Core Knowledge Area Module Number 2:

Principles of Human Development

Constructivist Theories of Cognitive Development and Digital Game-Based Learning

Mark Wagner

Dr. Jock Schorger

Assessor

Walden University

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Overview

This Knowledge Area Module (KAM) focuses on the relationship between constructivist theories of cognitive development and theories of digital game-based learning. In the breadth portion of the KAM, a working theory of constructivist cognitive development is synthesized from the work of Jean Piaget, Seymour Papert, and David H. Jonassen. In light of this working theory, the work of Marc Prensky, James Paul Gee, and Clark Aldrich is critically examined in the depth portion of the KAM. This portion also includes an annotated bibliography of related articles. Finally, the application portion of the KAM describes the development of a three hour hands-on professional development session for providing educators with guidance in using digital game-based instruction, informed by theories of constructivist cognitive development, to facilitate student learning.

Breadth

Introduction

The purpose of this breadth portion of he KAM is to synthesize a working theory of constructivist cognitive development for use in the educational application of video games, particularly Massively Multiplayer Online Role Playing Games (MMORPGs). This paper will therefore begin with an earnest investigation of seminal constructivist Jean Piaget followed by an examination of his student Seymour Papert, who was also a pioneer in educational technology. The paper will conclude with a discussion of David H. Jonassen's more contemporary and more pragmatic work regarding the use of computers as technologies that support meaning making by students. Finally, a working theory of instruction will be presented. This theory will then be applied to the critical examination of digital game-based learning theorists in the depth portion of this core Knowledge Area Module (KAM) demonstration. This in turn will serve to inform further investigations into the potential applications of MMORPGs in education.

Jean Piaget

The foundation of Piaget's (1952) work is the premise that "intelligence is adaptation" (p. 3) and that "life is a continuous creation of increasingly complex forms and a progressive balancing of these forms with the environment" (p. 3). He drew a distinction between the "variable structures" (p. 4) constructed within the mind and the "invariant functions" (p. 4) by which they are constructed. Because they were thought by Piaget to be in consistent operation throughout an individual's lifetime, the invariant

functions, or sometimes “functional invariants” (Elliot, Kratochwill, Littlefield, and Travers, 1996, p. 84) are the cornerstone of these foundational principles. The two “most general” (p. 5) functional invariants identified by Piaget (1952) were “organization and adaptation” (p. 5).

Piaget considered adaptation, which he described as “an equilibrium between assimilation and accommodation” (1952, p.6; 1950, p. 9) to be the most fundamental of the two functional invariants.

Assimilation, then, is the process by which an intelligence “incorporates all the given data of experience within its framework” (Piaget, 1952, p. 6). This assimilation occurs through what Piaget termed judgment, which is not merely “to identify… but… is to… incorporate a new datum in an earlier schema” (p. 410). Assimilation also includes the “the construction of [mental] structures at the same time as the incorporation of things to these structures” (p. 416). In short, assimilation accounts for both the process of incorporating new data into existing structures, and the creation of entirely new structures into which data can be incorporated.

Accommodation, in contrast, refers to the ways in which an intelligence “modifies [it’s earlier schemata] in order to adjust them to new elements” (Piaget, 1952, p. 7). Piaget (1950) postulates that schemata “grow out of one another by means of successive differentiations and integrations, and … must therefore be ceaselessly accommodated to situations by trial-and-error and corrections” (p. 73).

The three terms *framework*, *structures*, and *schemata* can be taken to mean the same thing as *variable structures* above. Some have come to know these simply as *schemes*, or “organized patterns of thought and action, that is, the cognitive structures and

behavior that help [one] to adapt to [the] environment" (Elliot, Kratochwill, Littlefield, and Travers, 1996, p. 85).

The second functional invariant is "organization," (Piaget, 1952, p. 5), a term meant to capture the internal relationships between these variable structures (frameworks, schemata, or simply schemes). As Piaget said, "every intellectual operation is always related to all the others… [and] every act of intelligence presupposes a system of mutual implications and interconnected meanings" (p. 7). Simply articulated, organization is "Piaget's term for the connections between cognitive structures" (Elliot, Kratochwill, Littlefield, and Travers, 1996, p. 85). Piaget (1952) considers "organization… inseparable from adaptation: They are two complementary processes of a single mechanism, the first being the internal aspect of the cycle of which adaptation constitutes the external aspect" (p. 7). In other words, adaptation might be said to describe the way in which a mind takes in data from the environment, while organization describes the way in which this information is stored and used.

Piaget (1950) also assigned a great deal of significance to "social factors in intellectual development" (pp. 171-182), and is careful to establish that "the term 'social' must not be thought of in the narrow sense of educational, cultural, or moral transmission alone; rather, it covers an interpersonal process of socialization which is at once cognitive, affective, and moral" (1969, p. 95). His observations lead him to claim that "society, even more, in a sense, than the physical environment, changes the very structure of the individual, because it not only compels him to recognize facts, but also provides him with a ready-made system of signs, which modify his thought" (1950, p. 171). Elaborating on this theory, he suggests that "social life affects intelligence through the

three media of language (signs), the content of interaction (intellectual values), and rules imposed on thought (collective logical or pre-logical norms)" (p. 171). These social signs, values, and norms are of course also subject to assimilation and accommodation as they are integrated into an individual's mental organization, and as such they take on a new "half-individual, half-socialized" (p. 175) meanings in an individual's mind.

All of these concepts, and the overarching understanding that intelligence is constantly adapting and organizing such that it is constantly "constructing mentally structures which can be applied to those of the environment" (Piaget, 1952, p. 4), have endured and continued to influence other theorists - even where Piaget's theory of stages has fallen under greater criticism. His assertion that "experience… is not reception but progressive action and construction: this is the fundamental fact" (p. 365) has resonated with educators for over half a century. So too has his insistence that intelligence is not simply "an ensemble of responses mechanically determined by external stimuli" (p. 409), but rather "constitutes a real activity" (p. 409). His ultimate conclusion that "the process of construction characterizes [intelligence]" (1950, p. 74), or that "intelligence is the construction of relationships" (1952, p. 418), has become a hallmark of what is now known as constructivist pedagogy.

Piaget (1929) had remarked early in his career that "it is usually just when an implicit conviction is about to be shattered that it is for the first time consciously affirmed" (p. 191). It may seem fitting, then, that one of Piaget's brightest students was soon setting out to shatter his theories.

Seymour Papert

Papert (1980) began his discussion of children and computers with an anecdote of his childhood, and a criticism of Piaget. Papert shared his infantile fascination with cars and the way that "gears, serving as models, carried many otherwise abstract ideas into [his] head" (p. xviii-xix), thus doing "more for [his] mathematical development than anything [he] was taught in elementary school" (p. xviii). This was particularly important because "many years later when [he] read Piaget this incident served [him] as a model for [Piaget's] notion of assimilation, except [Papert] was immediately struck by the fact that [Piaget's] discussion does not do full justice to [Piaget's] own idea" (p. xix). This was because there is an affective component to assimilation in addition to the cognitive component discussed by Piaget (p. xix). Papert's seminal book *Mindstorms* then begins as "an exercise in an applied genetic epistemology expanded beyond Piaget's cognitive emphasis to include a concern with the affective" (p. xx). Papert noted that not everyone had the same affective experience as he did with gears and mathematics, but described his own thesis as "what the gears cannot do the computer might… because it can take on a thousand forms… serve a thousand functions, [and] appeal to a thousand tastes" (p. xxi). In Papert's vision,

> "*the child programs the computer*, and in doing so, both acquires a sense of mastery over a piece of the most modern and powerful technology and establishes an intimate contact with some of the deepest ideas from science, from mathematics, and form the art of intellectual model building." (p. 5)

Perhaps Papert's (1980) greatest contribution with *Mindstorms* was the concept of microworlds as incubators for knowledge (p. 120). This concept of microworlds stems from Papert's belief "that learning physics consists of bringing physics knowledge into

contact with very diverse personal knowledge, [and that] to do this we should allow the learner to construct and work with transitional systems that the physicist may refuse to recognize as physics" (p 122). Microworlds, then, can be considered simply "transitional systems." Papert explores a set of criteria for creating microworlds. The first of these is that the design should be very simple and accessible (p. 126). It must also offer the "possibility of activities, games, art, and so on… to make the activity in microworlds matter" (p. 126). Finally, microworlds should be designed such that "all needed concepts can be defined within the experience of that world" (p. 126).

Ultimately, the goal of a microworld is to help students "get a feel for *why* the world works as it does" rather than "to establish a given truth" as the goal would be in traditional pedagogy (p. 129). Papert points out that "we learned how to build and use theories only because we were allowed to hold 'deviant' views… for many years" (p. 132). In microworlds, unlike in school, false theories are tolerated (p. 132). Learning in microworlds is also product-oriented, such that the child is learning new concepts "as a *means* to get to a creative and personally defined end" (p. 134). Perhaps most importantly, children are able to practice *bricolage*, or tinkering, and to become *bricoleurs*, or tinkerers (p. 173, 175, 223), when learning in a microworld.

When Papert wrote *Mindstorms* in 1980 it was not yet reasonable to expect that every student would have the kind of access to a computer necessary to benefit from becoming a *bricoleur* in *microworlds* like the LOGO programming environment, Papert's attempt at creating a Mathland for children to learn math. However, by 1993, when he wrote *The Children*'s *Machine* computers were becoming common in schools. By that time he was also framing his ideas in the context of helping the United States of America,

his home of 30 years, to regain (from the Japanese at that time), its dominance in the skill of learning (p. vii-x).

By 1993, video games were also common, and within the first few pages of his book, Papert was making the argument that these games encouraged in students "an industriousness and eagerness that school can seldom generate" (p. 3-4), despite the fact that "most are hard, with complex information – as well as techniques – to be mastered" (p. 4). He argued that "video games teach children what computers are beginning to teach adults – that some forms of learning are fast-paced, immensely compelling, and rewarding" (p. 5). In contrast, Papert suggested that "school strikes many young people as slow, boring, and frankly out of touch" (p. 5).

Papert (1993) went on to imagine the idea of a "Knowledge Machine" (p. 8) which would extend the range of experiences with immediacy to a child, by placing "the power to know what others know into [a child's] hands" (p. 9) and allowing the child to "grow up with the opportunity to explore the jungles and cities and the deep oceans and ancient myths and outer space" (p. 9). More importantly, this Knowledge Machine would offer children

> "a transition between preschool learning and true literacy in a way that is more personal, more negotiational, more gradual, and so less precarious than the abrupt transition we now ask children to make as they move from learning through direct experience to using the printed word as the source of important information." (p. 12)

Following the articulation of this revolutionary vision, Papert acquiesced that he shares much with constructivist philosophy, including the "criticism of school as casting the child in the role of passive recipient o knowledge" (p. 14). He suggested, though, that most constructivist experiments had failed because "they simply did not go far enough in

making the student the subject of the process rather than the object" (p. 14). However, he also suggested that they were limited by the fact that they "lacked the *tools* that would allow them to create new methods in a reliable and systematic fashion" (p. 14). Of course, he offers the use of computers "for the construction of microworlds" (p. 17) as just such a tool. He also saw computers as enabling a future in which "millions of children all over the world [will be] engaged in work that makes a real contribution to the … study of a socially urgent problem" (p. 25).

