Learning by Design: Games as Learning Machines

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Introduction

Many good computer and video games, games like *Deus Ex, The Elder Scrolls III: Morrowin*d, or *Rise of Nations*, are long, complex, and difficult, especially for beginners. People are not always eager to do difficult things. Faced with the challenge of getting them to do so, two choices are often available. We can force them, which is the solution schools use. Or, a temptation when profit is at stake, we can dumb down the product. Neither option is open to the game industry, at least for the moment. They can't force people to play and most avid players don't want their games dumbed down.

For people interested in learning, this raises an interesting question. How do good game designers manage to get new players to learn their long, complex, and difficult games—not only learn them, but pay to do so? It won't do simply to say games are "motivating". That just begs the question of "Why?". Why is a long, complex, and difficult game motivating? I believe it is something about how games are designed to trigger learning that makes them so deeply motivating.

So the question is: How do good game designers manage to get new players to learn long, complex, and difficult games? Of course, there are some

forces in the game industry that want to dumb games down. That is not a very interesting answer to our question. Another answer that is not interesting, at least initially, is that some good games appear to be made only for people who are already adept game players. These games can be uninviting or frustrating for newcomers. Some thoroughly excellent games that fall into this category are *Panzer Dragoon Orta* (good start, very hard finish even on easy), *Jak II* (spatially challenging timed tasks guaranteed to make many newcomers feel they are learning disabled), *Prince of Persia* (you think you can play until you face the first boss and realize you haven't learned near enough), and *Viewtiful Joe* (only my eight-year-old can play it, not my graduate students or myself).

The answer that is interesting is this: the designers of many good games have hit on profoundly good methods of getting people to learn and to enjoy learning. Furthermore, it turns out that these methods are similar in many respects to cutting-edge principles being discovered in research on human learning (for details, see my books *What Video Games Have to Teach Us About Learning and Literacy*, New York: Palgrave/Macmillan, 2003 and *Situated Language and Learning: A Critique of Traditional Schooling*, London: Routledge, to appear 2004).

I care about these matters both as cognitive scientist and as a gamer. I believe that we can make school and workplace learning better if we pay attention to good computer and video games. This does not mean just using game technologies in school and at work, though that is something I advocate. It also means applying the fruitful principles of learning that good game designers

have hit on. As an avid gamer, I also believe that more people, young and old, men and women, will play games, and get more out if them, if games are highly learnable, but remain powerfully complex.

But why should game designers care about these matters? Well, perhaps, they don't need to. Hopefully, there will always be games like *Prince of Persia* and *Viewtiful Joe*. But here are some reasons to care. First, computer and video games are going to become the predominate form of popular culture interaction in our society. We can watch them get progressively dumbed down or we can see them spread to new people and new niches while retaining their power and complexity. Their spread will make more money for more people, but retaining their power in the act will, I am convinced, make a better and smarter society.

Second, whether they know it or not, good game designers are practical theoreticians of learning, since—at a beginning or advanced level—what makes games deep is that players are exercising their learning muscles, though often without knowing it and without having to pay overt attention to the matter. Under the right conditions, learning, like sex, is biologically motivating and pleasurable for humans (and other primates). It is a hook that game designers own to a greater degree—thanks to the interactivity of games—than do movies and books. Game technologies and principles are going to spread into schools, workplaces, and society for a great many purposes. This, too, will open up new markets and new possibilities for progress in society. Whether their motive be profit or reform, then, some designers may want to care about games and learning

In the end, I have to admit, though, that I believe game designers can make worlds where people can have meaningful new experiences, experiences that their places in life would never allow them to have or even experiences no human being has ever had before. These experiences have the potential to make people smarter and more thoughtful.

Good games already do this and they will do it more and more in the future. *Star Wars: Knights of the Old Republic* immerses the player in issues of identity and responsibility: What responsibility do I bear for what an earlier, now transformed, "me" did? *Deus Ex: Invisible War* asks the player to make choices about the role ability and equality will or won't play in society: If we were all truly equal in ability would that mean we would finally have a true meritocracy? Would we want it? *Freedom Fighters* allows players to live out the ideologies surrounding the U.S.-Iraq war in reverse: Is the difference between a freedom fighter and a terrorist simply that the person using the terms believes, in one case, the cause is right and not in the other? In these games, such thoughtful questions are not abstractions, they are part and parcel of the fun and interaction of playing. [And you find out things about yourself, perhaps unfortunate ones: In *Star Wars: Knights of the Old Republic*, I discovered that, having become "good", I was nonetheless proud of having once been powerfully bad and wanted the other characters to respect my former identity, though I didn't want actually to behave out of that identity].

