (2004).

6. Gee (1992, 1996, 2004); Kress (2003).

7. Kress (2003); Kress, Jewitt, Ogborn, & Tsatsarelis (2001); Kress & Van Leeuwen (2001, 2006).

8. Galloway (2006).

9. New London Group (1996).

10. GAPPS Group (2006).

11. Neuman & Celano (2006); Warschauer (2007).

12. American Educator (2003); Chall, Jacobs, & Baldwin (1990).

13. Dickinson and Neuman (2006).

14. Dickinson and Neuman (2006); Senechal, Ouellette, and Rodney (2006).

15. Chomsky (1986); Labov (1979); Pinker (1994).

16. Gee (2004); Schleppegrell (2004).

17. Crowley and Jacobs (2002, p. 333).

18. The transcript is adapted from Crowley and Jacobs (2002, pp. 343-344).

19. Vygotsky (1978).

20. Gee (2004).

21. Gardner (1991).

22. Chi, Feltovich, & Glaser (1981).

23. Gee (2004) .

24. Brown, Collins, & Dugid (1989); Clark (1989, 1997); Gee (2004).

25. Clark (1993).

26. Newell & Simon (1972)

27. Clark (1989); Gee (1992).

28. Bransford, Brown, & Cocking (2000).

29. Barsalou (1999a: p. 77); see also Barsalou (1999b).
30. Glenberg (1997: p. 3; see also Glenberg & Robertson (1999).
31. Hawkins (2005, p. 96).
32. Barsalou (1999b); Clark (1997); Glenberg & Robertson (1999).
33. Gibson (1979).
34. Gee (2005).
35. Gee (2004).
36. Gee (2004); Hutchins (1995); Shaffer (2004).
37. Shaffer (2004, 2005).
38. Beck (1999); Gee (2004); Gee, Hull, & Lankshear (1996).
39. DiSessa (2000); Gee (2004, 2005).
40. Elman (1991a, b).
41. DiSessa (2000).
42. Bereiter & Scardamalia (1993).
43. Kirschner, Sweller, & Clark (2006).
44. Schank (1982, 1999); Kolodner (1993, 1997).
45. These points are adapted from Kolodner (2006, p. 227).
46. Kolodner (1993, 2006). "Case-based reasoning" is just one instantiation of the viewpoint that we primarily learn from reflections in the connections and patterns in our own embodied experiences and experiences we have learned about from media, discussion, and experts, see also Barsalou (1991a, b); Clark (1993);Gee (1992); Glenberg (1997).
47. Lave (1996); Lave & Wenger (1991); Wenger (1998).
48. See Greeno (2006) & Sawyer (2006) for overviews. See also Rosebery, Warren, & Conant (1992); O'Connor & Michaels (1996).
49. Gee 2004; Halliday (1985).
50. Collela (2000); diSessa (2004); Lehrer & Schauble (2000, 2005, 2006); Stewart, Passmore, Cartier, Rudolph, & Donovan (2005); see also Nersessian (2002) on the cognitive basis of model-based reasoning in science.
51. Toffler & Toffler (2006).
52. Friedman (2005); Hagel & Brown (2005); National Science Board (2002).
53. Shaffer & Gee (2005).
54. Gee (2004).
55. Neuman & Celano (2006).
56. Delpit (1996); Gee (2001).
57. Bransford, Brown, & Cocking (2000); Chi, Feltovich, & Glaser (1981); Gardner (1991).

58. Gee (2001, 2004).
59. Cobb, Confrey, diSessa, Lehrer, & Schauble (2003).
60. Church (1999). All page references following are to this paper.
61. Committee on Prospering in Global Economy of the 21st Century (2006).
62. Brown & Thomas (2006); Gee (1996).
63. Bereiter 2002; Scardamalia & Bereiter(2006).
64. Schon (1983, 1987).

REFERENCES

American Educator (2003). The fourth-grade plunge: The cause. The cure. Special issue, Spring.

Barsalou, L. W. (1999a). Language comprehension: Archival memory or preparation for situated action. Discourse Processes 28: 61-80.

Barsalou, L. W. (1999b). Perceptual symbol systems. Behavioral and Brain Sciences 22: 577-660.

Beck, U. (1999). World risk society. Oxford: Blackwell.

Bereiter, C. (2002). Education and mind in the knowledge age. Mahwah, NJ: Lawrence Erlbaum.

Bereiter, C. & Scardamalia, M. (1993). Surpassing ourselves: An inquiry into the nature and implications of expertise. Chicago: Open Court.

Bransford, J., Brown, A. L., and Cocking, R. R., (2000). How people learn: Brain, mind, experience, and school: Expanded Edition. Washington, DC: National Academy Press.

Brown, J. S., Collins, A., & Dugid (1989). Situated cognition and the culture of learning. Educational Researcher 18: 32-42.

Brown, J. S. & Thomas, D. (2006). You play World of Warcraft? You're hired! Wired Magazine 14.04, April, http://www.wired.com/wired/archive/14.04/learn.html.

Castranova, E. (2005). Synthetic worlds: The business and culture of online games. Chicago: University of Chicago Press.

Chall, J. S., Jacobs, V., & Baldwin, L. (1990). The reading crisis: Why poor children fall behind. Cambridge, MA: Harvard University Press.

Chi, M., Feltovich, P., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. Cognitive Science 5.2: 121-152.

Chomsky, N. (1986). Knowledge of language. New York: Praeger.

Church, D. (1999). Formal abstract design tools. *Gamasutra,* [online journal], viewed 1 July 2006, <http://www.gamasutra.com/features/19990716/design_tools_01.htm>.

Clark, A. (1989). Microcognition: Philosophy, cognitive science, and parallel distributed processing. Cambridge, Mass.: MIT Press.

Clark, A. (1993). Associative engines: Connectionism, concepts, and representational change. Cambridge: Cambridge University Press.

Clark, A. (1997). Being there: Putting brain, body, and world together again. Cambridge, Mass.: MIT Press.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in education research. Educational Researcher, 32: 9-13.

Collela, V. (2000).Participatory simulations: Building collaborative understanding through dynamic modeling. The Journal of the Learning Sciences 9: 471-500.

Committee on Prospering in Global Economy of the 21st Century (2006). Rising above the gathering storm: Energizing and employing America for a brighter economic future. Washington, DC: National Academies Press.

Crowley, K. & Jacobs, M. (2002). Islands of expertise and the development of family scientific literacy. In G. Leinhardt, K. Crowley, & K. Knutson, Eds., Learning conversations in museums. Mahwah, NJ: Lawrence Erlbaum, pp. 333-356.

Delpit, L. (1996). Other people's children: Cultural conflict in the classroom. New York: New Press.

Dickinson, D. K. & Neuman, S. B., Eds. (2006). Handbook of early literacy research: Volume 2. New York: Guilford Press.

diSessa, A. A. (2000). Changing minds: Computers, learning, and literacy. Cambridge, Mass.: MIT Press.

diSessa, A. A. (2004). Metarepresentation: Native competence and targets for instruction. Cognition and Instruction 22: 293-331.

Elman, J. (1991a). Distributed representations, simple recurrent networks and grammatical structure. Machine Learning 7: 195-225.

Elman, J. (1991b). Incremental learning, or the importance of starting small. Technical Report 9101, Center for Research in Language, University of California at San Diego.

Friedman, T (2005). The world is flat: A brief history of the twenty-first century. New York: Farrar, Straus and Giroux.

