"Surmise the Possibilities": *Portal* to a Game-Based Theory of Learning for the 21st Century

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Introduction

This paper offers a perspective on learning inspired by video games. The areas of Game Studies (Raessens & Goldstein 2004; Wolf & Perron 2003) and Games and Learning (Gee 2003; Hawisher & Selfe 2007; Shaffer, Squire, Halverson, & Gee 2005a; Shaffer 2007) have burgeoned over the last few years. A number of people, from different disciplines, have argued either that we should use games for learning (Squire 2006: Squire & Jenkins 2004) or that we should learn from games how to build better learning spaces that need not themselves be games (Gee 2003).

Different people have taken different messages about learning from games (see Prensky 2007 for a good overview of different approaches). Some have stressed "training", others have tried to build better skill-and-drill, and still others believe games can lead to deep conceptual and collaborative learning. This paper represents one particular perspective meant to speak to the issue of what learning ought to look like in the 21st century.

I will use a game called *Portal* as a portal into a theory of what should be learned and how it should be learned in our high-tech global world. *Portal* is a game developed by Valve (a developer famous for the game *Half-Life* and its sequels). The game was released in a bundle package called *The Orange Box* for PC and Xbox 360 on Oct. 10, 2007 and for PlayStation 3 on Dec. 11, 2007.

In our current world, information grows at an ever increasing rate; academic disciplines are withering in favor of inter- and trans-disciplinary projects dealing with complex

systems; and knowledge is produced at a great many sites beyond the university, including "everyday" people using digital tools and entering communities of practice to become passionate experts in a myriad of different areas (Gibbons, Limoges, Nowotny, Schwartzman, Scott, & Trow, M. 1994; Hagel and Brown 2005; Leadbeater & Miller 2004; Toffler & Toffler 2006). Yet our schools are still built around "academic subject matter" (e.g., math, science, social studies) usually passively consumed as "facts" or "information" (Gee 2004).

I start with some comments on games and learning. Then I move on to the question of what should be learned or, better put, where the focus of learning should be: facts, theories, practices, or how to surmise possibilities? Using the game *Portal*, I argue that the answer is "how to surmise possibilities". I discuss the way in which "knowledge tools" teach us to how look at the world in a new way, a way that enhances the uses of these tools to solve problems, build knowledge, and surmise possibilities.

Then I move on to the role of words in learning, arguing that knowledge tools create landing sites or niches to which words can attach. Words so attached then turn tacit knowledge into explicit and articulate knowledge. Finally, I turn to what teaching means in this perspective.

This brief introduction makes the project sound bigger than it is, however. In reality, I offer but sketch of a perspective, not a finished and detailed painting. I am really here just trying to use video games as a way to surmise some possibilities.

Games and Learning

In past work I have argued that video games are good for learning in two senses: First, good commercial games get themselves learned in effective ways because they are built on sound learning principles (Gee 2003, 2007), principles supported by research in the Learning Sciences (Bransford, Brown, and Cocking 2000; Gee 2007). This is so, in part, because video games are often long, difficult, and complex. If they could not be learned and mastered in a motivating fashion, no one would play them, at least for entertainment. And, second, video game technologies hold out great promise, beyond entertainment, for building new learning systems for non-entertainment purposes in and out of school (Gee 2004, 2005a, 2007).

I have also argued that the relationship between games and learning is not one way (Gee 2007). While games are good for learning, learning is good for games. Video games are, at heart, problem solving spaces. Learning is integral to their design and success. Good games create good learning in order to create good problem solving and, in the act, create deep engagement and satisfaction.

Of course, not all video games are "good" in the sense in which I am using the term (i.e., effective learning machines). And, too, there are different types of video games and learning works differently in different types of games. We can make a distinction between two major types of games: "problem games" and "world games". The distinction, however, is not air tight. Problem games focus on solving a given problem or

a single class of problems (e.g. *Tetris*, *Diner Dash*), while world games simulate a wider world within which the player must solve many different sorts of problems (e.g., *Half-Life*, *Rise of Nations*).

A game like *Portal* melds these two types in a very innovative way. The game is set in a 3D world and driven by a minimal but fascinating story. The player has a "portal gun" and can make a blue portal and an orange one. If the player goes through one portal, she comes out the other (your avatar in the game is a female).