I am not arguing that game designers have a lot to learn from cognitive scientists or that they should start reading papers on learning theory. Of course,

those designers who want to extend their products into the educational arena might want to do so. But, in fact, my argument is that good game designers are already doing a very good job at making learning happen. Why? For good old Darwinian reasons. Games that people can't learn to play and from which they don't get the enjoyment of learning won't sell. Those like *Jak II* that cater to more advanced players trade on the learning more newcomer-friendly games have already triggered, games like *Ratchet and Clank: Going Commando*, and themselves trigger deep learning at more advanced levels. So, in the end, I am arguing that learning is one lens game designers may want to apply to their thinking about game design.

Learning in Good Games

There are many good principles of learning built into good computer and video games. I list a baker's dozen below. We can view this list as a checklist: The stronger any game is on more of the features on the list, the better its score for learning. Of course, as I have said, some games (like *Prince of Persia*) will score high only on the assumption that a good deal of initial learning has already taken place. Other games (like *Rise of Nations*) will score high for a wider audience.

The list is organized into three sections: I. Empowered Learners; II. Problem Solving; III. Understanding. Under each item on the list I first give a principle relevant to learning, then a comment on games in regard to that

principle, and, finally, I offer a comment on some games that are strong on that principle. Those interested in citations to research that supports these principles and how they apply to learning things like science in school should consult the references in my books cited above.

I. EMPOWERED LEARNERS

1. Co-design

Principle: Good learning requires that learners feel like active agents (producers) not just passive recipients (consumers).

Games: In good games, players feel that their actions and decisions—and not just or primarily the designers' actions and decisions—are co-creating the world they are in and the experiences they are having.

Example: Players' decisions in *The Elder Scrolls: Morrowind* shape the world and game play in such a way that the game becomes different for each different player.

2. Customize

Principle: Different styles of learning work better for different people. People cannot be agents of their own learning if they cannot make decisions about how

their learning will work. At the same time, they should be able (and encouraged) to try new styles.

Games: Good games achieve this goal in one (or both) of two ways. In some games, players are able to customize the game play to fit their learning and playing styles. In others, the game is designed to allow different styles of learning and playing to work.

Example: *Rise of Nations* allows players to customize myriad aspects of the game play to their own styles, interests, and desires. *Deus Ex* and its sequel *Deus Ex: Invisible War* both allow quite different styles of play and, thus, learning, too, to succeed.

3. Identity

Principle: Deep learning requires an extended commitment and such a commitment is powerfully recruited when people take on a new identity they value and in which they become heavily invested—whether this be a child "being a scientist doing science" in a classroom or an adult taking on a new role at work.

Games: Good games offer players identities that trigger a deep investment on the part of the player. They achieve this goal 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. 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.

Example: *Metal Solid Gear* offers a character (Solid Snake) that is so well developed that he is, though largely formed by the game's designers, a magnet for player projections. *Animal Crossing* and *The Elder Scrolls: Morrowind* offer, in different ways, blank-slate characters for which the player can build a deeply involving life and history. On the other hand, an otherwise good game like *Freedom Fighters* offer us characters that are both too anonymous and not changeable enough by the player to trigger deep investment.

4. Manipulation

Principle: Cognitive research suggests that for humans perception and action are deeply inter-connected. Thus, fine-grained action at a distance—for example, when a person is manipulating a robot at a distance or watering a garden via a web cam on the Internet—causes humans to feel as if their bodies and minds have stretched into a new space. More generally, humans feel expanded and empowered when then can manipulate powerful tools in intricate ways that extend their area of effectiveness.

Games: Computer and video games inherently involve action at a (albeit virtual) distance. The more and better a player can manipulate a character, the more the player invests in the game world. Good games offer characters that the player can move intricately, effectively, and easily through the world. Beyond characters, good games offer the player intricate, effective, and easy manipulation of the world's objects, objects which become tools for carrying out the player's goals.

Example: *Tomb Raider*, *Tom Clancy's Splinter Cell*, and *ICO* allow such fine-grained and interesting manipulation of one's character that they achieve a strong effect of pulling the player into their worlds. *Rise of Nations* allows such effective control of buildings, landscapes, and whole armies as tools that the player feels like "god". *Prince of Persia* excels both in terms of character manipulation and in terms of everything in its environment serving as effective tools for player action.

II. PROBLEM SOLVING

5. Well-Order Problems

Principle: Given human creativity, if learners face problems early on that are too free-form or too complex, they often form creative hypotheses about how to solve these problems, but hypotheses that don't work well for later problems (even for simpler ones, let alone harder ones). They have been sent down a "garden

path". The problems learners face early on are crucial and should be well-designed to lead them to solutions that work well, not just on these problems, but as aspects of the solutions to later, harder problems.