Galloway, A. R. (2006). Gaming: Essays on algorithmic culture. Minneapolis, MN: University of Minnesota Press.

Gardner, H. (1991). The unschooled mind: How children think and how schools should teach. New York: Basic Books.

GAPPS Group (2006). A productive approach to learning and media literacy through video games and simulations. Grant to the MacArthur Foundation. Madison: University of Wisconsin-Madison.

Gee, J. P. (1992). The social mind: Language, ideology, and social practice. New York: Bergin & Garvey.

Gee, J. P. (1996) Social linguistics and literacies: Ideology in Discourses. London: Taylor & Francis (First Edition, 1990).

Gee, J. P. (2001). Progressivism, critique, and socially situated minds. In C. Dudley-Marling & C. Edelsky, Eds., The fate of progressive language policies and practices. Urbana, IL: NCTE, pp. 31-58.

Gee, J. P. (2003). What video games have to teach us about learning and literacy. New York: Palgrave/Macmillan.

Gee, J. P. (2004). Situated language and learning: A Critique of traditional schooling. London: Routledge.

Gee, J. P. (2005). Why video games are good for your soul: Pleasure and learning. Melbourne: Common Ground.

Gee, J. P., Hull, G., & Lankshear, C. (1996). The new work order: Behind the language of the new capitalism. Boulder, CO.: Westview.

Gibson, J.J. (1979). The ecological approach to visual perception. Boston: Houghton Mifflin.

Glenberg, A. M. (1997). What is memory for. Behavioral and Brain Sciences 20: 1-55.

Glenberg, A. M. & Robertson, D. A. (1999). Indexical understanding of instructions. Discourse Processes 28: 1-26.

Greeno, J. G. (2006). Learning in activity. In R. K. Sawyer, Ed., The Cambridge handbook of the learning sciences. Cambridge: Cambridge University Press, pp. 79-96..

Hagel, J. and J.S. Brown (2005). The only sustainable edge: Why business strategy depends on productive friction and dynamic specialization. Boston, MA: Harvard Business School Press.

Halliday, M.A.K. (1985). An introduction to functional grammar. London: Edward Arnold.

Halverson, R. (September, 2005) What Can K-12 School Leaders Learn from Video Games and Gaming? Innovate 1.6 (http://www.innovateonline.info/index.php?view=article&id=81).

Hawkins, J. (2005). On intelligence. New York: Henry Holt.

Hutchins, E. (1995). Cognition in the wild. Cambridge, MA.: MIT Press.

Juul, J. (2005). Half-real: Video games between real rules and fictional worlds. Cambridge, MA: MIT Press.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why Minimal Guidance during Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching. Educational Psychologist 41: 75-86.

Kolodner, J. L. (1993). Case based reasoning. San Mateo, CA: Morgan Kaufmann Publishers.

Kolodner, J. L. (1997). Educational implications of analogy: A view from case-based reasoning. American Psychologist 52: 57-66.

Kolodner, J. L. (2006). Case-based reasoning. In R. K. Sawyer, Ed., The Cambridge handbook of the learning sciences. Cambridge: Cambridge University Press, pp. 225-242.

Kress, G. (2003). Literacy in the new media age. London: Routledge.

Kress G., Jewitt, C., Ogborn, J., & Tsatsarelis, C. (2001). Multimodal teaching and learning: The rhetorics of the science classroom. London: Continuum.

Kress, G. & Van Leeuwen, T. (2001). Multimodal discourse: The modes and media of contemporary communication. London: Arnold.

Kress, G. & Van Leeuwen, T. (2006). Reading images: The grammar of visual design. Second Edition. London: Routledge.

Labov, W. (1979). The logic of nonstandard English. In P. Giglioli, Ed., Language and social context. Middlesex, U.K.: Penguin Books, pp. 179-215.

Lave, J. (1996). Teaching, as learning, in practice. Mind, Culture, and Activity 3: 149-164.

Lave, J. & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. New York: Cambridge University Press.

Lehrer, R. & Schauble (2000). Modeling in mathematics and science. In R. Glaser, Ed., Advances in instructional psychology: Educational design and cognitive science. Vol. 5. Mahwah, NJ: Lawrence Erlbaum, pp. 101-159).

Lehrer, R. & Schauble, L. (2005). Developing modeling and argument in the elementary grades. In T. Romberg, T. P. Carpenter, & F. Dremock, Eds., Understanding mathematics and science matters. Mahwah, NJ: Lawrence Erlbaum, pp. 29-53.

Lehrer, R. & Schauble, L. (2006). Cultivating model-based reasoning in science education. In R. K. Sawyer, Ed., The Cambridge handbook of the learning sciences. Cambridge: Cambridge University Press, pp. 371-387.

National Science Board (2002). Science and engineering indicators--2002 *(NSB-02-01)*. Government Printing Office. Retrieved November 18, 2003 from http://www.nsf.gov/sbe/srs/seind02/start.htm: Washington, DC.

Nersessian, N. J. (2002). The cognitive basis of model-based reasoning in science. In P. Carruthers, S. Stich, & M. Siegal, Eds., The cognitive basis of science. Cambridge: Cambridge University Press, pp. 133-155.

Neuman, S. B. & Celano, D. (2006). The knowledge gap: Implications of leveling the playing field for low-income and middle-income children. Reading Research Quarterly 41.2: 176-201

Newell, A. and H. A. Simon. 1972. Human problem solving, Prentice-Hall, Inc., Englewood Cliffs NJ.

New London Group (1996). A pedagogy of multiliteracies: Designing social futures. Harvard Educational Review 66: 60-92.

Ochs, E., Gonzales, P. & Jacoby, S. (1996). "When I come down I'm in the domain state." In E. Ochs, E. Schegloff, & S. A. Thompson, Eds., Interaction and Grammar. Cambridge: Cambridge University Press, 328-369.

O'Conner, M. C. & Michaels, S. (1996). Shifting participant frameworks: Orchestrating thinking practices in group discussion. In D. Hicks, Ed., Discourse, learning, and schooling. Cambridge: Cambridge University Press, pp. 63-103.

Pinker, S. (1994). The language instinct: How the mind creates language. New York: William Marrow.

Rosebery, A. S., Warren, B., & Conant, F. R. (1992). Appropriating scientific discourse: Findings from language minority classrooms. Journal of the Learning Sciences 2: 61-94.

Sawyer, R. K. (2006). Analyzing collaborative discourse. In R. K. Sawyer, Ed., The Cambridge handbook of the learning sciences. Cambridge: Cambridge University Press, pp. 187-204.

Scardamalia, M. & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In R. K. Sawyer, Ed., The Cambridge handbook of the learning sciences. Cambridge: Cambridge University Press, pp. 97-115.

Schon, D.A. (1983). The reflective practitioner: How professionals think in action. New York: Basic Books.

Schon, D.A. (1987). Educating the reflective practitioner: Towards a new design for teaching and learning in the professions. San Francisco: Jossey-Bass.

Schleppegrell, M. (2004). Language of schooling: A functional linguistics perspective. Mahwah, NJ: Lawrence Erlbaum.

Senechal, M., Ouellette, G., and Rodney D. (2006). The misunderstood giant: Predictive role of early vocabulary to future reading. In Dickinson, D. K. & Neuman, S. B. Eds., Handbook of early literacy research: Volume 2. New York: Guilford Press, pp. 173-182.