Papert (1993) used personal anecdotes and reflections on the work of Jean Piaget to elucidate his own theory on the importance of "personal thinking" (p. 22) on learning. He was "convinced that the best learning takes place when the learner takes charge" (p. 25) and is able to develop an "intellectual identity" (p. 29), and that children learn to love learning, or particular domains of learning, "for reasons that are as personal and in a sense as irreproducible as those that determine any kind of falling in love" (p. 27). Piaget's suggestion that "play is child's work" (Papert, 1993, p. 33) is important to him as well, as is the opposite suggestion, which Papert makes, that "work (at least serious intellectual work) might be adult's play" (p. 33). He is interested in "mobilizing and strengthen[ing]" (p. 27) such "commonsense knowledge about learning" (p. 27) as opposed to the "prevalent literal-minded, 'what you see is what you get' approach measuring the effectiveness of computers in learning by the achievements in present-day classrooms" (p. 29), a practice he felt "makes it certain that tomorrow will always be the prisoner of yesterday" (p. 29).

As such, Papert (1993) criticized school for giving "more importance to knowledge about numbers and grammar than to knowledge about learning" (p. 85). He was more interested in teaching heuristics (or the art of intellectual discovery) and principles of problem solving (p. 85), such as "trying to think of other problems that are similar to the one in hand" (p. 86), the principle of dividing and conquering to solve a problem as a series of smaller problems (p. 86), and the principle of "taking time" (p. 87-89) when engaging a new problem. Developing these proficiencies would take "more than technical aids" (p. 92) according to Papert; it would also require developing a complex and nuanced system of psychological support (p. 92, 94), which would replace the common "one-dimensional concept of 'being motivated'" (p. 94).

Here, through additional personal anecdotes, Papert (1993) delved more into the nature of learning, suggesting that while it is powerful, the "metaphor of learning by constructing one's own knowledge" (p. 104) was after all only a metaphor. Based on his reflections, he also offers additional metaphors, such as *cultivation*, a garden metaphor, and *connectionism* (p. 104), which suggest "a strategy to facilitate learning by improving the connectivity in the learning environment" (p. 105). Following an additional anthology of learning stories, Papert also makes a distinction between clean and dirty models of learning, where clean signifies the "impersonal technical work [of] mastering a collection of steps" (p. 134) seen in most schools, and dirty signifies learning that does not exclude such elements as social issues, overcoming fear, and bodily involvement (p. 136). Papert (1993) spends an additional chapter exploring the differences between instructionism and constructionism (p. 137-156). Instructionism, as Papert defines it, expresses "the belief that the route to better learning must be the improvement of

instruction" (p. 139), while constructionism "is built on the assumption that children will do best by finding for themselves the specific knowledge they need " (p. 139) and that "education can help most by making sure [students] are supported morally, psychologically, materially, and intellectually in their efforts" (p. 139). Here, Papert once again pointed out that many children "learn difficult video games with no professional teaching at all" (p. 140), thus insinuating that video games have something to teach us about learning and literacy. Perhaps the most important difference between the constructionist learning that happens in video games and the instructionist teaching that happens in schools is that "the principal lesson school teaches is the need to be taught" (p. 141), thus creating "a dependence on school and a superstitious addition to belief in its methods" (p. 141). Papert hoped to encourage "the incitement to revolt against accepted wisdom that comes from knowing you can learn without being taught and often learn best when taught least" (p. 141).

Papert (1993) also goes to some pains to differentiate his theory of constructionism from the more common theories of constructivism. Explaining what he calls his "reconstruction of constructivism" (p. 144), Papert described its main feature as "the fact that it looks more closely than other educational *–isms* at the idea of mental construction" (p. 143) and that it "attaches special importance to the role of constructions in the world as a support for those in the head, thereby becoming less of a purely mentalist doctrine" (p. 143). This focus on constructions in the world extended, for Papert, to virtual constructions created with a computer (p. 116). The concept of *bricolage* made reappearance here "to serve as a source of ideas and models for improving the skill of making – and fixing and improving – mental constructions" (p.

144) with “formal methods on tap, not on top” (p. 146). He felt that Piaget and others “failed to recognize that the concrete thinking they had discovered was not confined to the underdeveloped” (p. 151), that it is “present at the core of important and sophisticated intellectual enterprises” (p. 151) as well.

Though computers were common in schools by 1993, and though *The Children’s Machine* was subtitled *Rethinking School in the Age of the Computer*, only three years later, Papert had all but given up on schools as too resistant to change. In his last major publication, *The Connected Family*, Papert (1996) turned instead to the family as a “major (perhaps *the* major)” force for educational reform (p. 15). He once again built his argument for megachange on the familiar concept that “learning works best when the learner is a willing and conscious participant” (p. 19). In one particular case he shared that his former Ph.D. student Idit Harel discovered that “when students [are] asked to make educational software about a subject they found boring…they developed an interest in the subject and increased their test scores” (p. 21-22). He also based this third and final book on the premise that there are “many more important and long-lasting topics than office computer skills” (p. 28) for students to learn, among them “the study of learning” (p. 28).

Papert (1996) advocated for a return to “home-style learning (sometimes called ‘natural learning or ‘Piagetian learning’)” (p.41-42) in place of “school-style learning” (p. 42). Central to his argument was his belief that “the computer can enrich the home culture so that in many cases in which only school-style learning was available in the past, home-style learning can now work” (p. 42), and he rolled out several anecdotes to illustrate his point (for example a child learning about math from downloading an image

on the internet and discussing the lag time with an elder, p. 42-44). He focused on the family learning culture as "a family's way of thinking about learning – its beliefs, preferred activities and traditions associated with learning" (p. 80) and suggested that "the computer will affect the learning culture and the learning culture will affect what you do with the computer" (p. 81). Most importantly he suggests that children should see adults engaged in learning, and that adults "should also be ready to talk in an uninhibited way with [their] children about learning [they] did on [their] own and about the difficulties [they] encountered, whether [they] overcame them or not" (p. 84).

Constructivism was once again defined in contrast to behaviorism. Papert (1996) described constructivism as arguing "that learning happens best when it is self-directed" (p. 45), as complaining "that much traditional teaching is based on a model of a pipeline through which knowledge passes from teacher to student" (p. 45), and as deriving from "an alternative model, according to which the learner has to *construct* knowledge afresh every time (p. 45). Behaviorism, in contrast, was defined as the practice of breaking up a task into pieces "which fit together in the end like a puzzle" (p. 45) the nature of which need only be known by the teacher.

Returning to the topic of video games, he described the way in which an instructionist might create a game to teach, while a constructionist would ask students to make a game themselves (p. 46-47). More important than either approach, though, is his suggestion to encourage "learning about learning" (p. 49-50) by "engaging children about strategies for learning" (p. 50) when they are playing video games. He suggests that parents "keep it concrete, learn some games under [the child's] tutelage, [and] extend the same idea to discussing 'strategy' as a <u>powerful idea</u>" (p. 50). He even suggested the

meta-activity of creating "a family game out of collecting strategies" (p. 50) related to games (and other pursuits).

Microworlds, too, make another appearance when Papert discussed the use of a "big powerful machine … for making simple, restricted worlds" (p. 56) that are "limited enough to be thoroughly explored and completely understood" (p. 59). "In an analogy between ideas and people," he explains that "microworlds are the worlds of people we know intimately and well" (p. 59). In contrast, he also offered the concept of a hyperworld, or a "large world of.. loose connections" (p. 59) not unlike knowing a person casually. He called the World Wide Web "the ultimate hyperworld" (p. 59). Because it is likely to have "a few focal problems" (p. 60) the task of creating a video game he classified as working in a microworld. In fact, he considered programming "the ultimate microworld" (p. 62). (An updated version of Papert's programming language, LOGO, called MicroWorlds, p. 124, was also included on the companion CD-ROM with the book.)

Asking children to program a video game was also used as an example of how a constructionist solution might solve several ethical dilemmas in education. When a child is designing a game "nobody 'does anything to the child'" (p. 69), thus avoiding the problems of deception and a lack of respect (p. 65) which are often found in educational software.

The concepts of bricklayer, or the process of trial and error (p. 86), and bricoleurs, or tinkerers (p. 87) reappear in Papert's (1996) discussions of the family learning culture, and in yet another discussion about children making a video game (p. 147-148).

Before returning to the discussion of school and the future of education at the end of *The Connected Family*, Papert (1996) offered three guiding principles as advice to parents hoping to incorporate computers into their home learning culture. First, he suggested encouraging "attitudes of extension" (p. 113), which "open doors to further things beyond them" (p. 113), based on the model of good video games, which "have understood the principle of rewarding hard-won achievement by giving players yet more difficult levels of challenge" (p. 113). Second, he suggested that adults "look at what [they] do with [their] computer as a source of ideas about what kids can do with theirs" (p. 113). A sort of corollary to this position is his suggestion to " look with suspicion on anything made for kids that is too boring to be interesting for [adults]" (p. 114). Finally, he called for any good family computer project to "have roots in the culture of children; it must feel to a kid like it is connected with the kinds of things that kids do, and in particular with the kinds of things that kids do with computers" (p. 114).

Finally, the idea of megachange returns in Papert's (1996) appeals for the school of the future:

> "Megachange will come only when most learning is taking place in the course of carrying out challenging projects lasting weeks, months, or years. Here digital technology has a double role: as a material (or a medium), it lends itself to more complex and sophisticated projects than were previously within the reach of children. As an information and communication channel, it allows children to get access to knowledge when they need it instead of when a curriculum says they should get it. This shift makes nonsense of the idea of a lockstep curriculum and, in fact, of the idea of segregating children into grade levels. Indeed, it makes nonsense of the accepted image of school." (p. 160)

David H. Jonassen

In the volume *Constructivism and the Technology of Instruction*, edited by Duffy and Jonassen (1992), the authors explain in the preface that they felt "constructivism [was] not a new perspective… [but that] two changes in our society – the volume of information we must manage and the new opportunities provided through technology – have caused [them] to revisit constructivism" (p. ix). In contrast to the objectivist and behaviorist traditions, Duffy and Jonassen believe constructivism argues "meaning is imposed on the world by us, rather than existing in the world independently of us" (p. 3). Jonassen (1992) further explains that constructivism "is concerned with how we construct knowledge from our experiences, mental structures, and beliefs that are used to interpret objects and events" (p. 139), and that "an important conclusion from constructivist beliefs is that we all conceive of the external world somewhat differently, based on our unique set of experiences with that world and our beliefs about those experiences" (p. 139).