The portals obey a law of conservation of momentum, so if the player goes in one fast, she comes out the other one equally fast and can, thus, fly across large spaces if the second portal is, for example, high up. The player must navigate complex environments—sometimes with hazards like lasers, electrical beams, and toxic waste—with just this tool (the portal gun can also pick up crates and place them on switches). For example, you often have make portals to redirect electric beams so they hit specific targets that operate platforms.

Someone appears to be testing both you and your intelligence and by the end you realize they intend to kill you. As with the classic *Half-Life*, a minimal ending gives you just a glimpse of what is going on.

Portal is a "problem game" set in an interesting world. You solve one specific class of problems with a specific tool, but in a world that sets up a "real world" like environment

built to enhance and facilitate just such problem solving with just such a tool. *Portal* makes clear in a very overt way how the "fun" of a game is learning to solve problems and eventually gain some degree of mastery over both the problems and the tools that compose the core of the game.

A more complex game like *Half-Life 2* simply involves a wider array of integrated problems and tools. It loses some of the focus and "purity" of a game like *Portal*, but gains a more "real world" feel, since, of course, the real world is itself largely a set of problem-solving spaces, but much more "open ended" (and consequential) than video games. Neither type of game is "better" or "worse".

Portal also throws light on the distinction between "entertainment games" and so-called "serious games" (see, e.g., seriousgames.org), i.e., games made for non-entertainment purposes. *Portal* makes a game out of a coherent set of problems that are largely defined by gravity and other principles from physics. A game can of course be made out of any problem space, provided the designers are innovative enough.

Some people consider some problem spaces more "serious" than others, usually if a problem space is connected to some academic or work domain. But the principles of engagement with a game remain the same regardless of the problem space (or spaces) around which the game is made. In that sense, there need be no distinction at a game-design level between entertainment and serious games.

However, an important distinction between entertainment and serious games can be seen if we think about the fact that *Portal* does not demand that the player come to an explicit understanding of the principles and concepts behind the solutions to its problems (e.g., the physics of the conservation of momentum). It does not demand that players can articulate their understandings. Rather, players gain tacit understandings that they can apply to new levels in the game (so, of course, transfer is built into the game: later levels demand transfer of knowledge developed at earlier levels, knowledge that must also be put together with new learning at the later level).

A non-entertainment learning space would usually want to create and enhance explicit learning and the ability to articulate one's knowledge, hopefully without losing tacit knowledge and actual problem solving ability. If we use a game, such explicit learning is something that could be done in game or out of game with related activities, or in both ways at the same time.

Such explicit understandings and the ability to articulate one's knowledge are not, however, foreign to commercial entertainment video games. Explicit understandings are often created and enhanced through web sites and communities connected to games, as well as strategy guides of various types. For example, below is a section from a Wikipedia entry on *Portal* that is replete with explicit language articulating concepts a player picks up tacitly in the game:

> The portals create a visual and physical connection between two different locations in 3D space. Portal ends are restricted to planar surfaces, but if the portal ends are on nonparallel planes, bizarre twists in geometry and gravity can occur as the player character is immediately reoriented to be upright with respect to gravity after leaving a portal end. An important aspect of the game's physics is "momentum redirection". Objects retain the magnitude of their momentum as they pass through the portals but in a direction relative to the surface the exit portal is on. This allows the player character to launch objects, or even herself, over great distances, both vertically and horizontally, a maneuver referred to as "flinging" by Valve. [http://en.wikipedia.org/wiki/Portal_(video_game)—11/22/07]

In this passage, the reader is linked through the phrases “3D space” and “momentum” to Wikipedia entries that deal with the physics of these concepts in quite a bit of technical detail.

Interactions around such explicit and technical language is common when gamers discuss games on boards, devote websites to them, or write technical strategy guides (“faqs”). For example, consider the piece below from a forum devoted to *World of WarCraft*. Here a player is discussing a test he has carried out, using a player made modification (a damage meter), on the amount of damage done by the Shaman class. The player is arguing that a patch (change) that Blizzard made to the game has significantly hurt the

Shaman character. He concludes from his test that "…. this is one of the worst DPS nerfs in World of Warcraft history, standing at 180.44 DPS loss, or a 16.39% damage loss".

2.3 Elemental shaman DPS test.

The damage meters mod was used to record DPS.

All tests were with lightning bolt only, on Dr. Boom in Netherstorm.