Shaffer, D. W. (2004). Pedagogical praxis: The professions as models for post-industrial education. Teachers College Record 10: 1401-1421.

Shaffer, D. W. (2005). Epistemic games. Innovate 1.6 http://www.innovateonline.info/index.php?view=article&id=81.

Shaffer, D. W., & Gee, J. P. (2005). Before every child is left behind: How epistemic games can solve the coming crisis in education. Madison: University of Wisconsin-Madison,

Shaffer, D. W., Squire, K., Halverson, R., & Gee, J. P. (2005). Video Games and the Future of Learning. Phi Delta Kappan, 87.2: 104-111.

Schank, R. C. (1982). Dynamic memory. New York: Cambridge University Press.

Schank, R. C. (1999). Dynamic memory revisited. New York: Cambridge University Press.

Steinkuehler, C. A. (2006). Massively multiplayer online videogaming as participation in a Discourse. Mind, Culture, & Activity 13: 38-52.

Steinkuehler, C. A. (2005). Cognition & learning in massively multiplayer online games: A critical approach. Unpublished doctoral dissertation, University of Wisconsin-Madison.

Stewart, J., Passmore, C., Artier, J., Rudolph, J., & Donovan, S. (2005). Modeling for understanding in science education. In T. Romberg, T. Carpenter, and F. Dremock, Eds., Understanding mathematics and science matters. Mahwah, NJ: Lawrence Erlbaum, pp. 159-184.

Squire, K.D. (2005). Changing the game: What happens when videogames enter the classroom? Innovate 1.6 (http://www.innovateonline.info/index.php?view=article&id=81).

Squire, K. & Jenkins, H. (2004). Harnessing the power of games in education. Insight 3.1: 5-33.

Taylor, T. L. (2006). Play between worlds: Exploring online game culture. Cambridge, MA: MIT Press.

Toffler, A. & Toffler, H. (2006). Revolutionary wealth: How it will be created and how it will change our lives. New York: Knopf.

Tomasello, M. (1999). The cultural origins of human cognition. Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, Mass.: Harvard University Press.

Warschauer, M. (2007). Laptops and literacy: Learning in the wireless classroom. New York: Teachers College Press.

Wenger, E. (1998). Communities of practice: Learning, meaning, and identity. Cambridge: Cambridge University Press.

APPENDIX: SHORT STATEMENTS

TECHNOLOGIES TO UNDERSTAND AND TEACH COMPLEX PRACTICES

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Video game design stands as the logical successor to a central motive force in late 20th century sciences: the computer simulation. The capacity of the computer to simulate cognitive processes, Howard Gardner (1985) points out, gave rise to the "mind's new science" by allowing researchers to observe new dimensions of cognition and to model complex human processes. The capacity for computers to simulate complex phenomena provided a giant step beyond prior observational or experimental research because researchers could now test predictions about complex systems that could not be directly observed. Constructing simulations also forces designers to "operationalize" theories into a series of interactive rules that are intended to reflect the operation of the actual systems they represent. The performance of the simulation serves to test the initial assumptions built into the model, and, if effective, enables researchers to make predictions about the simulated phenomena.

Game design can serve as a method for teasing out the practical implications of research-based theories. This is hugely important for fields such as educational leadership that are regularly criticized for maintaining a theory-practice gap. The bulk of education leadership research seems to consist of case study descriptions of specific practices, prescriptions for interventions, or evaluations of intervention outcomes. Each of these kinds of knowledge require new (and veteran) practitioners to understand when, and under which circumstances, new ideas can be appropriately deployed. Halverson (2004) describes this capacity to fit ideas to circumstances as a form of *practical wisdom* that evades many current models of educational research. Developing video games for learning will force designers to operationalize assumptions about best practices into a game model, to test models against the observations and game play of experienced professionals, and to develop new, more nuanced theories of how school leaders actually engage in complex practices such as instructional improvement in schools. This knowledge generation, often simply folded into the design process, can be highlighted as a method for tracking how practical wisdom is expressed in complex learning environments. Thus, just as Howard Gardner and others built computer simulations to research cognition, video game development promises to provide an important new venue for research on practice.

While video game design promises a new path of research *on* practice, video game play is a form of research *for* practice that addresses a critical gap in professional preparation programs such as school leadership. The traditional menu of classroom learning, seminars and practica served by education leadership programs provide inadequate training for many school leaders (Levine, 2005). Students learn about cases, theories and heuristics in courses and seminars, and learn to navigate specific school environments in practica, but often are unable to make a principled connection between theories and practice. Video games build on a long tradition of tools used by leadership preparation programs to address this gap, from role playing activities, to problem and case-based learning activities (Bridges and Hallinger, 1995; Merseth, 1997) to board games (*Making Change,* 1989) to computer simulations (Hallinger & McCary 1990). Video games such as *School Tycoon, Virtual U* and *In the Center of Things* provide early models for players to practice generic management skills in experimenting with the infrastructural, financial, and personnel systems in K-12 and post-secondary schools.

Thus video games provide new opportunities to conduct research *on* and *for* practice. In other words, video game design can contribute to educational research's age old theory-practice divide. We argue that the advent of real time strategy and role-playing video games can create dynamic learning environments for creating, testing and using practical theories of action (see Shaffer et.al, 2005; Castronova, 2005). The capacity to contextualize the practice of school leadership through video games fills a real void in training school leaders to become successful practitioners. As a result of our participations in the Spencer conversations, we propose to create an example of a game for professional learning through designing a web-based video-game that will help leaders develop, adapt and test practical theories for identifying and supporting classroom teaching practice. Our design research questions address the two emphases of the game development process: *knowledge generation* and *learning assessment*:

1) How can the design of video game-based learning environments generate new practical knowledge about developing the organizational conditions for improving student learning?
2) What do novice and veteran school leaders learn from engaging with video game-based learning environments for teacher evaluation?

We will focus our game development project on the practices of teacher evaluation. Reform-based teacher evaluation practices present an interesting challenge for school instructional leaders. While teacher evaluation programs promise the ability to access, monitor and correct teaching practices in context, without clear, legitimate access to how reformed teaching practices play out in classroom teaching, it is very difficult to provide the support necessary to help teachers learn new practices. Teacher evaluation has experienced a recent standards-based renaissance. More and more, districts have adopted standards-based teacher evaluation frameworks that integrate prior research on expert teacher practice, content knowledge, pedagogical knowledge, classroom management and assessment skills (e.g. Danielson, 1996; Danielson & McGreal, 2000). Still, school leaders and evaluators must know how to use evaluation frameworks in the context of typical school and classroom settings.

While we would not argue that evaluation practices can be essentially reduced to how evaluators fit classroom observation evidence to general observation frameworks, we would suggest that a lack of knowledge about how to select proper evidence and communicate effectively with teachers can reduce evaluation from an instructional to a political process (Halverson, Kelley & Kimball, 2003). Research that details the practices evaluators actually use to engage in standards-based evaluation practices (e.g. Halverson & Clifford, in press) demonstrates how evaluators customize rubrics to filter observation data and assemble reports, and shows how leaders use evaluation as a process to build faculty good will rather than critique. Game design will operationalize the practical and theoretical assumptions about teaching built into standards-based evaluation frameworks, and will construct learning environments to guide players through the process of observation, assessment and follow-up conversation that constitute the evaluation cycle. Video-game play will show how to engage in research *for* practice by allowing aspiring school leaders to practice with new identities, strategies and schools in this game-based interactive learning environments for teacher evaluation.