The learning context, in particular, was important to Duffy and Jonassen (1992). They explain that constructivists "emphasize 'situating' cognitive experiences in authentic activities" (p. 4), even when using instructional technologies (p. 4). Phrased another way, they believed that "instruction should provide contexts and assistance that will aid the individual in making sense of the environment as it is encountered" (p. 5). Later, they suggested that "we must aid the individual in working with the concept in the complex environment, thus helping him or her to see the complex interrelationships and dependencies" (p. 8). It is significant, especially in terms of instructional or educational technologies, that they point out "the context need not be the real world of work in order for it to be authentic… rather, the authenticity arises from engaging in the kinds of tasks

using the kids of tools that are authentic to that domain" (p. 9).

As an addendum to his essay on evaluating constructivist learning, Jonassen (1992) also introduced the concepts of incidental learning, such as that which takes place when a student surfs the web or plays a video game at home, and intentional learning of the sort educators charged with helping students to master specified standards are interested in (p. 146).

In the blatantly constructivist volume, *Learning with Technology: A Constructivist Perspective*, Jonassen, Peack, and Wilson (1999) wrote about the use of technologies for meaning making. Jonassen, Peck, and Wilson's (1999) chapter on "Learning by Exploring with Technology" focused on the Internet and World Wide Web, but two elements of this discussion are worth highlighting in this KAM demonstration. They dedicated a section to "Role-Playing on the Web" (p. 33) and discussed the creation of web-based simulations and games; they were especially interested in the promise of new technologies to allow even "elementary students [to] build simple to complex microworlds" (p. 33). Role-playing appeared again in Jonassen, Peck, and Wilson's discussion of visualizing with technology when they suggested that students might "role play press conference(s)" (p. 66). This theme recurred yet again in their treatment of learning by constructing realities with hypermedia, where they shared a handful of examples of "anchoring instruction in hypermedia learning environments" (p. 92), which provide a scenario for the student to explore and play.

Jonassen, Peck, and Wilson (1999) also mentioned the promise of text based MUDs (Multi-User Dungeons, and later Multi-User Domains) and MOOs (Object Oriented MUDs) as a powerful role-playing context for students (p. 140), where students

can “can assume a virtual persona different from their real-world persona” (p. 141). These environments were also associated with “facilitat[ing] dialogue and knowledge building among the community of learners” (p. 200). Although “children enjoyed opportunities to choose their own paths through the environment, with some eventually learning to construct their own rooms and environments” (p. 141), there were some potential drawbacks to the use of these games in education; “boys seemed to show more interest than girls… [and] older children (11-14) participated more than younger children” (p. 141). Modern Multiplayer Online Role Playing Games (MMORPGs) are direct descendents of these early text based games, and may share some of the same potentials and drawbacks.

Jonassen, Peck, and Wilson (1999) also included a description of constructivist learning environments, arguing that “they are comprised of information banks, symbol pads, construction kits, phenomenaria, and task managers” (p. 194). In addition, they discussed the importance of the problem context, the way the problem is first presented to students, and the space in which students can manipulate a problem (p. 197). Constructivist environments must include the information the learner will “need in order to make sense of the topic” (p. 199), as well as the cognitive and conversation tools needed to work together solving the problem (p. 200). Naturally, students must also have social and contextual support in an environment that does not inhibit learning (p. 200-201).

In his discussion of mindtools, Jonassen (2000) returned to the microworlds of Papert (1980). They described microworlds as “primarily exploratory environments, discovery spaces, and constrained simulations of real-world phenomena in which learners

can navigate, manipulate or create objects, and test their effects on one another" (p. 157), and makes this significant observation:

> "Video-based adventure games are microworlds that require players to master each environment before moving onto more complex environments. They are compelling to youngsters, who spend hours transfixed in these adventure worlds. Microworlds are perhaps the ultimate example of active learning environments, because users can exercise so much control over the environment." (p. 157)

Jonassen (2000) explained some of the qualities of well-designed microworlds. In these, "instruction proceeds from simple to complex skills" (p. 159), and the environment exploits "the interest and curiosity of the learner" (p. 159). They should also be "*simple*, so they can be understood, *general*, so they apply to many areas of life, *useful*, so the ideas are important to learners in the world, and *syntonic* (resonant with one's experience), so learners can relate them to prior experience" (p. 159). These elements may be what some games lack, and making these judgments will be one of the challenges of creating good educational games or simulations to serve as microworlds.

The advantages of microworlds are many, and their disadvantages few. Jonassen (2000) considers microworlds to be environments that "encourage active participation" (p. 168), "provide instruction that is situated in rich, meaningful settings" (p. 169), and "support self-regulated learning" (p. 169). However, "their openness can be frustrating at first" (p. 169), and overcoming this may require students to acquire skills they do not posses.

Jonassen returned to, and updated, the ideas from the previous two books in his 2003 publication, *Learning to Solve Problems with Technology: A constructivist Perspective*, a book that "provides a new look at how educational technologies can support knowledge construction through production rather than knowledge reproduction"

(p. v). Before returning to the idea of meaningful learning, Jonassen began by defining learning as (a) biochemical activity in the brain, (b) a relatively permanent change in behavior, (c) information processing, (d) remembering and recalling, (e) social negotiation, (f) thinking skills, (g) knowledge construction, (h) conceptual change, (i) contextual change, (j) activity, (k) distributed among the community, (l) tuning perceptions to environmental affordances, and (m) chaos (pp. 3-5). He then focused in on meaningful learning, which he continued to define as active, constructive, intentional, authentic, and cooperative (pp. 6-8). In the conclusion to the chapter, Jonassen captured these ideas simply:

> "Meaningful learning will result when technologies engage learners in:
> - knowledge construction, not reproduction
> - conversation, not reception
> - articulation, not repetition
> - collaboration, not competition
> - reflection, not prescription" (p. 15)

Finally, Jonassen (2003) turned to how technology can facilitate such meaningful learning, once again looking to technology as support, a vehicle, a context, a social medium, and an intellectual partner (p. 12). Picking up where he left off in the previous book, Jonassen (2003) then went on to explore some of the implications of constructivism for the teacher and for the student. Teachers were called upon to "relinquish at least some of their [intellectual and management] authority" (p. 13), and to "gain some familiarity with the technology" (p. 14). In response, students were expected to assume of the authority relinquished by teachers (p. 15), a process not without risks (p. 15).

The addition of "solve problems" to the title of this text represented a new focus for Jonassen's philosophy. He now believed that "solving problems can… be the most meaningful kind of learning activity in formal educational settings" (p. 20) and that "the

primary, if not exclusive, purpose of all education should be to teach students to solve problems" (p. 20). He was interested in helping students to solve logical problems, algorithmic problems, story problems, rule-using problems, decision-making problems, troubleshooting problems, diagnosis-solution problems, tactical/strategic problems, case/systems analysis problems, design problems, and dilemmas, or ill-structured issue-based problems (pp. 21-24). Problem solving "is more interesting than memorizing" (p. 25) and provides students with a sense of ownership of the material because they are "conceptually engaged" (p. 25). Jonassen suggested that once a problem is identified, then technologies can help students "to seek information needed to solve the problem, model the system or domain in which the problem occurs, make decisions about how to solve these problems, and design different technology-enhanced representations of these systems" (p. 25). Each discussion of a specific technology or strategy that follows ends with a treatment of the learning processes, the problem-solving processes, teacher roles, and assessing learning.

The concept of intentionality was still important to Jonassen, particularly, with respect to moving from information to knowledge through inquiry on the Internet. While "browsing does not necessarily cause thinking... a self-regulated learner who keeps his or her information-seeking goals in mind and makes good decisions can find the WWW an essential information resource during intentional learning" (p. 40). Cooperative, or socially negotiated learning also plays a role in using technology to search for information, as "intentionality and focus are enhanced when a group of learners is committed to the same goals [because] they regulate each other's performance" (p. 41). As an example of a structured inquiry-oriented cooperative Internet learning activity,

Jonassen offers Bernie Dodge's WebQuests, which can "incorporate cooperative learning, consideration of multiple perspectives, analysis and synthesis of information, and creation of original products that demonstrate knowledge gained" (Jonassen, 2003, p. 47). Jonassen also values the element of fun that can be provided by a WebQuest (p. 47). He takes a similar approach to open-ended, student directed research projects (pp. 49-55), web publishing (pp. 55-59), and virtual travel (pp. 60-67).

Jonassen's (2003) discussion of building technology-supported learning communities on the Internet is significant for its approach to MUDs, MOOs, and role-playing games. In contrast to the usual classroom dynamic where students are "disconnected or competing with each other" (p. 72), Jonassen is interested in fostering learning communities where students "share common learning goals or interests" (p. 72), and where emphasis is "placed on the social and cognitive contributions of a group of learners to each other, with students collaborating and supporting each other" (p. 73). Such communities "depend heavily on both student and teacher buy-in, responsibility, and continuing motivation, as well as a rich collection of information and learning resources to support them" (p. 73). In addition to commonplace technologies such as e-mail and instant messaging, MUDs and MOOs can support such learning communities. These "internet-based multiuser environments… are engaging learners in high-level conversations that support personal reflection" (p. 101). In addition, "users can enter the virtual environment and travel between locations – for example, homes, museums, coffee shops, or science labs" (p. 101). MUDs and MOOs were originally text based, but modern massively multiplayer online role-playing games (MMORPGs) now offer similar experiences in 3D graphical virtual environments. In the text based games, "visitors not

only interact, but, depending on their level of experience, can participate in the design and construction of the environment itself" (p. 101) and this is beginning to be true of graphical games as well; most allow players to craft items, and some, such as Linden Lab's *Second Life* rely on user creation of almost all elements of the online environment.