Quartz was used in all tests, along with the macro:
/stopcasting
/cast Lightning Bolt (Rank 12);

* there is an issue with the global cooldown on the test servers. However, using the stopcasting macro negates the problem *

On 2.2 live, the meter parsing was paused when I went oom, just as the final lightning bolt struck the target. Any Lightning overload proc's from the final lightning bolt were not recorded.

On 2.3 test server, the meter parsing was paused when the totems despawned. (the totems were placed in order - mana spring, totem of wrath, wrath of air. the meter was paused just as mana spring despawned.)
therefore, all test server times will be near 2 minutes.

gear used is the same throughout the tests. the lightning capacitor was not used.

41/0/20 spec. all lightning talents taken.
http://forums.worldofwarcraft.com/thread.html?topicId=2518764441&sid=1

Of course, this post is engaging explicit language and meta-knowledge about a technical area that many people don't consider "serious". However, as Constance Steinkuehler (2006) has argued, such posts represent and provoke discussions that involve hypothesizing, arguing, thinking, and model building that are epistemologically and cognitively similar to moves made in science.

It is pretty clear that one could imagine designing a "learning game" that like *Portal* combined a problem-solving space designed for building tacit understandings with tools for developing explicit understandings tied to these tacit understandings. In this way learners would gain an overt understanding that they could put into words, but would still retain the ability to actually use such understandings to solve real problems (and not just pass paper-and-pencil tests, as is so often true in schools today). And, in fact, one good way to do this would be to create an "affinity space" (Gee 2003, 2004) or "community of practice" (Lave & Wenger 1991; Wenger 1998) connected to the game that generates explicit discussion and argumentation, as well as model building.

What to Learn, not Just How to Learn

In the 21st century there is a crucially important issue about **what** people should be learning (Kuhn 2007), not just **how** they should be learning it (though the "how question" takes up the lion's share of discussion in education these days). For example, it may be

the case that learning how to engage in scientific-like argumentation, how to leverage explicit and technical language for clarity and understanding, and how to build models for explicit understanding and problem solving do not always have to be done on and around "serious" ("academic") content.

Schools are very often about knowledge as factual content ("information") and "coverage" of that knowledge (Gee 2004). But such knowledge today goes out of date or, at least, is transformed, very fast (Hagel and Brown 2005; Kelly 1994). Further, there is now so much of it produced at such a massive rate that the idea of "coverage" becomes absurd, even within a given knowledge domain or academic discipline.

Educators have long been obsessed with "what everyone should know", that is, with the idea that "everyone" should know the same things (e.g. "what every student/citizen should know about science"). This approach has not led, by and large, to everyone knowing a good deal about mathematics and science. This is true, in part, because people tend to understand and remember, over the long haul, only what is important and meaningful to them and most people don't find wide but superficial coverage of a bunch of academic areas (usually defined in terms of largely disconnected "facts" and "skills") all that meaningful.

At the same time as schools engage in coverage, facts, and basic skills, we live in the age of "Pro-Ams" (Anderson 2006; Leadbeater & Miller 2004; Toffler & Toffler 2006). Pro-Ams are people who have, as amateurs, become experts at whatever they have developed

a passion for. Many of these are young people who use the Internet, communication media, digital tools, and membership in often virtual, sometimes real, communities of practice to develop technical expertise in a plethora of different areas such as digital video, video games, digital storytelling, machinima, fan fiction, history and civilization simulations, music, graphic art, political commentary, robotics, anime, fashion design (e.g., for Sims in *The Sims*), and nearly every other endeavor the human mind can think of (some such endeavors being for adults only).

These Pro-Ams have passion and go deep rather than wide. In fact, it seems that developing such a passion is a *sine qua non* of deep learning that leads to expertise. At the same time, they are often adept at pooling their skills and knowledge with other Pro-Ams to bring off bigger tasks or to solve larger problems. These are people who don't know what everyone else knows, only how to engage with other Pro-Ams to put knowledge to work to fulfill their intellectual and social passions.

Let me give one quick example. A young, working class, non-school affiliated girl, who plays the *Sims*, became part of a club that was working to help girls become "tech savvy" (Hayes, in press). The girl wanted badly to turn real clothes into virtual clothes for her Sims in *The Sims*. The people running the club told her that they knew this could be done using Adobe Photo Shop, but didn't know themselves how to do it.