REFERENCES

Bridges, E.M. and Hallinger, P. (1995) "Implementing problem-based learning in leadership development." Eugene, OR: ERIC Clearinghouse on Educational Management, University of Oregon.

Castronova, E. (2005) *Synthetic worlds: The business and culture of online gaming*. University of Chicago Press.

Gardner, H. (1985). *The mind's new science: A history of the cognitive revolution.* New York: Basic Books.

Danielson, C. (1996). *Enhancing professional practice: A framework for teaching*. Alexandria, VA: Association for Supervision and Curriculum Development.

Danielson, C., & McGreal, T. L. (2000). *Teacher evaluation to enhance professional practice*. Alexandria, VA: Association for Supervision and Curriculum.

Hallinger, P., & McCary, C. E. (1990). Developing the strategic thinking of instructional leaders. *Elementary School Journal (91)* 2 89-108.

Halverson, R. (2004). Accessing, documenting and communicating the phronesis of school leadership practice. American Journal of Education, 111(1), 90-122.

Halverson, R., and Clifford, M. (in press) Evaluation in the wild: A distributed cognition perspective on teacher assessment. *Education Administration Quarterly.* August 2006.

Halverson, R., Kelley, C. & Kimball, S. (2004) Implementing teacher evaluation systems: How principals make sense of complex artifacts to shape local instructional practice." in C. Miskel (Ed.) Theory *and Research in Educational Administration*, *Volume 3*.

Levine, A. (2005) Educating School Leaders. New York: The Education Schools Project. New York: Wallace Foundation. Retrieved March 6, 2006, from http://www.edschools.org/reports_leaders.htm.

Making Change for School Improvement: A Simulation Game (1989). The Network, Inc. Information retrieved on-line 5/22/06 at http://www.wested.org/cs/li/view/rs/108.

Merseth, K. K. (1997). *Case studies in educational administration*. New York: Longman.

Shaffer, D., Gee, J., Halverson, R., & Squire, K. (2005) "Video-games and the future of learning" *Phi Delta Kappan. 87*(2). 104-111.

GIRLS, GAMING, AND TRAJECTORIES OF IT EXPERTISE

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An interesting contradiction exists in the burgeoning literature on young people's use of new information technologies (IT), including gaming and game modding. On the one hand are celebratory descriptions of sophisticated young "power users" whose expertise seems to rival that of most adults. On the other hand, such young people's sophistication contrasts sharply with the growing concern about individual's and society's ability to meet the technological demands of a global information society (Friedman, 2005). There is continued evidence of a digital divide among young people, not only in terms of access to technologies but also in how they use various technologies, particularly in ways that will contribute to their success in school and the workplace (Becker, 2000). Clearly, while some young people have access to experiences, resources, communities – in, and increasingly, out of school - that support such expertise, many others do not. Certain social groups are particularly affected by these disparities, including socio-economically disadvantaged youth and young women. The role of gender in shaping young people's potential technological practices holds particular interest since it affects even young women of relatively affluent backgrounds. Girls and young women are clearly not technophobic, and they engage in certain technology related practices, such as use of the internet, at comparable rates as men (Girl Scout Research Institute, 2001; Lenhart & Madden, 2005). However, there is an ongoing gap between the degree of technology use among young girls and their subsequent adult educational and career choices related to technology. For example, women are vastly underrepresented as students in academic subject areas such as computer science, and in occupations associated with science, engineering, and technology (National Center for Women and Information Technology, 2005).

While a variety of young people's popular media practices may serve as entry points for the acquisition of tech-savvy identities and knowledge, gaming seems to offer some particularly powerful affordances for IT-related learning. The vast majority of elementary school age children, male and female, now have some gaming experience, and gaming may be the first introduction to digital technologies for both sexes. However, patterns of game play vary considerably over time for girls and boys. While girls now play games in increasing numbers, they spend less time playing games (Roberts et al., 2005) and they play different kinds of games, both factors that likely influence their motivation and opportunity to engage in IT-based practices associated with gaming. In addition, girls desert much of their interest in gaming during middle school, when they are pressured to fit certain stereotypes about women and romance (c.f. Hayes, 2005a; 2005b; Roberts et. al., 2005). Alternatively, gaming seems to be a particularly significant source of productive computer experience for boys (Keersten, Linn, Clancey, & Hardyck, 1998; Taylor & Mounfield, 1994). For example, playing and modding computer games are often reported as a trigger for boys' continuing interest in computer science (Tillberg & Cohoon, 2005).

Simply involving more girls in gaming, for example by developing educational and commercial games that appeal to "female sensibilities" has been proposed as one way to address this disparity. However, such efforts are likely to be ineffective (and we have some evidence that they are ineffective) without a better understanding of not only particular features of games, but also how the communities and practices associated with them offer affordances for developing domains of IT expertise. The crucial issue is not differentiating female or male play styles, or designing girl games (though designing games that girls want to play is of course important, and designing games as an activity itself contributes to certain aspects of IT expertise). We need to identify the valued skills and practices associated with IT expertise, how learning these skills and practices can be initiated and scaffolded through gaming and gaming communities, and find ways to provide girls (and more boys) with opportunities to engage with these games and participate in these communities.

Our new conceptualizations of gaming literacy and media literacy require a rethinking of dominant ways of understanding IT expertise. Currently the most expansive framework is the National Research Council (NRC)'s (1999) definition of "technological fluency," which includes three domains: intellectual capabilities, domain-general information technology concepts, and contemporary information technology skills. However, the NRC's concepts of "collaboration" and "communication" do not sufficiently reflect the social dimension of IT expertise; we need to add a fourth domain, "social practices," to represent the ability to participate in new forms of community and social interactions made possible by digital technologies. Key to engagement in such communities is the acquisition of specialist language, a fifth domain that seems to have been backgrounded in the shift from computer literacy to IT fluency. The ability to learn the specialist language of IT is crucial not only for learning new concepts, but also for communicating with others and for being recognized as a legitimate member of IT-mediated communities (Gee, 2004). Also necessary is an understanding of how language is used when mediated by particular technologies; i.e., IM, email, live chat, as well as in particular contexts, such as forums, blogs, or websites. Lastly, the NRC framework still seems to be informed primarily by a vision of the individual as a consumer of information, rather than as a producer of multiple forms of digital media. Being a producer with and of digital media requires capabilities beyond those outlined in the NRC framework. Design knowledge is central to production. Design knowledge requires a good understanding of relevant technologies, but it also requires identification of design problems, the ability to manipulate many kinds of information, an understanding of the users, or audience for the design (as manifested in a website, a video clip, a new game level, and so forth), a sense of artistry or aesthetics, and the ability to critically evaluate alternative designs (Lawson, 2004). In the context of new technologies, design knowledge also includes the ability to integrate multiple forms of representation (graphics, sound, text, motion) as well as to master the "design grammar" by which messages are produced and effects achieved in a particular medium (Gee, 2003, 2004; New London Group, 1996).

So why might *games* be particularly powerful starting points for trajectories of IT expertise? At first glance, games might seem to be a rather unlikely source of IT expertise after all. While many games now offer in-game tools that enable gamers to personalize avatars or create customized game scenarios, gaming itself doesn't require much algorithmic thinking, programming, or even mastery of presumably important applications like spreadsheets or email. What games (at least good ones) do offer, and what may be most significant, are incredibly immersive, rich, challenging and emotionally charged experiences, along with the ability to take on new and compelling identities. These experiences are what can prompt gamers' desire to document their gaming through screenshots, machinima, and story-telling; to extend gameplay through creating new levels and scenarios, to further improve on their gameplay by modding everything from interface designs to the eye color of an avatar, and to enhance the visual effects of the game by figuring out how to install the latest graphics card. These experiences are also what prompt gamers to participate in gaming communities, to seek and offer assistance, and share accomplishments and mods, which also supports their development of specialist language, the ability to leverage distributed expertise, and so forth.