Some educational applications of these technologies had been studied by when Jonassen wrote the book, and he offers these findings:

- "Boys seemed to show more interest than girls in the activity…
- Older children (11-14) participated more than younger children.
- Role-playing opened up interesting possibilities for exploration. Children can assume a virtual persona different from their real-world persona. One young boy, for example, wanted to assume a female identity, while another wanted to play a child from the 18th century.
- Children enjoyed opportunities to choose their own paths through the environment, with some eventually learning to construct their own rooms and environments." (Dyke and Waldorf, 1995, as cited in Jonassen, 2003, p. 103)

Jonassen (2003) also offered this compelling vision of MUDs in the classroom, a vision that applies as well or better to modern MMORPGs:

> "Imagine, for instance, a MUD in which a student is placed on the main street in a small community in colonial America, with the option of entering stores, blacksmith shops, pubs, jails, homes, and other buildings of the period. Inside each building would be descriptions of the people and artifacts it contained. Students would make decisions and express their choices, to which the MUD's characters and objects (and other students) would react. Imagine, too, that teachers and their classes could work together to *develop* new buildings. This option (which is often provided in MUDs) could be great incentive for research, collaboration, problem-solving, and other high-level activities." (p. 104)

Such an environment would be ideal for sort of mentoring that Jonassen (2003) advocates (pp. 108-109), and would also be an environment in which a teacher could foster community, provided the infrastructure would allow for communication – especially feedback (p. 111), attention to student differences (pp. 111), shared culture

(pp. 111-112), adaptation to the needs of student groups (p. 112), dialogue (pp. 112-113), access to information (p. 113), membership (pp. 113-114), and motivation (p. 114). Jonassen offers the advice to teachers that "the concept of learning communities is [only] an ideal" (p. 114), that "technology, resources, and models can help" (p. 115), that "it's not all or nothing" (p. 115), and to "respect [their] own knowledge and situation" (p. 115).

These environments (MUDs or MMORPGs) also make natural microworlds, which Jonassen (2003) is still concerned with. Central to his philosophy is his belief that "transfer of learning, particularly higher order kinds of learning, requires well-developed mental models" (p. 190) and that "in order to construct mental models, learners must explore and manipulate phenomenon, observe the effects, and generate mental representations of those phenomena" (p. 190). This can occur in MMORPGs if they adhere to the four essential characteristics of a microworld, as Jonassen interprets Papert:

- "simple to understand
- reflects generic characteristics that can be applied to many areas of life
- presents concepts and ideas that are useful and important to learners in the world
- reflects syntonic characteristics, which allow learners to relate prior knowledge and experience to current phenomenon being studied" (p. 191)

Jonassen later added the following:

- "Provides a meaningful learning context that supports intrinsically motivated and self-regulated learning
- Establishes a pattern whereby the learner goes from the "known to the unknown"
- Provides a balance between deductive and inductive learning
- Emphasizes the usefulness of errors
- Anticipates and nurtures incidental learning" (p. 193)

In addition to the above, MMORPGs, like other games in general, "can embed cognitive, social, and cultural factors within the environment (Reiber, 1996), which can help learners transfer skills from play and imitation to real situations that they will experience" (Jonassen, 2003, p. 191). Those that allow user creation within the game environment can tap into the idea that "the creation process is an important component of learning (Papert, 1980), which is supported with students constructing their understanding of a phenomenon in a microworld" (Jonassen, 2003, p. 197). Jonassen also points out that "as is the case with most instructional design projects, the people who learn the most are the designers and developers, not the target audience" (p. 191). With respect to virtual reality environments, which modern MMORPGs provide, Jonassen also suggests that active decision-making in the environment "gives students the feeling of participating in a real-world environment, and also transforms learning into exploration" (p. 205).

A working theory

In order to facilitate constructivist cognitive development, a digital game-based learning environment should provide opportunities for context-embedded, inquiry-driven, and socially negotiated (or collaborative) learning. In addition, the support that is necessary and appropriate for individual students to succeed in such an open-ended environment must also be provided. Drawing on the previous sections of this paper, each of these elements is discussed briefly below.

Provide opportunities for context-embedded learning. Piaget believed that the environment provided input for the processes of assimilation and accommodation, which in turn affected the internal organization of individual's mental constructions. It followed that educators cannot influence these processes except through the environment. Therefore, Seymour Papert suggested the concept of microworlds to provide a controlled environment designed to define all necessary concepts while maintaining its simplicity and accessibility, thus allowing students to explore and experiment in a natural active way. His theory of constuctionism also suggested that the act of construction in a microworld was developmentally important. Jonassen, too, was interested in the context of situated experiences, problems, and authentic activities, particularly in simulated or virtual environments such as microworlds.

Provide opportunities for inquiry-driven learning. Piaget was interested in students being able to act as little scientists when making inquiries and discoveries about the world. Papert's anecdote about his love for gears leading him to the study of in mathematics is an excellent example of this principle in action. Papert believed that students should not be passive recipients of knowledge, but that they should be active in their own inquiries; after all, the philosophy of constructionism was focused on the value of students discovering on their own the knowledge they need for their own inquiries, and coming to love learning was as personal an affair (in his mind) as falling in love with another person. Inquiry is born of the need to solve a problem, and Jonassen felt that teaching students to solve problems should be the primary purpose of education, and wanted to see students (and school systems) move from a focus on information to a focus on inquiry.

Provide opportunities for socially negotiated (collaborative) learning. Piaget, felt that the social environment was even more powerful an influence than the physical environment in developing and modifying an individual's mental constructs. Piaget's student, Seymour Papert went on to advocate a dirty education that did not exclude social issues. In his later work, Papert turned to the family culture to model ways of thinking, including beliefs, activities, traditions, and especially the pursuit (and love) of learning – especially ways in which adults overcome obstacles in learning. Jonassen was explicitly interested in socially constructed (or negotiated) meaning making and in creating common understanding through conversation. He also advocated the acceptance of distributed knowledge and processing capacity within a social group or groups. Finally, he called for collaboration, not competition, in a constructivist learning environment.

Provide support for content-embedded, inquiry-driven, and socially negotiated (collaborative) learning. Elliot, Kratochwill, Littlefield, and Travers cautioned followers of Piaget's philosophies to provide direction and guidance to students involved in active Piagetian learning. Papert recognized this when he suggested developing psychological support systems for students in addition to providing them with the technologies, such as microworlds, necessary for his brand of inquiry-driven learning. Papert was also one of the early voices for on-demand information, a cause that Jonassen also took up. Jonassen's most important contribution, though, was the concept of providing intentionality for student activities. In addition he was concerned that teachers must not only model, coach and scaffold learning for students, but also become familiar in the technologies used to do so. Naturally, any design for a context-embedded, inquiry-driven, and socially negotiated learning environment must also provide support for teachers,

classroom management, curriculum coverage, and time allocation.

Games, or video games specifically, can provide all of these things in an engaging and motivating package. Papert called for the use of video games as microworlds for teaching students, especially when teaching them how to learn. Jonassen, too, was interested in video games, especially role playing games, as microworlds; he recognized the incidental learning that takes place in a video game, called them the ultimate example of active learning environments, and suggested schools could focus similar experiences on intentional goals.

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Depth

Introduction

The breadth portion of this Knowledge Area Module (KAM) presented a working theory of instruction based on the constructivist cognitive development theories of Jean Piaget, Seymour Papert, and David H. Jonassen. It concluded with the suggestion that to facilitate constructivist cognitive development, a digital game-based learning environment should provide opportunities for context-embedded, inquiry-driven, and socially negotiated (or collaborative) learning. In addition, the support that is necessary and appropriate for individual students to succeed in such an open-ended environment must also be provided.

The purpose of this depth portion of the KAM is to critically examine theories of digital game-based learning in light of this working theory of constructivist instruction. Sections related to context, inquiry, collaboration, and support will therefore appear in the discussion of each author below. This portion will begin with an investigation of Marc Prensky's initial contributions to the field of digital game-based learning, followed by an examination of James Paul Gee's pioneering work about video games and literacy. The critique will conclude by addressing Clark Aldrich's discussions of games and simulations as the future of learning.

In this discussion, particular attention will be given to exploring the potential applications of massively multiplayer role playing games (MMORPGs) as constructivist learning environments in formal education. The conclusions of this depth portion of the KAM will be used to guide the application portion and to inform future research into the

potential educational applications of video games, particularly MMORPGs.

Marc Prensky

In his discussion of how games teach and why they work, Prensky (2001) invoked the constructivist theories of Jean Piaget and Seymour Papert, both of whom were discussed in the Breadth section of this KAM demonstration (p. 162). Prensky was particularly interested in Papert's suggestions that kids do not dislike school because it is too hard, but because it is boring (p. 18), and that game designers know more about learning than curriculum designers (pp. 97, 131). Prensky also believed that megachange was necessary in schools, because, as Papert had said, "putting a computer in [a] classroom is like strapping a jet engine on a stagecoach" (Papert, as quoted in Prensky, 2001, p. 187). Jonassen's philosophy was also present in Prensky's work; he discussed the difference between incidental and intentional learning (p. 155).

The key premise of Prensky's (2001) *Digital Game-Based Learning* was that "by marrying the engagement of games and entertainment with the content of learning and training it is possible to fundamentally improve the nature of education and training for… students and trainers" (p. 5), a suggestion made at a time when the "video and computer games [had] equaled or surpassed movie box office in revenue" (p. 9). He felt that "the true twenty-first century learning revolution is that learning – training and schooling – is finally throwing off the shackles of pain and suffering that have accompanied it for so long" (p. 14). According to Prensky, this was necessary because "*learners have changed in some fundamentally important ways*" (p. 16).

In his landmark article *Digital Natives, Digital Immigrants*, Prensky (2001a) introduced the metaphor of students who grow up with new technologies being "**digital natives**" (p. 1), while their teachers who must learn new technologies are considered "**digital immigrants**" (p. 2). He suggested that teachers who are digital immigrants need to change the way they teach in order to reach the digital natives; his preferred solution was the use of computer games for teaching even serious content (2001a, p. 4); though video and computer games are not the only way to effectively teach digital natives, he (2001) felt they were "one of the few structures that we currently have that is capable of meeting many of the Games Generation's changing learning needs and requirements" (p. 65). In response to the question of whether or not digital natives *really* think differently, Prensky (2001b) offers evidence of the brain's neuroplasticity (p. 1) and malleability (p. 2), concluding that digital native's brains develop differently (p. 3). In *Digital Game-Based Learning*, Prensky, (2001) Identifies and explains ten differences in cognitive style between digital natives and immigrants:

> "1. Twitch speed vs. conventional speed
> 2. Parallel processing vs. linear processing
> 3. Graphics first vs. text first
> 4. Random access vs. step-by-step
> 5. Connected vs. standalone
> 6. Active vs. passive
> 7. Play vs. work
> 8. Payoff vs. patience
> 9. Fantasy vs. reality
> 10. Technology-as-friend vs. technology-as-foe" (p. 52)

Prensky (2001), citing Massively Multiplayer Online Role-Playing Games (MMORPGs) such as *Everquest* as examples of the pervasive fantasy elements in students' lives, suggested that educators might take advantage of these differences rather than "admonish Games Generation workers to 'grow up and get real' and abandon their rich fantasy worlds" (p. 62). Using the video and computer games that students play is one way to take advantage of their new digital age aptitudes and learning styles.