The girl found a version of Photo Shop and spent many highly focused hours learning how to take pictures of clothes from stores she liked and turn them into virtual clothes.

The process is technical and complex. To do this the girl had to gain both tacit and some explicit knowledge of concepts like texture, layering, mesh, hue, perspective, and design. The girl made (and re-designed) clothes for her Sims and continued to work over months on perfecting the process.

Eventually, the girl gave clothes away to her friends, who came to admire greatly her skill and taste. She discovered she could upload her virtual clothes for strangers to use and soon had over 300 people using and praising her clothes. Her status and her self-concept rose greatly. She decided she would like to go on in life and "work with computers"—ironically, perhaps, not clothing design. She said that she had discovered that computers could make you feel "powerful".

This girl has not yet sold her clothes, only given them away. She has become a classic example of what the Tofflers (Toffler & Toffler 2006) call a "prosumer", a consumer who produces and transforms, not just passively consumes, for off-market status and as part of a community of like-minded experts. As the Tofflers point out, such prosumer activity often eventually impacts on markets when people like this little girl eventually sell their goods or services. In fact, the Tofflers believe such activity, though unmeasured by economists, is a big part of the global economy and will be a yet bigger part in the future.

Is this girl learning something "serious"? What she is learning is not a school subject or defined by an academic label or the name of an academic discipline. Nonetheless, it

seems "serious" to me. Of course, the girl finds what she is doing engaging because she has a passion for it and the word "serious" probably does not come to her mind. What she is doing is certainly not trivial and is much more deeply relevant to both her future and the global world than is much of what she is doing (or ignoring) in school.

Back to *Portal*

The game *Portal*—in its own way—is on to something deep about the question of what should be learned in the 21st century and, indeed, contributes, as well, insights into how to learn it. Consider the following remark from a Valve website advertising the game:

> The game is designed to change the way players approach, manipulate, and surmise the possibilities in a given environment; similar to how Half-Life® 2's Gravity Gun innovated new ways to leverage an object in any given situation. [http://orange.half-life2.com/portal.html-11/22/07]

To elaborate on the implications of this remark, let me start with this: We all agree that school involves learning "content" in some sense. But what is "content"? Usually it is defined around an academic area or discipline, like "science", "biology", "mathematics", "algebra", "social studies", "literature", and so forth. There are two ways to look at such academic areas or disciplines.

First, we can—as school often does—see an academic area or discipline as a set of facts or a body of information. Unfortunately, such facts don't get retained long, don't lead to being able to solve real problems in a domain, and are in overwhelming supply these days (Bransford, Brown, and Cocking 200; Gardner 1991; Gee 2004; Shaffer 2007). Further, they are often pretty meaningless—and certainly not very motivating—when detached from the conceptual underpinnings (theories, tools, methods) of a given area or discipline, since it is these conceptual underpinnings that give the facts meaning and purpose (diSessa 2000).

Second, we can see an academic area or discipline in terms of its conceptual underpinnings. This would mean mastering the concepts, theories, tools, and methods of a discipline, the things in a discipline that produce facts and render them meaningful and useful for solving problems (diSessa 2000; Latour 1987). These concepts, theories, tools, and methods should not be turned into a sort of higher content to be memorized. They are, in fact, part and parcel of the professional practices (of *doing*, not re-telling) of a biologist or geologist, for instance (Latour 1987, 1999). Thus, often, when this perspective is incorporated into school, we try to turn learners into practicing scientists, for instance, engaged in "inquiry" (Olson, S. & Loucks-Horsley 2000). This sets us on a much better track. However, there are problems here too.

First, knowledge today is very often not produced in the name of traditional disciplines. Rather, people from a variety of disciplines work together to create knowledge around a specific theme or issue that crosses traditional disciplinary boundaries (Gibbons,

Limoges, Nowotny, Schwartzman, Scott, & Trow 1994). People work on issues like adaptation, complexity, social and cultural interactions with technology, environmental degradation, the relationships between language and learning, and many more such themes that incorporate more than one disciplinary lens.

Further, traditional academic divides between "art", "science", and "technology" are fast falling in our modern word. Many a graphic artist today is as tech-savvy as any scientist and many scientists use graphic tools of the same sort artists use to represent knowledge in user-friendly ways that allow complex and massive knowledge bases to be interfaced with in productive ways (Tufte 2006—note the title of this book: "Beautiful Evidence").