This suggests the importance of understanding IT learning as the increasing ability to participate in valued practices as recognized members of IT-related communities or groups. In terms of gaming and gender, such a perspective highlights the centrality of identity, that is, how multiple and potentially conflicting social identities play out in girls' and boys' opportunities and motivation to engage in game and IT-related practices (Hayes, 2005a; 2005b). Thus, IT learning via gaming is tied not just to the affordances of particular game-based technologies (though these are crucial) but also to access to particular social practices, communities, identities and meanings associated with those technologies.

Overall, we need a better understanding of why some young people might find such gaming communities to be supportive and motivating, while others, particularly girls, might feel excluded and deterred. More specifically, we need to identify (1) features of games that serve as starting points for IT expertise, (2) the features of gaming communities that support such learning, and (3) how educators as well as other adults might create more intentional, designed gaming environments and experiences that can be a starting point for developing tech-savvy girls as well as boys.

REFERENCES

Becker, H.J. (2000). Who's wired and who's not: Children's access to and use of computer technology. *Children and Computer Technology*, *10*(2), 44-75.

Friedman, T. (2005). *The world is flat: A brief history of the twenty-first century*. New York: Farrar, Straus and Giroux.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. New York: Palgrave/Macmillan.

Gee, J. P. (2004). *Situated language and learning: A critique of traditional schooling*. London: Routledge.

Girl Scout Research Institute (2001). *The girl difference: Short-circuiting the myth of the technophobic girl.* New York: Girl Scouts of the USA.

Hayes, E. (2005a). *Gendered identities at play*. Paper presented at the Games, Learning, & Society Conference, Madison, WI, June 23-24.

Hayes, E. (2005b). Women, video gaming, & learning: Beyond stereotypes. *TechTrends*, 49(5), 23-28.

Kersteen, Z., Linn, M., Clancy, M., & Hardyck, C. (1998). Previous experience and the learning of computer programming: The computer helps those who help themselves. *Journal of Educational Computing Research*, *4*, 321-333.

Lawson, B. (2004). *What designers know*. Oxford: The Architectural Press, LTD

Lenhart, A. & Madden, M. (2005). *Teen content creators and consumers*. Washington, DC: Pew Internet & American Life Project.

National Center for Women and Information Technology (2005). *Women and information technology: By the numbers*. Washington, DC: Author.

National Research Council (NRC). (1999). *Being fluent with information technology*. Washington, DC: National Academy Press.

New London Group (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard University Press*, *66*(1), 60-92.

Roberts, D. F., Foehr, U.G., Rideout, V. (2005). *Generation M: Media in the lives of 8-18 year olds*. Menlo Park, CA: Kaiser Family Foundation Study.

Taylor, H. G., & Mounfield, L. C. (1994). Exploration of the relationship between prior computing experience and gender on success in college computer science. *Journal of Educational Computing Research*, *11*, 291-306

Tillberg, H. K. & Cohoon, J. M.. (2005). Attracting women to the CS major. *Frontiers: A Journal of Women Studies, 26*(1), 126-140

CIVILIZATION, HISTORY, AND MODELING

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For many kids, their first exposure to ancient History isn't through a book or even television, but through *models and simulations* where they *are* the leaders of ancient Egypt, Greece, or Rome. Yet, we know little about the interpretations people build on these experiences or how they use them to understand history (Squire, 2002; in press). Does playing Civilization lead to particular beliefs about politics or history? Do players come to understand the geographical / materialist political model behind the game, and if they do, do they use it as a tool to think about history with? Are kids raised with such games advantaged over those who aren't? The implicit challenge to educators might be summarized by Malcolm, a student quoted on video at the 2004 serious games conference: Why should I read about Rome in school when I've already built it at home?

Over the past five years, I have been investigating the potential of the *Civilization* series to help kids learn world history while also learning about scientific modeling and game design. This research started out of a simple observation: I, and many people I know my age, learned most of what I know about world history from playing *Civilization*. Might this game be used as the basis of a world history, particularly for those kids who enjoy gaming, but are turned off to school?

Working with teachers, I developed custom game scenarios and activities for *Civilization III,* designed to be used in world history classrooms. Building on Jared Diamond's Pulitzer Prize winning *Guns, Germs, & Steel*, I built a curriculum challenging kids to ask: Why did human history unfold differently on different continents for the last 13,000 years? Why, when Europeans met Native Americans, did Europeans have guns, large boats, and more sophisticated technologies than those from North America?

The scenario allowed kids to examine these questions by playing as Native American tribes (woodland Indians, Aztecs, or Incans), sub-Saharan African tribes, Asian civilizations (Chinese, Mongols, Indians), Northern European tribes (Celts, Russians, or Germanic Tribes) or as the ancient civilizations they study in school: Babylonians, Egyptians, Romans, Persians, and Greeks.

After examining dozens of games, the class developed some answers, answers that differed from the story of "Western expansion" that they were taught at school. First, playing in the Middle East was difficult. Every few hundred of years, someone – whether it be the Egyptians, Romans, Greeks, or Persians sought to either expand into the region or use it to cross from Europe to Asia. In every game, the European-Asian global trade networks developed more technologies, shared more natural resources, and reached the industrial era far more quickly than other continents. Native civilizations flourished, but it was clear that a few civilizations – that lacked horses and opportunities to develop key technologies could not compete with 5000 years of global trade.

By the end of the unit, students became interested in historical hypotheticals: Under what circumstances *could* history have been reversed? They developed many intriguing approaches – including uniting Sub-Saharan African, colonizing South America, and building a Native American trade network with China. They were using the game as a *model* for investigating historical questions. Some wanted to know where cities grew the quickest. Others wanted to explore the consequences of isolationist policies vs. engaging in trade networks. Teachers helped kids build interpretations of their actions (such as drawing attention to their isolationist policies) and drew comparisons between the kids' games and history. For example:

Dwayne: (I learned that) unifying Africa made us powerful…. Politics and geography. I got all of these resources then I could trade them with other countries. So it made my politics stronger.

Tony:	It makes more production. Everyone can work faster and more efficiently.
Teacher:	(Leading the activity, organizing reflection comments based on what they learned) Where should we put that?
Tony:	Well, in some ways, they're all related to each other. (General nodding)
Teacher:	That could be one thing we learned. How would you write that?
Tony:	Well, money is the key… money is the root to everything. With money you can save yourself from war, and that also means that politics…with money, that ties everything together. Luxuries buys you money and money buys you everything. The right location gives you luxuries gives you income. More income gives you technology which affects your politics. It all connects.
Kent:	Geography affects your diplomacy because it gets your more resources and affects how they treat you.
Tony:	Geography can affect the growth of your civilization.
Dwayne:	It affects your war.

This passage suggests how the game becomes a model that kids use to think with. Tony makes links between experiences in his games (that money opened opportunities) and the game model (geography determines your access to resources).