Prensky (2001) believed that games can be effective teaching and learning tools because they are learner-centered (p. 90), are excellent learning motivators (p. 100), and are engaging (p. 106). He considered well-designed games to be balanced (challenging but fair), creative (as opposed to formulaic), focused (fun – but without distractions), character-driven, story-driven (with a tension born of caring), and energetic (due to movement, momentum, and pacing) (pp. 133-134). Ultimately, Prensky thought that digital game-based learning works for three reasons: engagement, the interactive learning process, and the way these two elements are put together (p. 147). He categorizes existing interactive learning techniques used in digital game-based learning as:

- "Practice and Feedback
- Learning by doing
- Learning from mistakes
- Goal-oriented learning
- Discovery learning and 'guided discovery'
- Task-based learning
- Question-led learning
- Role Playing
- Coaching
- Constructivist learning
- 'Accelerated' (multi-sense learning
- Selecting from learning objects
- Intelligent Tutoring" (p. 157)

Perhaps the most important of these is Role Playing, which is particularly appropriate for teaching "soft skills" (p. 161), and which can increase learning by extending the duration of a traditional live role plays.

Role playing games (RPGs), including MMORGPs, can incorporate many of the other techniques as well. RPGs and MMORPGs can also include elements of reflection (p. 167), the inclusion of which Prensky (2001b) considers "one of the most interesting challenges and opportunities" of teaching digital natives (p. 5). Prensky suggests several MMORPGs as examples of the sort of complex games that have the most educational potential (2005a, p. 7). In addition, Role Playing Games would be ideal for the teaching of ethics (Prensky, 2001, p. 263, 283) and risk-taking (p. 288). In general, Prensky believed that the value of games in education becomes evident when one asks *how* students learn *what* (2001, p. 80; 2002, p. 8). For example, perhaps how students learn economics and management is not from reading, but from participating in running a business; in "Beyond the Lemonade Stand," Prensky, discussed the ways in which players learn principles of economics and management while playing an MMORPG.

Though Prensky (2001) is primarily concerned with corporate training, he does consider digital game-based learning in grades k-12 (pp. 187-194). He includes examples of successful digital game-based learning initiatives in schools, but concludes that "while Digital Game-Based learning probably holds more opportunity for school-age kids than for any other group, it is going to take a while" (p. 193). Even so, the next steps are well worth taking; games show a great potential to provide a context for learning,

opportunities for inquiry, frameworks for collaboration, and the support needed to integrate these elements into effective constructivist learning experiences.

Context. Prensky's theories support the notion that video and computer games can help provide a context for learning. In his discussion of why games are engaging, Prensky (2001) highlighted several relevant concepts; games have rules, goals, outcomes/feedback, conflict/competition/challenge/opposition, problem solving, interaction, representation, and story (p. 106), including character (p. 134). Many of these elements reappear in his discussion of what makes a game (pp. 118-127). Regarding goals specifically, Prensky suggests elsewhere that the goals must be "worthwhile" (2005a, p. 9), or specifically "worth it to [students]" (2005, p. 4), to be effective. When he covers game design, he considers the way in which a game must be balanced so that "the game is neither too hard nor too easy at any point" (Prensky, 2001, p. 133). A well-designed game, particularly an RPGs or MMORPG, can also include elements of exploration and discovery as well (p. 136).

In his projection of the future of digital games, Prensky (2001) predicts that games will be "much more realistic, experiential, and immersive" and include "more and better storytelling and characters" (p. 404).

Inquiry. The potential for games to offer opportunities for inquiry appears in Prensky's work. According to Prensky (2001), the digital natives, or the games generation, prefer "random access vs. step-by-step" (p. 54) instructions, and feel constrained when required to follow a single path or thought instead of being allowed to make their own connections (p. 54-55). They also prefer "active vs. passive" (p. 59)

learning in which they learn by experimentation. Prensky suggests that well-designed games provide an interactive environment which allows digital natives to learn in this way, and which adapts to their needs, allowing them to remain in a flow state of optimal learning (p. 106). While a game will include the structure of rules, goals, and objectives, it can also offer interaction and individualized feedback in ways that classrooms often do not (p. 119). This is because good games will keep "*a constant focus on the player experience*" (p. 134) and remain "*highly adaptive* [in order to] be fun for a variety of players" (p. 135). Perhaps most important, a good game "*includes exploration and discovery*" (p. 136).

When explaining the value of complex games for learning, Prensky (2005) stressed the "number of choices of decisions a player must make in the game" (p. 10), especially in contrast to classrooms, where "the time between decisions can often be measured in hours" (p. 10).

Ultimately, Prensky (2001) suggested that future players will be allowed even greater freedom in determining the direction of their individual inquiries, because "*we will create the games we want*" (p. 405).

> "We will have the ability to set enormous amounts of parameters, from who we are, to where the game happens, to who the players and opponents are, to how much challenge we want that day. In addition, the games will learn about us as we play, and adapt on the fly to what we enjoy. We will be able to take any perspective and viewpoint we choose. We will input our own individuality and creativity into our games as we do into our houses and clothes. In this sense, we will all design our own games." (Prensky 2001, p. 405)

Collaboration. Prensky (2001) saw the potential of video and computer games to provide a framework for collaborative learning. Whether in-game (as opponents or teammates), or in the activities surrounding the game (as fellow players and fans of the game), most good games offer players a degree of interaction with social groups (p. 106). Prensky considers this interaction between players more important than their interaction with the computer running the game (or with non-player characters in a game), and suggests that players tend to prefer playing with others, even going so far as to say that "like the internet, computer games are bringing people into closer social interaction – although not necessarily face to face" (p. 123).

"One key lesson many of [the digital natives'] games are teaching them is the value of people working together and helping each other" (Prensky, 2004, p. 1). In their games, they are able to "coordinate their activities online, and to run projects that may involve hundreds of people" (Prensky, 2004b, p. 7). This is such a powerful effect that the US Army turns to games in order to help them "take individuals and mold them into well functioning teams" (Prensky, 2001, p. 303). This is also one of the more motivating and engaging elements of modern games, particularly MMORPGs (Prensky, 2004, p. 4).

Prensky predicts that digital games of the future "will be fully online, wireless, and massively multiplayer" (p. 404) and that "communication and cooperation will become more important elements" (p. 405). With respect to learning, he projects that teachers and learners will be "hooked up to massive, persistent, multiplayer games where learning can be constantly happening, revisions input, students evaluated, and scores compared and tabulated" (p. 407).

Support. Much of what Prensky (2001) discussed related to how games (and teachers) can provide the necessary support for effective teaching and learning to take place. For instance, games have rules that give players structure (p. 106). Also, in order to focus on player experience, good games must "mak[e] the game accessible to their entire audience, including new players who might find challenging what has become trivial to the designers" (p. 134). Not only must good games be easy to learn, but they must be hard to master, thus "providing hours, or even lifetimes of challenge" (p. 135) In order to be successful, games must have a strong structure that is well thought out in advance, yet they must remain highly adaptive and "fun for a variety of players" (p. 135). They must even remain fun by "walk[ing] that fine line between not too hard and not too easy, and do it for a variety of players" (p. 135). Ideally, a good complex game "adapts to each player's skills and abilities through highly advanced artificial intelligence programs that sense just how a player is doing, and then change[s] the game slightly whenever the player leaves the 'flow zone' in order to move that player back into it" (Prensky, 2005a, p. 8).

Good games can also include "*frequent rewards, not penalties*" (Prensky, 2001, p. 135). In fact the motivational and engaging elements of games can be considered part of their support structure. Prensky identifies "fun the great motivator" (p. 107) and suggests that "the principal roles of fun in the learning process are to create *relaxation* and *motivation*" (p. 111) Similarly, he considers play "the universal teacher" (p. 111) and reports evidence that "people enjoy difficult tasks more when presented as play rather than work, and their minds wander less" (p. 115). The win states inherent in many games

can also be motivating and gratifying (p. 106). In "Evolving Instruction," Prensky (2002a) challenges academia to find new sources of motivation in order to capitalize quickly on new virtual environments; naturally, he suggests games as a solution (p. 6)

Another support element that might be considered rewarding is a concept that Prenksy calls "*mutual assistance – one thing helps to solve another*" (p. 136); in other words "clues about one puzzle or task can be embedded into another puzzle or task" (p. 136). In good games, the things that players learn early on, help them be successful later in the game.

Several logistical considerations can provide support as well. The game interface must be useful (Prensky, 2001, p. 136). Ordinarily this interface must provide "*the ability to save progress,*" thus allowing players the flexibility to continue a game from the point at which they stopped and saved (p. 136). Of course, the content must also be meaningful, but Prensky (2001) projected that future games will have many "*new game forms and subject matters*" (p. 405), many of which will be suited to intentional formal learning. He also predicted that games will become "*even more engaging"* (p. 406), which will support student learning. In terms of developing these games, Presnksy suggested an open and collaborative model not unlike that of the existing open source software movement (2002b, p. 3)

Games used in formal education must provide support for different cultures and individuals. Games must support the needs of those who are not digital natives (including teachers), allowing them the privacy to practice in order to overcome any embarrassment (Prensky, 2001, p. 138, p. 386). In general, games will need to provide support for the

needs of non-gamers of any age (p. 387). Naturally, learning games will need to address the issue of violence in video games in such a way as to avoid offending (or harming) students from various cultures (p. 139). Most importantly, games used in schools must address the needs of both genders, despite the traditionally male dominated history of commercial video and computer games.

However, the role of the teacher can be more important than any element built into a game. Prensky (2001) laid out a variety of other new roles for teachers, including being a motivator, a content structureer (integrator/reformulator), a debriefer, a tutor (individualizer, steerer, selector, adjuster, guide, facilitator), and a producer/designer (pp. 374-353). Of these, the role of the teacher in facilitating debriefings following game play may be the most vital (p. 240). Furthermore, Prensky (2002) reported that the difference between results of one-on-one tutoring and classroom learning is two standard deviations (p. 10). However, video and computer games can offer more one-to-one learning time – more student-to-computer time, and, because many students are engaged with the computer, more student-to-teacher time. Applied strategically, computer games and teachers can be a powerful combination.

James Gee

In his review of James Paul Gee's *What Video Games Have to Teach Us About Learning and Literacy,* Prensky (2003a) wrote that Gee "did something that is extremely unusual, courageous, admirable, and potentially quite helpful to a great many [of his readers]" (p. 3). Though he criticized Gee's use of jargon, Prensky was "a very big

supporter of Gee's overall message that games are powerful learning tools" (p. 3). Gee, like Prensky, was also interested in the concept of "hard fun" perpetuated by Seymour Papert (p. 165) and his work provided a rich discussion focused on principles of learning which good video games often exemplify, but which many classrooms do not.