Second, scientists take on the identity (practices and values) of being a scientist and doing science because they have a set of goals their share with their colleagues. They actively want to know something, want to produce knowledge of a certain type, because they know their field is in a certain state where the issue they are pursuing is topical, important, and ripe for inquiry (Latour 1999). They are part of a social state of affairs in their field that tells them what they should pursue and why.

Learners rarely have such motivation—they are told to engage in the practice of science so that they will "learn science"—something no scientist does. Scientists do science to advance science, not learn it, though it is true they learned much of it by doing it, but not with the sole goal of learning it, but with the goal to contribute to it. Learners rarely are part of social and historical trajectory that makes clear why they are doing what they are

doing and what the stakes are (usually there are no stakes for them beyond a grade). Thus, learners rarely have any personal commitment to a "discipline" in the way a scientist does, remembering that scientists are today usually committed to a sub-discipline that often interacts with people outside their larger discipline.

Third, much knowledge today is produced outside of academics and academic institutions altogether. Knowledge is produced in a great many technical and technological endeavors and in entrepreneurial sites (Hagel & Brown 2005; Kantor 2001; Kelly 1994). Furthermore, much knowledge production today is not strictly "professional". As I pointed out above, we live in the age of the "Pro-Am", the amateur who has used the internet, digital media, and other technological tools to become an expert (driven by a passion) in some domain (rarely defined by a traditional academic label) and often to join a like-minded community of such experts. Witness the young girl we discussed above. Witness the *World of WarCraft* gamer testing the game's mechanics.

All of these considerations make trying to turn learners in school into "little scientists" or "little professionals" a complex and interestingly problematic enterprise (Shaffer 2007). I am not arguing that is a bad thing to do or not often effective. It is certainly better than a diet of "fact" and "skill drills". But knowledge today is bigger than academic disciplines, often pours out of them, and is produced widely inside and outside of many domains and practices that are not tied to traditional academic labels.

So, let's return to the quote from the *Portal* website. There is a world out there: the "real world". People who want to produce knowledge—academic or otherwise—often find the real world too complex to take on all at once. To solve this problem they use tools that operate on the real world to solve certain specific types of problems. The tools they use cause them to look at the world in a certain way. They learn to look at the world in terms of the affordances of the tools they have, what the tools are good for. These tools are "… designed to change the way [people] approach, manipulate, and surmise the possibilities in a given environment".

Knowledge tools cause us to foreground and pay attention to certain aspects of the world and to background other aspects. In that sense, knowledge tools always create "virtual worlds". The real world is turned into just the aspects of it that our tools can leverage for powerful problem solving of a certain sort.

Photo Shop allowed the young girl we discussed above to foreground and then leverage for her own purposes a sub-set of the real world, certain specific properties of light, texture, and perspective. In the end, she saw things like clothes, design, and even computers in the real world differently. Galileo used geometry (the world on paper) to foreground and leverage certain specific properties of pendulums (diSessa 2000). In the end, he discovered the laws of the pendulum, laws with many applications to the real world. He most certainly did not just stare at and play with pendulums.

A game like *Portal* takes us out of the real world and presents a model of the real world that is built to "fit with" or foreground the sorts of problems the portal tool can help solve. The visual fit between world, tool, and problem has been maximized. The world in the game is the way in which someone would have to see the real world if they had a portal building tool and wanted to use it to solve the sorts of problems *Portal* sets up.

Of course, what would be great, but, sadly, not (yet) possible, would be to play the game—really get the "concepts" down—and then take out a portal gun and use it in the real world. We would already be good at the basic portal problem solving process, but, in the real world, we would discover new problems and new and innovative uses of the portal tool.

"Transfer" would happen as the real world, with its greater complexity, forced us to extend our tool from a world "well built" for the tool into a world that we have to actively see in a certain way and shape to our purposes for the tool to be effective. Of course, nothing stops players from looking at the real world as if they had a portal gun and thinking about how to solve problems in that world—indeed, gamers often learn to look at the real world in a new way when they have played a given game for a long while.

Knowledge building tools train vision. Let me give another and telling example: I once watched a physicist give a presentation on reflection and refraction of light to a group of teachers. He had a tank filled with water and put a stick in it to show the teachers how

the stick looked bent when in the water. He expected that by looking they would understand reflection and refraction. But they did not.