In closing interviews, students showed increased knowledge in history, geography, and politics. As one student put it, if you can't find Rome on a map you're going to lose. If you don't understand the significance of feudalism and knights in the middle ages you will lose. One interesting feature of game-based approaches (as a post-progressive pedagogy) is that they produce – indeed require deep *expertise* (Squire, in press b). Because expertise in Civilization has ties to school-based expertise, it means that students can develop affiliations with school – as well as affiliation to groups and social practices beyond school. In short, they developed identities as learners who could understand history, but also identities as expert game players and possibly even designers, affiliations that could be at least as helpful as those operating in school.

Over the past few years, I've been working with colleagues to build after school centers for underprivileged kids to investigate the potential of such a program to develop 21st literacy skills around game modding and development. Through playing the game, not only will kids develop an interest in history (and perhaps school), but also begin using the game design software that comes packaged with the game to design their own game scenarios. We are especially interested in giving under privileged teens access to the resources, opportunities, and critically *social practices* that their middle class and more educated peers are getting at home. In short, we're building *centers of expertise* that seek to spawn the kinds of productive learning exchanges described by Crowley and Jacobs (2002).

Over the past year and half we have been iteratively designing and researching such a learning program at an after school center for at risk middle school students. The students we work with entered with a very consumerist (as opposed to producer or designer) orientation to media as evidenced in the following exchange.

Interviewer:	Would you like to learn how to do game design?
Malcolm:	No, it's too hard.
Monroe:	No, that's not something I could do.

When we tried to introduce Civilization, most of these students found the game initially too difficult and complex. Most also had little interest in school.

Interviewer:	Do you like school?
Jason:	I don't really like school, unless there's something fun going on, that's the only time there's actually something to do. You just sit there going (puts hand on head as if to sleep). That's all you ever do really…. Social studies can be fun depending on what you're doing. Last year we made a mountain out of graham crackers and we made it stuck together out of frosting and in the end we got to eat it.

Compare this reaction to those of Malcolm, quoted in the introduction. Whereas Malcolm is engaging in sophisticated gaming practices at home, practices that threaten to make school irrelevant, these students do not have access to such practices – and don't see themselves as the kind of people who could engage in them. These students *also* find school irrelevant, but have no outlets for productive development as people. Perhaps it is no wonder that lower income boys continue to struggle in schools, primarily for social reasons (Jacob, 2002; Kleinfeld, 1997)

Our approach has been to provide a thematic series of historical games designed to leverage students' interest in video games and lead toward developing productive identities as media *producers* so that they develop knowledge, skills and identities that will enable them to participate more fully in 21st century society. These games simply so that students can begin playing even before they enter middle school (our youngest participant is 8, average age is 12). They tie to content areas covered in school (ancient civilizations) but also are designed to extend their interest and skills into the realm of undergraduate world history.

Working and playing with these kids over the past year, we have observed a trajectory by which they come in as (1) reticent (even fearful) beginners, (2) achieve basic competency with the game, (3) develop mastery over the game vocabulary, concepts, and systems, and (4) begin identifying exploits in the system, weaknesses or superior strategies to take advantage of the games' properties. This understanding, which we call systemic understanding, is characteristic of *Civilization* (and indeed good game players), and we see as a primary benefit to the program. As described in the Spencer report, it is a kind of thinking that requires identifying patterns and relationships among multiple variables and then *actively engaging with the system* to think from inside of it and understand its nuances. Because Civilization is a model of world history, it's an especially productive site for studying gamer cognition.

Indeed, this ability to think within systems – something Gee (2004) has called embodied empathy, may be an excellent starting spot to thinking about the design of educational games (e.g. What systems do you want students to have a deep understanding of), as opposed to traditional educational games, that think in terms of content. These can be *targeted* games that go for specific conceptual understanding, such as our game Supercharged, which was designed to give kids a conceptual model of electromagnetism (c.f. Squire, Barnett, Higgenbotham, & Grant, 2004) or bigger systems such as regional watersheds (Squire & Jan, forthcoming).

Such games have value in and of themselves, but we believe a critical skill for tomorrow's learners will be to manipulate such systems even more directly and deeply. To investigate the potential of such a program, we have been introducing game modding and production tools into our program. We've found that even kids "who don't think they can design games" will do so, when design activities are introduced as a natural extension of game play. As discussed in the Spencer report, game play is on some level a productive stance to media, whereby gamers are manipulating systems in order to achieve outcomes. Introducing the mechanisms to manipulate the system more directly (e.g. change variables) right when learners are ready (indeed hungry) for it can lead them into game design practices.

Knowing how (and when) to introduce such practices has become the most important role of mentors in our program. Adults' roles have been to identify kids' emerging interests (particular areas of history, or designing games for friends), opening up the editor to show them how they might create their own games, and then providing just-in-time instruction on how to create games. The following exchange with Jason captures the thinking of one student knee deep in this iterative process of gaming, design, and studying history.

Interviewer: Who are you playing as today?
Jason: Scandinavia like always…Because I get berserkers … I put them on the galleys and any cities close to the shore, I can just go off and use them to attack whoever is in the city...
Interviewer: So do you think that is like the real Vikings?
Jason: Actually it is because the berserks would take this stuff which they made called wolf-bane…. like with Ivan the Boneless, which is my name in the game.
Interviewer: Where did you learn this?
Jason: It's from a book I'm reading. It's a fantasy, but all the land and stuff is just like real Europe. They have Iceland on the map, and the long ships.
Interviewer: So have you read about this at school at all?
Jason: No…
Interviewer: So what do you think about that historically? Were the Vikings sort of isolated, were they on an island?

Jason: Well, Vikings were up in the Netherlands, but then they also controlled Iceland and the northern tip of the United Kingdom. They were kind of isolated, and if you saw them in battle or if they came to your town you were very unlucky because—well you were kind of lucky and kind of unlucky because they don't really attack a lot. If they are sailing, they were go to different islands, and if there are no people there, they will leave guys there to start building up cities. Then they'll just have more people come to the city. They'll just keep on taking over the land. If there is a village in their way, they will destroy the village.

Here, we see Jason's emerging interest in gaming, history, and game modeling coming together. What started as an interest in game play (developing an early lead in naval and military technologies) led to an interest in the Scandinavians, including the geography of Europe (an exploit of sorts). This led to an emerging interest in history, and he now checks out books from the library and is reading on his own.

A key to this productive practice is that Jason is developing a particular form of *expertise* that is valued in this community. Each of the kids in this camp has developed a unique set of strategies and interests. Some are interested in ancient Rome and wonders of the world, while others are interested in politics and negotiation. A key feature of educational systems built for a knowledge economy will likely be that they need to not just accommodate, but *produce* students with deep, specialized expertise that goes far beyond what any one person (i.e. teacher) in the class can provide.

For those students who do, the potential of a game like Civilization to support productive expression is extensive. Monroe, another student in our program typifies what we think the potential for this pedagogy. Having played through our scenarios, Monroe developed an interest in how the game might be used for historical modeling. He has produced two scenarios: (1) depicting current geopolitical climate as it pertains to the war in Iraq and (2) an American revolutionary war scenario. He researched and built these entirely on his own, using resources found on Civilization fan sites, the CIA factbook website, and others sites on the web. At the end of the school year, we found a homework assignment in Monroe's bag in which Monroe's teacher asked to write a list of "10 things he wants to learn next year in school." All 10 related to Civilization. They ranged from "How could you model the entire world with 12 civilizations" to "Could you improve how *Civilization III* models religion?". This exchange exemplifies the kind of impact that Civilization playing had on Monroe.