Context. Like Prensky, Gee discussed ways in which video games can provide a context for learning. Gee (2003), a linguist and cognitive scientist asserted that "words, symbols, images, and artifacts have meanings that are specific to… particular situations (contexts)" (p. 24). He argued that a good game can provide a "context within which to understand and make sense of what one is going to do" (Gee, 2004, p. 64). He also suggested that "the theory of learning in good video games is close to… the best theories of learning in cognitive science" (Gee, 2003, p. 7). In the constructivist tradition, Gee argued that learning involves situating (or building) meanings in context, and that "video games are particularly good places where people can learn to situate meanings through embodied experiences" (p. 26). He highlighted examples in which "the player (learner) is immersed in a world of action and learns through experience, though this experience is guided or scaffolded by information the player is given and the very design of the game itself" (Gee, 2005, p. 59). Gee (2003) understood that "meaning and knowledge are built up through various modalities (images, text, symbols, interactions, abstract design, sound, etc.)" (p. 111), which video games can provide in spades. The learning context itself took on a special meaning for Gee, because he believed that "thinking, problem solving, and knowledge are 'stored' in material objects and the environment" (p. 111).

Gee (2003) focused on the way that video games can provide a learning

environment that is "set up to encourage active and critical, not passive, learning" (p. 49). He believed that active critical learning was based on experiencing (seeing, feeling, and operating on) the world in new ways (p. 23), and on being able to not only "understand and produce meanings" in the domain being learned, but also being able to "think about the domain at a 'meta' level as a complex system of interrelated parts" (p. 23).

However, Gee was most interested in the way that good games can facilitate learning by requiring players to take on a new identity and form "bridges from [their] old identities to the new one" (p. 51). He felt that "all deep learning – that is active, critical learning – is inextricably caught up with identity" (p. 51), and he tapped into the tradition of Piaget's little scientists when he offered the example of "a child in a science classroom engaged in real inquiry, and not passive learning, [who] must be willing to take on an identity as a certain type of scientific thinker, problem solver, and doer" (p. 51). This concept he extended to the many roles that students might play in good role-playing video games, which he reported made him "think new thoughts about what [he as a player] valued and what [he] did not" (p. 56). He suggested that game designers and teachers "need to create a game-like biology world in which learners can act and decide as certain types of biologists" (Gee, 2005, p. 85) in order to help students become "authentic professionals [with] specific knowledge and distinctive values tied to specific skills gained though a good deal of effort and experience" (p. 51). Gee felt that good games can facilitate learning that "involves taking on and playing with identities in such a way that the learner has real choices" (p. 67).

Even at a more basic level, Gee (2003) believed that "basic skills are not learned in

isolation or out of context; rather… a basic skill is discovered bottom up by engaging with the domain" (p. 137). Gee also suggested that learners should get "lots of practice in a context where the practice is not boring (i.e. in a virtual world that is compelling to learners on their own terms and where the learners experience ongoing success)" (p. 71).

Gee offered the following recipe for providing students with a context for learning.

> "The recipe is simple: Give people well designed visual and embodied experiences of a domain, through simulations or in reality (or both). Help them use these experience to build simulations in their heads through which they can think about and imaginatively test out future actions and hypotheses. Let them act and experience consequences, but in a protected way when they are learners. Then help hem to evaluate their actions and the consequences of their actions (based on the values and identities they have adopted as participants in the domain) in ways that lead them to build better simulations for better future action. Though this recipe could be a recipe for teaching science in a deep way, it is [also] a recipe for an engaging and fun game. It should be the same in school." (Gee, 2005, p. 63)

Inquiry. Gee's work, like Prensky's, illuminates the potential of video games to provide learners with opportunities for inquiry. Implicit in the Active Critical Learning Principle (Gee, 2003, p. 39) is the presumption that interacting with the learning environment in a way that is not passive involves a measure of learner initiative, which can be inqury-driven by their individual interests and strengths. The Probing Principle (Gee, 2003, P. 107) makes this element of inquiry explicit, suggesting not only that a learner should be "probing the world (doing something)" (p. 107), but that they should be forming, testing, and re-forming hypothesis about the world. Naturally, the direction this cycle of probing and re-probing takes, will be driven by the learner's own curiosity. This sentiment is formalized in the Multiple Routes Principle, which values learning that allows "learners to make choices, rely on their own strengths and styles of learning and

problem solving, while also exploring alternative styles" (p. 108).

An integral element of inquiry-driven learning, perhaps even the goal of inquiry-driven learning, is the possibility of student discovery. This surfaces in Gee's (2003) Discovery Principle (p. 138), in which he suggests that good games keep overt telling to a "well-thought-out-minimum, allowing ample opportunity for the learner to experiment and make discoveries" (p. 138). Gee (2005b) also encourages educators and game designers to empower learners; he asserts that "good learning requires that learners feel like active agents (producers) not just passive recipients (consumers)" (p. 25). In light of the fact that different learning styles appeal to (and work for) different people, Gee suggests that "people cannot be agents of their own learning if they cannot make decisions about how their learning will work" (pp. 25-26) and advocates allowing learners to customize their experience. Again, good games, particularly RPGs and MMORPGs, allow learners to heavily customize their experience, even including their identity by manipulating such things as their appearance, physical attributes, and skills. This leads to Gee's belief that "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" (p. 26). Finally, games (or other learning environments) must provide learners with the tools necessary to manipulate elements within the learning context, for as Gee says, "humans feel expanded and empowered when they can manipulate powerful tools in intricate ways that extend their area of effectiveness" (p. 26).

Collaboration. Like Prensky, Gee also found a good deal of value in games as a framework for collaborative learning and socially negotiated meaning making. His concern that "children are expected to read texts with little or no knowledge about any social practices within which those texts are used" (Gee, 2003, p. 16) lead to his initial focus on the importance of connecting learners with *affinity groups*, or "insiders" who are "into" a certain semiotic domain and share "certain ways of thinking, acting, interacting, valuing, and believing" (p. 27). He explained that people who play particular games, or genres of games, are able to connect with an affinity group (online or gathered around a game console), even if the game is not multiplayer (p. 27). In a way, even players of a single player game are also collaborating with the game designers in co-creation of the story line (p. 81).

These ideas initially culminated in Gee's (2003) Affinity Group Principle, which focused on the need for learners to be a part of "a group that is bonded primarily through shared endeavors, goals, and practices... not shared race, gender, nation, ethnicity, or culture" (p. 197). However, he later refined this idea and focused more on *affinity spaces* (Gee, 2004, p. 77). Though he continued to validate the importance of a "community of practice" (p. 77), he turned instead to focusing on the "*space* in which people interact" (p. 77). In addition to the original Affinity Group Principle, he added that in an affinity space newcomers are not separated from masters, both individual and distributed knowledge are encouraged, dispersed knowledge is encouraged, tacit knowledge is encouraged (and honored), there are different routes to status, and leadership is porous (and leaders are resources) (pp. 85-87).

The Intuitive Knowledge Principle, which concerns the construction of tacit knowledge "through repeated practice and experience" (p. 111), suggested that this happens "in association with an affinity group" (p. 111) as well. In addition, three more of Gee's principles related to Cultural Models. He advocated that learning should be set up, and is in many good video games, such that "learners come to think consciously and reflectively" (pp. 166-167) about their cultural models regarding the world, learning, and semiotic domains.

When Gee (2003) addressed multiplayer games, including MMORPGs such as Everquest, he wrote explicitly about learning as a social process that happens in the game (p. 169). He discussed the way meaning and knowledge are both "*distributed* across the learner, objects, tools, symbols, technologies, and the environment" (emphasis added, p. 197) and "*dispersed* in the sense that the learner shares it with others outside the domain/game, some of whom the learner may rarely or never see face-to-face" (emphasis added, p. 197). Very much in keeping with the constructivist tradition, Gee felt that the learner should be "an 'insider', 'teacher', and 'producer' (not just a 'consumer') able to customize the learning experience and domain/game from the beginning and throughout the experience" (p. 197).

Gee (2003) also wrote a chapter concerning "the ways in which content in video games either reinforces or challenges players' taken-for-granted perspectives on the world" (p. 140). He predicts that

> "this is an area where the future potential of video games is perhaps even more significant than their current instantiations. It is also an area where we enter a realm of great controversy, controversy that will get even more

> intense as video games come to realize their full potential, for good or ill, for realizing worlds and identities." (Gee, 2003, 140)

Support. In addition to being interested in the way good games can provide a context for learning, opportunities for inquiry, and a framework for collaboration, Gee is also interested in the additional support games can offer for active critical learning.

Motivation is one of the key support elements games can provide, and Gee (2003) called good teaching and learning a matter of three things: enticing the learner to try, to put in lots of effort, to achieve some meaningful success (p. 61-62). He began *Why Video Games are Good for Your Soul* with a discussion of the motivating pleasures even simple games such as Tetris can bring a player (Gee, 2005, p. 13). He went on to say that "cognitive science… has shown quite clearly that feeling and emotion are not peripheral to thinking and learning" (p. 30), and that "if learners are to learn… deeply… then they need to feel and care about the world… in which they are playing" (p. 30). An interactive game space can offer "rewards from the beginning, customized to each learner's level, effort, and growing mastery and signaling the learner's ongoing achievements" (Gee, 2003, p. 67).

A game space, as opposed to a real space, may also allow learners to take risks where consequences are lowered (p. 67). Gee wrote about a "Regime of Competence" (p. 71) when he explained that good games allow learners to "operate within, but at the outer edge of, his or her resources, so that at those

points things are felt as challenging but not 'undoable'" (p. 71). Later he reverted to Vygotsky's term, the "Zone of Proximal Development" (Gee, 2004, p. 66), and illustrated how games can "help learners (players) pull of more than they could on their own and yet still feel a sense of personal accomplishment" (Gee, 2004, p. 66). Gee even expected a game to be "pleasantly frustrating" (Gee, 2005a, p. 26) such that "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" (p. 26). Also, because "people don't like practicing skills out of contest over and over" (p. 27), good games allow learners to "see a set of related skills as a strategy to accomplish goals they want to accomplish" (p. 27).

Gee (2003) was also interested in the ability of games to provide early learning situations that lead to "generalizations that are fruitful for later stages" (p. 137). He later wrote about the need for well-ordered problems that lead learners "to solutions that work well, not just on [the current] problems but as aspects of the solutions to later, harder problems" (Gee, 2005a, 26). In contrast, he also expected good games to allow learners to practice skills "until they are nearly automatic, then [to have] those skills fail in ways that cause the learners to have to think again and learn anew" (p. 27) in cycles of expertise. In addition, virtual contexts can provide a greater amplification of input for the learner; in other words, "for a little input, learners get a lot of output" (Gee, 2003, p. 67). Because of these elements, and because of the tireless replayability of a game (as opposed to a teacher who may quickly tire of explaining things more than once), games can

offer learners "a context where the practice is not boring" (p. 71) so that "they spend lots of time on task" (p. 71). Learners should also be given "ample opportunity to practice, and support for, transferring what they have learned earlier to later problems, including problems that require adapting and transforming that earlier learning" (p. 138).