Games: 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.

Example: *Return to Castle Wolfenstein* and *Fatal Frame2: Crimson Butterfly,* though radically different games, each do a good job of offering players problems that send them down fruitful paths for what they will face later in the game. They each prepare the player to get better and better at the game and to face more difficult challenges later in the game.

6. Pleasantly Frustrating

Principle: Learning works best when new challenges are pleasantly frustrating in the sense of being felt by learners to be at the outer edge of, but within, their "regime of competence". That is, these challenges feel hard, but doable. Furthermore, learners feel—and get evidence—that their effort is paying off in the sense that they can see, even when they fail, how and if they are making progress.

Games: Good games adjust challenges and give feedback in such a way that different 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.

Example: *Ratchet and Clank: Going Commando*, *Halo*, and *Zone of the Enders: The Second Runner* (which has different difficulty levels) manage to stay at a "doable", but challenging level for many different sorts of players. They also give good feedback about where the player's edge of competence is and how it is developing, as does *Sonic Adventure 2 Battle*.

7. Cycles of Expertise

Principle: Expertise is formed in any area by repeated cycles of learners practicing skills until they are nearly automatic, then having those skills fail in ways that cause the learners to have to think again and learn anew. Then they practice this new skill set to an automatic level of mastery only to see it, too, eventually be challenged.

Games: Good games create and support the cycle of expertise, with cycles of extended practice, tests of mastery of that practice, then a new challenge, and then new extended practice. This is, in fact, part of what constitutes good pacing in a game.

Example: *Ratchet and Clank: Going Commando*, *Final Fantasy X*, *Halo*, and *Pikmin* do a good job of alternating fruitful practice and new challenges such that players sense their own growing sophistication, almost as an incremental curve, as the game progresses.

8. Information "On Demand" and "Just in Time"

Principle: Human beings are quite poor at using verbal information (i.e., words) when given lots of it out of context and before that can see how it applies in actual situations. They use verbal information best when it is given "just in time" (when they can put it to use) and "on demand" (when they feel they need it).

Games: Good games give verbal information—for example, the sorts of information that is often in a manual—"just in time" and "on demand" in a game. Players don't need to read a manual to start, but can use the manual as a reference after they have played a while and the game has already made much of the verbal information in the manual concrete through the player's experiences in the game.

Example: *System Shock 2* spreads its manual out over the first few levels in little green kiosks that give players—if they want it—brief pieces of information that will soon thereafter be visually instantiated or put to use by the player. *Enter the Matrix* introduces new information into its "on demand" glossary when and as it becomes relevant and useable and marks it clearly as new. The first few levels of *Goblin Commander: Unleash the Hoard* allows the player to enact the information that would be in manual, step by step, and then the game seamlessly moves into more challenging game play.

9. Fish tanks

Principle: In the real world, a fish tank can be a little simplified eco-system that clearly displays some critical variables and their interactions that are otherwise obscured in the highly complex eco-system in the real world. Using the term metaphorically, fish tanks are good for learning: if we create simplified systems, stressing a few key variables and their interactions, learners who would otherwise be overwhelmed by a complex system (e.g., Newton's Laws of Motion operating in the real world) get to see some basic relationships at work and take the first steps towards their eventual mastery of the real system (e.g., they begin to know what to pay attention to).

Games: Fish tanks are stripped down versions of the game. Good games offer players fish tanks, either as tutorials or as their first level or two. Otherwise it can be difficult for newcomers to understand the game as a whole system, since the often can't see the forest because of the trees.

Example: *Rise of Nations'* tutorial scenarios (like "Alfred the Great" or "The 100 Years War") are wonderful fish tanks, allowing the player to play scaled down versions of the game that render key elements and relationships salient.

10. Sandboxes

Principle: Sandboxes in the real world are safe havens for children that still look and feel like the real world. Using the term metaphorically, sandboxes are good for learning: if learners are put into a situation that feels like the real thing, but with risks and dangers greatly mitigated, they can learn well and still feel a sense of authenticity and accomplishment.

Games: Sandboxes are game play much like the real game, but where things cannot go too wrong too quickly or, perhaps, even at all. Good games offer players, either as tutorials or as their first level or two, sandboxes. You can't expect newcomers to learn if they feel too much pressure, understand too little, and feel like failures.