Monroe: This whole game has changed my life. Yep.
Facilitator: This Rome scenario or CIV?

Monroe: I mean like the game, ever since I played it.
Facilitator: How has it changed your life?
Monroe: Well like, most of the other videos games are boring, but this isn't.
Facilitator: And this one isn't?
Monroe: Yeah, and my family plays it.
Sid (brother): No they don't.
Monroe: Mom and dad want to, my mom does.
(later that day)
Monroe: I want to become a Senator some day.
Interviewer: Is that from playing this game?
Monroe: Pretty much.

Monroe has recruited his brother (who is 8) to the program, as well as his sister. He has bought the game for home, and is lobbying his parents to buy him his own computer to play (the game can now be played on a $50 computer). We have hired Monroe to run next year's program, and he has established himself as a leader in the after school site more generally. For Monroe, playing Civ is a key part of his identity and perhaps most critically, he sees as leading him to new productive identities in the world.

While there is a temptation to look at the potential of educational games to "deliver content" or even to fit within today's educational system, I believe that seriously looking at this media (as representative of the digital age) and understanding not just its potential, but its implications for education means rethinking core assumptions about learning and schools. Whereas schools have been constructed around teacher (or nationally) driven standards, the modern age not only allows kids to explore topics and develop substantial expertise on their own, but it requires it. Schools need to prepare Monroe and Jason for jobs that don't even exist today. We see our clubs functioning as places where students pick up not just academic content or design skills, but as sites for providing trajectories into new kinds of identities. Our ultimate goal is that as our participants become leaders and co-producers of the club itself, they will learn to design their own social systems whereby they can learn the skills they need to succeed in the future as well.

REFERENCES

Crowley, K. & Jacobs, M. (2002). Building islands of expertise in everyday family activity. In G. Leinhardt, K. Crowley, & K. Knutson (Eds.), *Learning conversations in museums* (pp. 333–356). Mahwah, NJ: Lawrence Erlbaum Associates.

Gee, J. G. (2004). Video games: Embodied empathy for complex systems. Presentation made at the Education Arcade, LA, CA, 2004. http://labweb.education.wisc.edu/room130/PDFs/E3Paper.doc

Jacob, B. (2002). Where the boys aren't: Non-cognitive skills, returns to school and the gender gap in higher education" (May 2002). NBER Working Paper No. W8964.

Kleinfeld, J. (1997). None dare call it a problem: Male underachievement. *The Women's Freedom Network Newsletter*, *4*(1), 6.

Squire, K.D. (2002). Rethinking the role of games in Education. *Game Studies, 2(1).* (http://gamestudies.org/0201/Squire/).

Squire, K. D. (2003). Video games in education. *International Journal of Intelligent Simulations and Gaming (2)* 1.

Barnett, M. Squire, K. Higgenbotham, T. & Grant, J. (2004). Electromagnetism Supercharged! Paper published in the *proceedings of the 2004 International Conference of the Learning Sciences*. Los Angeles: UCLA Press.

Squire, K.D. (in press a). Games as designed experiences. To appear in *Educational Researcher*.

Squire, K.D. (in press b). Video game literacy: A literacy of expertise. To appear in D. Leu, J. Coiro, C. Lankshear, & M. Knobel (Eds.), *Handbook of Research on New Literacies*. Mahwah, NJ: Erlbaum.

EPISTEMIC GAMES: ONE APPROACH TO THE ISSUES, PERILS, AND POTENTIALS OF COMPUTER GAMES

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Games and Learning: Issues, Perils, and Potentials: A Report to the Spencer Foundation describes agenda for theory and research in the emerging field of games and learning. This addendum describes an approach to designing games for learning that exemplifies the agenda described in the report: the development of *epistemic games*.

Epistemic games are computer role playing games based on the professions. In these games, players become novice professionals-in-training to learn what it means to think like a professional: to ask questions, solve problems, and explain and justify answers the way people solve problems in the real world.

Such games have been described elsewhere, and over a decade of research, including controlled studies, have shown that epistemic games can be a productive approach to the development of games for learning (Halverson 2005; Shaffer 2005a, 2007; Shaffer & Gee 2005; Shaffer et al. 2005; Squire & Jan (2005); Zibit & Gibson 2005). This addendum describes how epistemic games provide a systematic approach to addressing the issues, perils, and potentials identified in the Spencer Foundation report.

Epistemic Games

Studies have shown that many children who can pass tests in school cannot actually apply their knowledge to the real world (Gardner 1991; McDermott 1998). Epistemic games address this problem by helping students learn not just to pass tests, but to be able to solve problems in the real world, even to be able to transform that world.

What epistemic games ask us to consider is this: Take a profession—say architecture, or journalism, or engineering, or urban planning, or even video game design—and consider the following facts. First, people in these professions know how to use skills—reading, writing, design, communication, research and other school-based skills—to solve real problems. Second, they know how to educate—to apprentice—their new members. Each profession owns and operates a tool kit of knowledge, skills, and values—*epistemic frame*—that it uses to look at and act on the world in a distinctive way. If you want to look at and act on the world in that way, you have to master the tool kit (Shaffer 2005a, 2007).

If we can entice kids to role-play such professions, will get school-based skills and learn to think about real problems in innovative ways. In epistemic games, players take on the identity or role of a professional. They produce the products professionals produce—products they can produce thanks to new digital technologies. And in the process they take ownership of knowledge.

These games are not just virtual worlds, like the game SimCity. In these games players go back and forth between the virtual world and the real world as they play. When they redesign a city as urban planners, it is their city. They can walk the streets of their town in both real space and in virtual world. When they write news reports as journalists, they are stories about the world around them. They walk the walk and talk the talk; they master the tool kit and, research shows, come to see the real world in a new way (Shaffer 2005a, 2007).

In epistemic games, players learn to care about the kind of problems that face doctors, lawyers, architects, engineers, journalists, and other professionals, and to develop the skills, knowledge, and ways of thinking that are used to solve such problems. These tool kits are replete with school-based knowledge and skills and, in almost every case today, replete with technical skills and technological devices. You cannot play these professional games without using basic skills, facts, and information: the content of school tests. That means hard work, and a lot of it. These games are rigorous, because the professions demand rigorous thinking. There are high standards, and rightly so, because by definition a professional works in situations that require judgment and autonomy—and thus trust. But games based on the training of professionals—high standards, hard work, and all—are also fun.

They are fun for two reasons. First, part of the fun of any game is playing by the rules, and the rules of many games are even more complex and demanding than the norms and practices of a profession. The rules of many games children like are extremely complex—and, of course, many games require a lot of hard work. In fact, all of the best ones do.

But more than that, adolescents in middle and high school are fascinated by efficacy: the things they can do in the world and the sense of their own power that comes from being able to make things happen (Csikszentmihalyi & Larson 1984; Csikszentmihalyi & Schneider 2000; Kegan 1982) An epistemic game gives players a chance to see how the world—or at least some piece of the world—works. It gives players a chance to experience their own efficacy in the face of complex problems by showing them what it is like to be one of the people who makes decisions that shape the world around them. In these games the focus is on solving problems by using the tool kit of a professional role which you think is "cool" and definitely worth inhabiting—games that you want to play because you want your shot at re-planning your downtown, facing an emergency like Katrina, or straightening people out on the science behind cloning.