Though one of the benefits of games is that they can provide an authentic context for student tasks, they can also provide support within this context, such that "learning even at its start takes place in a (simplified) subset of the real domain" (Gee, 2003, p. 137). This Gee (2003) called the Subset Principle (p. 137), and later "fish tanks" (2004, p. 61 and 2005a, p. 27), "supervised fish tanks" (2004, p. 65), "supervised sandboxes" (p. 66), "unsupervised sandboxes" (p. 70), and simply "sandboxes" (2005a, p. 27), but this might have been called a microworld by Papert and others. In a well-designed microworld, learners will see, "especially early on, many more instances of fundamental signs and actions than would be the case in a less controlled [context]" (Gee, 2003, p. 137).

Because "human beings are quite poor at using verbal information (i.e. words) when given lots of it out of context and before they can see how it applies in actual situations" (Gee, 2005a, p. 27), perhaps the most obvious form of support a game world can provide learners is the availability of "information both on-demand and just-in-time, when the learner needs it or just at the point where the information can best be understood and used in practice" (Gee, 2003, p. 138).

Twenty-first Century Skills. Gee has discussed many potential benefits of video games in education which are not neatly categorized within the framework of context, inquiry, and collaboration, yet are also too significant to be described merely as support. These additional benefits may, however, be described as helping students to develop twenty-first century skills such as digital age literacy, inventive thinking, effective communication, and high productivity (North Central Regional Educational Laboratory and the Metiri Group, 2003, p. 5).

Twenty-first century skills include a variety of digital age literacies, such as basic (reading, writing, and calculating), scientific, economic, technological, visual, information, multicultural, and global literacies (North Central Regional Educational Laboratory and the Metiri Group, 2003, p. 13). Gee (2003) touched on several of these. He described the way that video games can help develop a student's multimodal literacy (p. 14). This idea reappeared in his semiotic principle, which expressed the way in which students understand "interrelations within and across multiple sign systems (images, words, actions, symbols, artifacts, etc.)" (p. 49)

Gee (2003) also considered the metalevel thinking involved in mastering a semiotic domain; he felt that "learning involves active and critical thinking about the relationship of the semiotic domain being learned to other semiotic domains" (p. 50). This principle concerns many of the same values as the twenty-first century skill of inventive thinking, including curiosity (North Central Regional Educational Laboratory and the Metiri Group, 2003, p. 38), "thinking about

problems from multiple perspectives" (p. 34), and "higher order thinking and sound reasoning" (p. 44). Gee (2003) also explained that through playing video games and reflecting on the experience, students can learn to become self-teachers, an inventive thinking skill called simply self-direction by the North Central Regional Educational Laboratory and the Metiri Group (2003, p. 33). Later, he discussed the appropriateness of video games as a way to teach systems thinking (Gee, 2005a, p. 28), a skill that helps students to be adaptable and to manage complexity, both of which constitute twenty-first century skills (North Central Regional Educational Laboratory and the Metiri Group, 2003, p. 33).

Gee's (2003) Semiotic Domains Principle touched on the importance of learners being able to participate in an affinity group associated with a domain of study (p. 49). This includes elements of effective communication (a twenty-first century skill), such as "teaming and collaboration" (North Central Regional Educational Laboratory and the Metiri Group, 2003, p. 48), "social and civic responsibility" (p. 54), and "interactive communication" (p. 56).

The design principle discussed by Gee (2003), explains that students "learn[ing] about and come[ing] to appreciate design and design principles is core to the learning experience" (p. 49). This is also a part of the twentieth century skills of high productivity, particularly those of "prioritizing, planning, and managing for results" (North Central Regional Educational Laboratory and the Metiri Group, 2003, p. 60), but also "effective use of real world tools" (p. 62) and the "ability to produce relevant, high quality products" (p. 64).

Gee (2003) was particularly interested in games that challenge learners' thoughts and values (p. 56), that help them develop a sense of ethics (p. 79), and to come to a greater degree of self-knowledge (p. 67). These interests are not only related to the digital age literacies of multicultural and global awareness (North Central Regional Educational Laboratory and the Metiri Group, 2003, p. 15), but also to the personal, social, and civic responsibilities of an effective communicator (p. 47). The alignment of these concepts is even more clear in Gee's (2004) discussion of affinity spaces (p. 98) and networks (p. 99).

Clark Aldrich

In *Digital Game-Based Learning*, Marc Prensky (2001) shared a phone conversation in which Clark Aldrich pointed out that "the online gaming world… is a self-generated, well-served, highly active, thriving community of learners " (p. 222). Prensky, like Aldrich, was concerned with whether simulations might be useful for game based learning, but questioned whether simulations were actually games (p. 210). After discussing the relationship between the two, Prensky offered advice on how to make a simulation a game (p. 215). Prensky also quoted Aldrich as consistently telling clients to "get more gamelike" in their simulation designs (p. 286). Four years later, Aldrich (2004) wrote *Simulations and the Future of Learning*, in which he in turn cited Marc Prensky's metaphor of digital natives and digital immigrants (p. 218). In the introduction of his following book, *Learn by Doing*, Aldrich (2005) was still drawing on Prensky's ideas in his discussion of how "students are changing" (p. xxix).

In contrast, Aldrich (2005) seemed more critical of James Gee's "wide-ranging hypotheses, organized pre-proof, established by reason… WHOPPERs for short" (p. xxxiv), though he did not mention Gee by name. Aldrich himself was not an academic and proudly declared his lack of desire to ever be one (p. 91). Still, as an experienced practitioner and researcher he offered a powerful vision of what the world would be like "if e-learning truly worked" (Aldrich, 2004, p. 1-2) described the conception, design, building, and marketing of "a new-generation educational simulation" (p. 9), and advocated for new genres of computer games and simulations, such as the interpersonal genre typified by *The Sims* and *Virtual Leader*, in order to present cyclical, linear, and systems content (p. 64). Considering the games or simulations debate, he suggested that "it is more productive to think about the distinct *elements*, namely: *Simulation* elements, *Game* elements, [and] *Pedagogical* elements" (Aldrich, 2005, p. 80).

Context. In the tradition of Seymour Papert's microworlds, Aldrich (2004) is interested in the way "simulations describe small worlds" (p. 152) as a context for learning. Aldrich (2005) quotes Will Thalheimer on the role of context in simulations:

> "The first thing that makes simulations work is *context alignment*. The performance situation is similar to the learning situation… when the learners enter a real situation, you want the environment to trigger the learning. That results in a 10 to 50 percent learning impact" (Will Thalheimer, as quoted in Aldrich, 2005, p. 84).

When Aldrich (2004) discussed the objectives of designing an interface system for a simulation, his most important points were that a simulation interface should "represent the actual activity at some level" (p. 173) and "be a part of the learning" (p. 174) in the sense that simply learning the interface would help a user learn about the subject being

learned. Though he advocated for keeping a simulation interface simple and streamlined (p. 175), he was interested in fidelity where it impacted learning. He suggested that a simulation interface should operate in real time such that "all options are available all the time"(p. 175). Similarly, he called for simulation design that, like the real world, included all three types of content, linear, cyclical, and open-ended (p. 99). He also opposed simulations that presented the world as it should be rather than as it is, even if this is done in the name of political correctness (p. 215).

Inquiry. Like Prensky and Gee, Aldrich discussed many ways in which computer simulations can provide learners with opportunities for inquiry. In creating *Virtual Leader* he was interested in creating open-ended content through the creation of virtual sets that players could explore (Aldrich, 2004, pp. 105-106). Aldrich (2005) quoted Will Wright, creator of the Sims, as saying that "the more creative the players can be, the more they like the simulation" (p. xxx). Conversly, Aldrich also quoted Wright as saying "one way kills creativity" (p. xxxii). Aldrich considered computer games to be "empowering activities" because the player is the key to success (p. 136); the process of trial and error is necessary on the path to success as well (p. 136). He also acknowledged that "no single game… appeals to everybody" (p. 149), but envisioned a world where "students everywhere… truly engaged (and ultimately created) wondrous new environments" (p. 271).

Collaboration. Though Aldrich (2005) quoted Will Wright as saying that "getting people to engage other people with what they learned is critical" (p. xxxii), Aldrich himself was unconvinced of the value in multiplayer games and simulations. In terms of

Role Paying Games in particular, Aldrich (2004) felt that role playing "is an incredibly high-pressure environment that forces traditional, not experimental behavior" (p. 87). He debated whether or not Virtual Leader should be an MMORPG, but concluded that there were several reasons not to follow a multiplayer design. "Role playing environments are highly public… [and] people in a role play don't act 'normally'" (p. 101). Similarly, "groups of people act differently from one another" (p. 101) and "real people act erratically" (p. 101). He later called online multiplayer games unpredictable (Aldrich, 2005, p. 68). Some of his objections are related to the logistical expense required for getting people together at the same time and in the same place (or virtual place), issues which are avoided by single player games (Aldrich, 2004, p. 101). Also unlike single player games, multiplayer games (and certainly massively multiplayer games, especially ones in which players are actually role-playing) do not allow for repeatability of scenarios (p. 101). At one point, Aldrich even poses the following question: "why are so many teachers and trainers obsessed with multi-player computer games, especially since most have never played them?" (Aldrich, 2005, p. 95)

Aldrich (2005) did acknowledge the value of role playing games as the " most life like, reflecting the long-term career and life decisions most of us make" (p. 142). He felt they could teach "the scarcity of development opportunities and the absolute need to align development with strategy" (p. 142). He also suggested that during the stage in which learners are fully engaged by a simulation, people are most successful when learning in groups (p. 244). However, he does not consider that MMORPGs might provide a framework for this. When he does discuss the potential of MMORPGs to

"teach how to meet strangers and… form deep relationships with which to perform heroic quests carefully balancing each other's strengths and weaknesses" (p. 142), he is also quick to point out that players can "alternatively cheat, rob, and kill" each other (p. 142).

Ironically, given his objections to MMORGPs, Aldrich (2005) advocates live role playing as a powerful learning experience (pp. 96-105). In his vision, a computer might be used simply to facilitate the use of rules in the game (pp. 96 and 104). This may be in part because of his focus on the importance of support provided by an instructor (p. 245).