As they failed to follow his verbal explanations, he said "just look" and did the demonstrations again and again. "Watch", "just look", he said over and over again. What he failed to realize was that his vision had been trained by his physics tools and knowledge. He saw the real world in just the way that made it fit his tools. The teachers' vision was not trained, because they had not played with his tools.

Portal trains your vision. Many video games do. *Full Spectrum Warrior* makes you see the real world as places where you can move safely from cover to cover. *Thief* makes you see the world as places of darkness and illumination, fit for hiding and melting into the shadows. *SWAT 4* makes you see buildings and rooms in terms of places for safely checking your surroundings and safe routes of entry and exit. *Portal* makes you see the real world as just those places where, for instance, you could put the law of the conservation of momentum to use.

Words and Symbols as Knowledge Tools

Tools are often objects or technologies made out of "stuff" or virtual stuff (like the portal tool). But it is important to see that words are special sorts of tools for training vision. They often require other sorts of tools to prepare a space or niche—a sort of landing zone—for them in the world and then they come to serve as higher-order tools.

Let me return to the young girl turning real world clothes into virtual clothes for her Sims. Her activities with Photo Shop foregrounded certain features of the real world as important to her productive goals. These features—things like different degrees of hue or mesh or texture—come, through this sort of process, to **need names**—they need words attached to them. So, too, did different aspects of how to save and store different types of files on a computer. Her activities created niches for words to attach to.

With words attached, the young girl can extend, discuss, and eventually come to be able to explicate her knowledge. She can ask questions, make claims, and interact with other emerging and accomplished experts (on *Sims* sites, for instance). The words become themselves tools for foregrounding and leveraging aspects of the real world, as well as aspects of an explicit knowledge building process. They become, in collaboration with other sorts of tools, tools for building and transforming both clothes and knowledge.

So we see that work with tools like Photo Shop (or tools in science) opens up niches for words to attach to. Sometimes these words are technical terms, sometimes they are everyday words. But in both cases they are technically "technical" because they are explicitly attached to an emerging expert practice and take on their specific meanings (whatever other meanings they may have elsewhere) here and now in terms of this practice (Gee 2005b). As we become expert at a practice we all speak "jargon", but it is never really jargon to insiders only to outsiders. We hate other people's jargon, but not our own.

Let me give an example from my own background (though "hue" would be a good example from our young girl's knowledge building activities). When I was trained as a theoretical linguist, we had ways of diagramming the grammar of sentences that expressed what our theories said was important about ("true of") their grammatical properties.

Some of these diagrams were called "phrase-structure diagrams". In one form, they were also called "context free re-write rules". However, different linguistic theories diagrammed sentences differently and, indeed, theories that were significantly different used altogether different diagrammatic techniques (e.g., dependency diagrams).

These diagrams were tools to train "vision"—in this case, they foregrounded various features of language to be leveraged for knowledge building purposes. Different theories foregrounded different features of language. Linguists' theories were expressed in and argued over in terms of their diagrams and diagrammatic techniques.

For example, a certain set of diagrams and operations on diagrams came to be associated with the word "passive" (or "passive construction") in a particular theory at a particular time (say, for instance, "Government and Binding", Chomsky 1981). The word "passive" attached to this niche. It's meaning was technical in the sense that here it meant not what it did in "everyday language", but just the niche it came to label in terms of diagrams, operations on diagrams, and the theories they expressed. Thus, too, the word meant different things in different theories.

Once the word got attached, linguists could use it as a substitute for their diagrams, to generalize, extend, and argue over their diagrams and theories. It became a sort of higher-order tool, though one collaborating closely with other tools: the diagrams and operations we did on them and the practices and arguments we engaged in regard to them.

Words attached to niches this way allow a certain sort of quite practical generality. Two linguists can use the word "passive", each applying it to different diagrams, operations, and theories, and, thus, each using the word for a different niche, but know what they are talking and arguing about—in this case, a difference in diagrams, operations, and theories. Something odd happens: people use a word that means different things, but know what they are talking about and, in some higher-order sense, are actually talking about the same thing.

Words need niches prepared for them. When they get attached to a niche, they can gravitate to get attached to other related niches (as in the case of "passive") connected to other related practices (like alternative theories about what a "passive construction" is). Then we can argue (and even sometimes make progress) without having to mean specifically the same exact thing. We are arguing over which niche should be privileged. We are arguing over which niche (which we abstracted from the real world in the first place) is the one that is a sub-set of the real world and, thus, "true".