Epistemic games are thus a potentially important part of children's development. To do good work you have to care about what you are doing (Davenport 2005). In most professions caring about what you are doing means stepping outside yourself and seeing things as others see them: stakeholders, the public at large, or some specific client. It means shifting focus away from what is interesting to you and toward what matters to others—the kind of de-centering is an essential part of growing up (Kroger 2007; Pajares & Urdan 2006). Epistemic games thus fulfill basic needs that young people have in a way that lets them express their desire to make things happen in a positive and constructive way.

To be clear: these games are not about becoming professionals. The goal of epistemic games is not to train players to be doctors, nurses, therapists, lawyers, architects, graphic designers, engineers, negotiators, debaters, urban planners, business leaders, plumbers, carpenters, contractors, or any of a host of socially valued and socially valuable professions. Rather, by playing a game based on the things professionals do in training, players can learn to think in valuable ways, and to care about a wide range of complex and important problems and situations.

Issues, Perils, and Potentials

Epistemic games thus provide a systematic approach to developing games for learning. They are, as the Spencer report suggests, games that can engage players with deep and fruitful forms of learning in a highly motivating context. Players of epistemic games become "literate" in the tools and practices of different professions, learning to be critical consumers and productive producers as part of the play.

Our studies show that epistemic games can help address the equity gap in gaming literacy by giving a productive stance toward design and a tech-savvy identity to players from a range of socioeconomic backgrounds and with different levels of previous experience with games and technology. These games address the traditional literacy gap by providing players with language that is technical, specialized and academic—the sort of language that is tied to learning content in school. Moreover, they address the problem of rote content by giving players situated understanding of ideas in context. Epistemic games are based on making and applying knowledge. Instead of learning facts, information, and theories first and then trying to apply them, the facts, information, and theories are learned and remembered because they were needed to play the game—that is, to solve some real world problem—in the first place (Shaffer 2005a, 2007).

Epistemic games are built on contemporary research in the Learning Sciences, which shows that learning always involves becoming part of some community of people. When people become part a community, they start to think and act in particular ways. They develop the skills of the community. They start to care about things that matter to the community. They start to see themselves as members of the community. They start to think about things in ways that other members of the community do. All of this is only to say that a community has a culture, and becoming a member of the community means developing that culture's ways of doing things, of valuing things, and of knowing things (Rohde & Shaffer 2004).

A community's distinctive ways of doing, valuing, and knowing is it's epistemic frame (Shaffer 2005a). An epistemic frame is "epistemic"—it is a particular way of thinking about the world, of making decisions and deciding what matters—and it "frames" the way someone thinks about the world—like putting on a pair of colored glasses. For example, lawyers act like lawyers, identify themselves as lawyers, are care about legal issues, and know about the law. These skills, affiliations, values, and understandings are made possible by looking at the world in a particular way. Acting and talking and reading and writing like a lawyer are made possible by thinking like a lawyer.

The epistemic frame of a profession is built through professional training. In most professions, the focus of this training is on having trainees work in a supervised setting and talk about what they do with other trainees and with mentors. By doing and then thinking about what they did over and over again in this supervised way, trainees learn to tie skills—the "right way of acting"—to knowledge and values—the "right ways of understanding." In the process, the trainee develops the "right way of thinking": the epistemic frame of his or her chosen profession.

Doctors know how to create more doctors; lawyers know how to create more lawyers; and the same is true for a host of other socially and economically important epistemic frames of innovation. Epistemic games use new technologies to let students learn to innovate by participating in simulations of the supervised settings of professional training (Shaffer 2004, 2005b, in press; Shaffer et al. in press).

Because they are based on learning practices that have already been shown to be effective, epistemic games take advantage of many of the features that make any game a good game:

- They offer identities that trigger a deep investment on the part of the player.
- They provide a sequence of well-ordered problems, in which early problems are designed to lead players to form hypotheses about how to proceed when they face harder problems later on.
- They give feedback in such a way that the game is challenging but doable, in the same way that professional training does.
- They are fundamentally built around the cycle of expertise, because they are based on the way expertise is actually developed in the real world.
- They are *deep* and *fair*. The elements of the game are easy to learn and use, but become more complex as one comes to master and understand them.
- They offer lots of guidance without taking away immersion or ownership.

Epistemic games are one way to educate young people for innovation in a world of global competition, because they are based on training for innovation in the real world. These are games in which players learn to think like innovators by becoming innovators in the world of the game (Shaffer 2004, 2007).

REFERENCES

Csikszentmihalyi, M., & Larson, R. (1984). *Being adolescent : conflict and growth in the teenage years*. New York: Basic Books.

Csikszentmihalyi, M., & Schneider, B. L. (2000). *Becoming adult : how teenagers prepare for the world of work* (1st ed.). New York: Basic Books.

Davenport, T. H. (2005). *Thinking for a living : how to get better performance and results from knowledge workers*. Boston, Mass.: Harvard Business School Press.

Gardner, H. (1991). *The Unschooled Mind*. New York: Basic Books.

Halverson, R. (2005). What Can K-12 School Leaders Learn from VideoGames and Gaming? *Innovate, 1*(6).

Kegan, R. (1982). *The evolving self : problem and process in human development*. Cambridge, Mass.: Harvard University Press.

Kroger, J. (2007). *Identity development : adolescence through adulthood* (2nd ed.). Thousand Oaks, Calif.: Sage Publications.

McDermott, L. C. (1998). Students' conceptions and problem solving in mechanics. In A. Tiberghien, E. L. Jossem & J. Barojas (Eds.), *Connecting Research in Physics Education with Teacher Education*: International Commission on Physics Education.

Pajares, F., & Urdan, T. (Eds.). (2006). *Self-Efficacy Beliefs of Adolescents*. Greenwich, CT: Information Age Publishing.

Rohde, M., & Shaffer, D. W. (2004). Us, ourselves, and we: Thoughts about social (self-) categorization. *Association for Computing Machinery (ACM) SigGROUP Bulletin, 24*(3), 19-24.

Shaffer, D. W. (2004). Pedagogical praxis: The professions as models for post-industrial education. *Teachers College Record, 106*(7), 1401-1421.

Shaffer, D. W. (2005a). Epistemic Games. *Innovate, 1*(6). Reprinted in *Computer Education* (in press).

Shaffer, D. W. (2005b). Epistemic Games. Shaffer, D. W. (2005). Epistemic games. Innovate 1.6 http://www.innovateonline.info/index.php?view=article&id=81

Shaffer, D. W. (2007). *How Computer Games Help Children Learn*. New York: Palgrave.

Shaffer, D. W. (in press). Epistemic frames for epistemic games. *Computers & Education*.

Shaffer, D. W., & Gee, J. P. (2005). *Before every child is left behind: How epistemic games can solve the coming crisis in education* (WCER Working Paper): University of Wisconsin-Madison, Wisconsin Center for Education Research.

Shaffer, D. W., Squire, K., Halverson, R., & Gee, J. P. (in press). Video Games and the Future of Learning. *Phi Delta Kappan*.

Shaffer, D. W., Squire, K. D., Halverson, R., & Gee, J. P. (2005). Video Games and the Future of Learning. *Phi Delta Kappan, 87*(2), 104-111.

Squire, K. D., & Jan, M. F. (2005). *Mad City Murder: A Professional Practice Simulation in Environmental Sciences.* Paper presented at the Annual meeting of the American Educational Research Association, Montreal, CA.

Zibit, M., & Gibson, D. (2005). simSchool: The game of teaching. *Innovate, 1*(6).