Example: *Rise of Nations*' "Quick Start" tutorial is an excellent sandbox. You feel much more of the complexity of the whole game than you do in a fish tank, but risks and consequences are mitigated compared to the "real" game. The first level of *System Shock* 2 is a great example of a sandbox—exciting play where, in this case, things can't go wrong at all.

11. Skills as Strategies

Principle: There is a paradox involving skills: People don't like practicing skills out of context over and over again, since they find such skill practice meaningless, but, without lots of skill practice, they cannot really get any good at what they are trying to learn. People learn and practice skills best when they see a set of related skills as a strategy to accomplish goals they want to accomplish.

Games: In good games, players learn and practice skill packages as part and parcel of accomplishing things they need and want to accomplish. They see the skills first and foremost as a strategy for accomplishing a goal and only secondarily as a set of discrete skills.

Example: Games like *Rise of Nations*, *Goblin Commander: Unleash the Hoard*, and *Pikmin* all do a good job at getting players to learn skills while paying attention to the strategies these skills are used to pull off. *Rise of Nations* even has skill tests that package certain skills that go together, show clearly how they

enact a strategy, and allow the player to practice them as a functional set. The training exercises (which are games in themselves) that come with the *Metal Gear Solid* and *Metal Gear Solid: Sons of Liberty* are excellent examples (and are great fish tanks, as well).

III. UNDERSTANDING

12. System Thinking

Principle: People learn skills, strategies, and ideas best when they see how they fit into an overall larger system to which they give meaning. In fact, any experience is enhanced when we understand how it fits into a larger meaningful whole.

Games: Good games help players see and understand how each of the elements in the game fit into the overall system of the game and its genre (type). Players get a feel for the "rules of the game"—that is, what works and what doesn't, how things go or don't go in this type of world.

Example: Games like *Rise of Nations*, *Age of Mythology*, *Pikmin*, *Call of Duty*, and *Mafia* give players a good feel for the overall world and game system they are in. They allow players to develop good intuitions about what works and about how what they are doing at the present moment fits into the trajectory of the game as a whole. Players come to have a good feel for and understanding

of the genre of the game they are playing (and in *Pikmin*'s case, this is a rather novel and hybrid genre).

13. Meaning as action image

Principle: Humans do not usually think through general definitions and logical principles. Rather, they think through experiences they have had. You don't think and reason about weddings on the basis of generalities, but in terms of the wedding you have been to and head about. It's your experiences that give weddings and the word "wedding' meaning(s). Furthermore, for humans, words and concepts have their deepest meanings when they are clearly tied to action in the world.

Games: This is, of course, the heart and soul of computer and video games (though it is amazing how many educational games violate this principle). Even barely adequate games make the meanings of words and concepts clear through experiences the player has and activities the player carries out, not through lectures, talking heads, or generalities. Good games can achieve marvelous effects here, making even philosophical points concretely realized in image and action.

Example: Games like *Star Wars: Knights of the Old Republic*, *Freedom Fighters*, *Mafia*, *Metal of Honor: Allied Assault*, and *Operation Flashpoint: Cold War Crisis*

do a very good job at making ideas (e.g., continuity with one's past self), ideologies (e.g., freedom fighters vs. terrorists), identities (e.g., being a soldier) or events (e.g., the Normandy Invasion) concrete and deeply embedded in experience and activity.

Conclusion

When we think of games, we think of fun. When we think of learning we think of work. Games show us this is wrong. They trigger deep learning that is itself part and parcel of the fun. It is what makes good games deep. If games are to stay complex and yet sell to more and more people, then learning as a lens for game designers may be significant. As a cognitive scientist and an avid gamer let me offer that as but a suggestion, at least as a way to think of some aspects of the deeper significance games have and will have for our society.

For those interested in spreading games and game technology into schools, workplaces, and other learning sites, it is striking to meditate on how few of the learning principles I have sketched out here can be found in so-called educational games. "Non-educational" games for young people, such as *Pajama Sam*, *Animal Crossing*, *Mario Sunshine*, and *Pikmin*, all use many of the principles fully and well. Not so for many a product used in school or for business or workplace learning. It is often said that what stops games from spreading to educational sites is their cost, where people usually have in mind the wonderful "eye candy" that games have become. But I would suggest that it

is the cost to implement the above principles that is the real barrier. And the cost here is not just monetary. It is the cost, as well, of changing people's minds about learning—how and where it is done. This may also change some people's minds about computer and video games, as well.

So, let's end with an award, since I write this at a time when all the game sites are giving out their Game of the Year awards (I myself am torn between *Call of Duty* and *Star Wars: Knights of the Old Republic*). What would I reward as Game of the Year for incorporating our learning principles at the highest level? The award goes to: *Rise of Nations*.