Playing *Portal* opens up all sorts of niches for words. For example, after trying to figure out how to fly through the air at the right speed and angle to get to hard-to-get ledges, the player certainly has prepared a niche for a term like "conservation of momentum" or even "a direction relative to the surface the exit portal is on". I don't know a shorter "word" for this latter phrase. And it is not uncommon that we attach phrases and not just words to niches. And, of course, these niches are related to words and niches in physics in an interesting way.

Games like *Portal*—and other related technologies—can do something else fascinating, something that is sometimes harder to do in the real world. They can create niches for words (that is, foreground properties in a world) that are non-existent in the real world. They can offer us tools that train vision for a wider set of "realities" (possible realities) than are actually present in the real world. They are, then, in that sense, about "possible worlds" (much like modal logic—see Lewis 1986).

We can then turn to the real world and see which sub-set of this wider set of possible worlds the real world represents (or argue over it, as do the linguists). This is an important knowledge building property. We can come to see that theories often predict sets of "possible world" which are narrowed down to the real world by empirical data. But these possible worlds also sometimes illuminate paths to new technologies, new hypotheses to test, and discoveries about new and unexpected properties of the real world. They are a key part of innovation and creativity. Words don't care whether they attach to niches in the real world, virtual worlds, or just imaginary worlds.

One of the promising things about games, simulations, and virtual worlds is that they allow us to create tools for foregrounding aspects of possible worlds (modeled usually on the real world in some sense) that can become niches for words. These words can then lead to debate about possibilities, innovation, transformation and change. We can ask: Why not (or can we?) actually make a new niche in the real world for this word to inhabit?

Teaching

Words don't come to occupy a niche—whether "hue" for the girl we discussed earlier, "passive" for me as a linguist, or "conservation of momentum" for *Portal* players—automatically. A player can play *Portal* and form tacit understandings for the conservation of momentum but never seek or find words for such understandings. So, too, for "hue". It would have been harder for this to happen with "passive", however, since I was then learning in a community explicitly committed to applying words to niches.

So it takes a "teacher" to ensure that the words are sought and found. This teacher need not be an official teacher. Such teaching can be built into communities of emerging experts built around a set of activities or a game. It can even be a "designed in" feature of a set of activities or game environment. It can be an artificial tutor or a smart NPC [Non-Playing Character in a video game] in a virtual world (Graesser, Jackson, &

McDaniel 2007). It can be lots of other things, as well, including a real person, even one called a "teacher".

Going further, "teaching" (in the expanded sense used above) is needed to ensure not just that words are attached to niches but that they merge into a "language", a way of arguing, discussing, claiming, reflecting, critiquing, and imagining. A set of words and phrases attached to a number of associated niches coalesce into a language—a distinctive way with words—when a community exists that speaks, demands, mentors, and, yes, even "polices", such a language. Sometimes, for teaching purposes, we have to build such communities (Gee 2004).

In thinking about growing a "language", let me reprint the Wiki article on physics in *Portal*:

> The portals create a visual and physical connection between two different locations in 3D space. Portal ends are restricted to planar surfaces, but if the portal ends are on nonparallel planes, bizarre twists in geometry and gravity can occur as the player character is immediately reoriented to be upright with respect to gravity after leaving a portal end. An important aspect of the game's physics is "momentum redirection". Objects retain the magnitude of their momentum as they pass through the portals but in a direction relative to the surface the exit portal is on. This allows the player character to launch objects, or even herself, over great distances, both vertically and horizontally, a maneuver referred to as

"flinging" by Valve. [http://en.wikipedia.org/wiki/Portal_(video_game)—11/22/07]

This is one "language" that can be attached to *Portal*. It is a language that is already attached to niches in the world (worlds) of physics and is being translated onto niches prepared by (or preparable by) *Portal*. For players who have no tools for training their vision to see the real world the way physicists do—thus, too, no niches for such words—*Portal* can be fertile ground. *Portal* can become a sandbox or playground for getting ready for physics.

But all this takes teaching (in the sense of mentoring via design, community, or individuals). And, of course, we could design many other such playgrounds. And, make no mistake, any learning that actually creates new niches for new words and new languages starts in some sort of sandbox or playground in just the way *Portal* is a playground or in just the way the real world is a playground when we are really learning.

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