Support. Like Prensky and Gee, Aldrich too was concerned with ways in which games and simulations could offer support for learning. One of his design criteria for *Virtual Leader* was that "all subsystems would reflect and enrich the learning" (Aldrich, 2004, p. 98) and he aimed to create an interface that would "represent the actual activity at some level" (p. 173) . At the same time he struggled with how to score a simulation because "tight metrics and open-ended play" seemed incompatible (pp. 190-191). He openly acknowledged that "it will be harder to evaluate simulation-based content" (p. 218) than traditional text-based content, in part because "as with life, people might learn different things" (p. 219) from a simulation.

Several other design issues related to support of the learner were highlighted by Aldrich. He considered "one of the biggest long term issues" (Aldrich, 2004, p. 212) to be the balance of free play versus guided play, or how much the designer should help players along. This balance is related to the success of what Aldrich (2005) called "the

frustration-resolution moment" (p. 243), the first encounter with frustration in which "students should expect to resolve their frustration in the learning experience" (p. 243). Another issue was the need for simulation designers to resist the temptation to model too much, and to instead "aim carefully, narrowly, and then go deep" (Aldrich, 2004, p. 216) in their modeling.

Aldrich was interested not only in how games and simulations might support learning, but also in how to support the use of games and simulations for learning. When he first urged teachers to explore the experience of playing video games by saying "log in a few hours of playing" (Aldrich, 2004, p. 17), he followed this closely with "then spend a few minutes sizing up the experience" (p. 17); reflection was an important element of learning with games or simulations for Aldrich. In fact he suggested that learning from simulations might require brief "learning sabbaticals" from a normal work or home environment (Aldrich, p. 214).

Because of the importance of reflection, the role of an instructor was critical to Aldrich, but not in a traditional sense. He felt that their value comes from "one-on-one contact with students" (Aldrich, 2005, p. 245), and that with the use of simulations, instructors could move to "the higher-value role of *coaching* and *diagnosing*, rather than the lower-value role of *lecturing* and *grading*" (p. 131). Instructors might also serve to help learners avoid reaching the point where they become "cynical and try to exploit the cracks" (Aldrich, 2004, p. 219) in a simulation. Though "instructor supported simulations are significantly more costly to deploy, [they] are more flexible to evolve on the fly, can provide more handholding, and result in more transformational experiences" (p. 61).

Aldrich considered the face-to-face symposia conducted with a roll out of *Virtual Leader* to be critical to its success (Aldrich, 2004, p. 207). In fact, he concluded that with the use of simulations, classrooms will not disappear, but will rather be used as "*set-up and support of a simulation's core learning*" (p. 215). He even quoted Jane Boston of Lucas Learning Ltd. as suggesting that "in some simulations, guided practice may be needed before starting the actual game" (Aldrich, 2005, p. xxxi). However, he did caution that "everything [live instructors] say to everyone more than a few times should eventually be encapsulated in the technology [because] the goal is not to replace instructors, but to keep them adding customized, user specific coaching" (p. 257).

Twenty-First Century Skills. Much of Aldrich's work relates to the development of educational simulations, and that is beyond the scope of this paper. However, Aldrich, like Gee, also described many educational benefits of games and simulations which are not easily categorized into context, inquiry, collaboration, or support. Many of these can be described in terms of the Twenty-First Century Skills developed by the North Central Regional Educational Laboratory and the Metiri Group (2003): digital-age literacies, inventive thinking, effective communication, and high productivity.

Games and simulations can help players develop digital-age literacies. For example, Aldrich (2004) points out that players develop a measure of computer literacy through their exposure to games and simulations (p. 137). He also suggested that simulations could be used to help learners develop their cultural literacy as well, citing *Age of Empires* and *First Flight – The Wright Experience Flight Simulator* as examples (Aldrich, 2005, pp. 178-179).

However, most of the benefits Aldrich discussed are particularly well suited for developing inventive thinking skills such as adaptability, managing complexity, self-direction, curiosity, creativity, and risk taking (North Central Regional Educational Laboratory and the Metiri Group, 2003, p. 33-42). While "classrooms and books teach linear, or process, skills" (Aldrich, 2004, p. 212) and could probably even be used to teach the digital age literacies, Aldrich suggested that "simulations teach dynamic skills" (p. 212) through cyclical, linear, and systems content (p. 231). He also wrote that in computer games "there are very complex and intertwined systems at play" (Aldrich, 2005, p. 136). This makes games and simulations ideal for teaching elements of inventive thinking, such as adaptability, managing complexity, and self-direction (North Central Regional Educational Laboratory and the Metiri Group, 2003, p. 33-36).

Similarly, Aldrich (2004) said that simulations should be challenging and frustrating (p. 214), an ideal environment for the sort of creativity and risk taking that makes learning exhilarating (p. 214). Aldrich (2005) also suggested that in a computer game the player is the key to success and that "mistakes are necessary on the path to success" (p. 136), which are ideal conditions for a player to practice and develop risk taking skills.

Perhaps the most important twenty-first century skill that players learn from games and simulations is self-direction. Aldrich (2005) pointed out that not only do people learn from computer games, "they *learn how to learn*" (p. 137). Unfortunately for traditional educators, the following is also true:

> "They expect for the environment to get harder gradually as they get better. They expect to go at their own pace, They expect to be fully engaged. They expect to be involved at a tactile level and at a high-level intellectual level at the same time." (Aldrich, 2005, p. 137)

Of course, a large part of the purpose of *Virtual Leader* was to provide players the opportunity to develop their skills of effective communication and high productivity as leaders in the workplace.

Conclusion

In order to facilitate constructivist cognitive development, a digital game-based learning environment should provide opportunities for context-embedded, inquiry-driven, and socially negotiated (or collaborative) learning. The purpose of this depth portion of the KAM was to critically examine theories of digital game-based learning in light of this working theory of constructivist instruction.

The work of Prensky, Gee, and Aldrich supported the notion that digital games and simulations can provide a context for learning and opportunities for inquiry. Prensky and Gee agreed that video and computer games can also provide learners a wide variety of individualized and differentiated opportunities for inquiry. While all three theorists found some value in the framework for collaboration offered by these games and simulations, Aldrich raised some arguments to support the use of single player scenarios as opposed to multiplayer games, particularly those with persistent environments. All three discussed ways in which games can support constructivist learning and ways in which games-based learning might be supported by instructors in a classroom environment. In

addition, each author, but particularly Gee and Aldrich, explored other potential educational benefits of games which can be described in terms of helping learners develop the twenty-first century skills of digital-age literacies, inventive thinking, effective communication, and high productivity. In most cases, each of these elements is best exemplified by the genre of role playing games and/or massively multiplayer online role playing games (MMORPGs).

These pioneering authors have provided a broad foundation for studies in the field of digital game-based learning, but this can only serve as a beginning for serious academic inquiry. Though James Paul Gee is an academic, a former linguist, and a former cognitive scientist, and though his writing draws on his knowledge of these fields, his work in the field of digital game-based learning is largely based on personal observation and reflections. Both Marc Prensky and Clark Aldrich, though experienced practitioners and researchers in the field, wrote from the perspective of for-profit corporate trainers. Especially where the use of such games and simulations in formal k12 education is concerned, more formal research studies are required in order to establish or disprove these preliminary conclusions with a greater degree of confidence. These initial projections about the potential of computer and video games, particularly MMORPGs, might first be established through a formal Delphi study involving these experts and others in the field, including additional academics.

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Annotated Bibliography

The study of computer and video games' educational value is a relatively new field. Though there were earlier explorations of these ideas, all but two of the articles below were published in 2005, the same year this bibliography was written; one was published in 2004, and one was published in 2000. As cutting-edge theories, few of these articles represent formal research studies. However, all but one was published in peer-reviewed journals, and all of the authors are leading academics and practitioners with a depth of knowledge and experience in the subject of games and learning. They are paving the way for the brave educators of tomorrow, and for the formal research studies that will validate or improve upon these theories.

Appelman, Robert. (2005). Designing experiential modes: a key focus for immersive learning environments. *TechTrends*. 49 (3) 64-74.

In the tradition of John Dewey experiential learning, Appelman introduced a framework of *Experiential Modes* (EMs), the smallest components of learning environments: the observable attributes and non-observable perceptions of learners. He also discussed the use of existing and emerging technologies for new learning environments, giving the example of Sasha Barab's work with *Quest Atlantis*, and the use of existing commercial games as learning environments, such as Kurt Squire's exploration of *Civilization III* in his dissertation. Though this article does not represent a formal research study,

Appelman draws on his decades of experience in many mediums as an instructional designer, researcher, and educator to support his discussion. This article is heavy in new jargon, but such efforts at defining a vocabulary for the design of twenty-first century instruction will pave the way for further innovative instructional design.

Blumberg, F. C., and Sokol, L. M. (2004). Boys' and girls' use of cognitive strategy when learning to play video games. *The Journal of General Psychology*. 131 (2), 151-158.

In a formal qualitative study, Blumberg and Sokol tested 104 diverse second grade and fifth grade children to discover how they learn to play a video game. All recorded responses were coded, and statistical analysis of their data *did not* support the hypothesis that girls would show greater inclination toward external strategies (of learning and problem solving) and that boys would show greater inclination toward internal strategies. However, the authors cautioned that continued investigation is needed in order to understand "the continuing distinctions between boys' and girls' preferences for games that may have different ramifications for cognitive gains" (p. 157). In addition, the closing discussion touched on several more important issues, such as the age of the players and their self-efficacy as frequent gamers.

Carstens, A., and Beck, J. (2005). Get ready for the gamer generation. *TechTrends*. 49 (3) 22-25.

Carstens and Beck provided little specific evidence for their argument that the brains of gamers are "hard wired" differently than non-gamers. However, they commissioned a formal study of 25,000 Americans and used instruments of previously established reliability to investigate the difference in belief systems between gamers and non-gamers. They found that “gamers showed a range of different opinions and behaviors compared to their non-gamer brethren” (p. 23). They suggested that gamers have little respect for traditional authority and training, and they provide suggestions for trainers serving gamers, including the suggestion that traditional leaders and leaders of the gamer generation be trained side by side so that they might benefit from the strengths of both styles.

Caperton, I. (2005) For Seymour Papert "hard fun" is the essence of good games AND good education. *Telemedium: the journal of media literacy*. 52 (1 & 2) 16-19. Madison, WI: National Telemedia Council.

Idit Caperton was the first to graduate with a Ph.D. from the MIT media lab in Papert’s epistemology & learning research group. Seymour Papert has remained her mentor and collaborator for 22 years. Caperton shared stories of Seymour Papert and his philosophies, including his playful style of brainstorming, the story of how he came to love mathematics through his love

of gears, and his concept of hard fun. She also related his belief that video games can be like constructionist projects and can help students to learn concepts and ways of thinking that might otherwise be beyond them.

Dede, C. (2005). Planning for neomillenial learning styles: implications for investments in technology and faculty. *Educating the Net Generation* Educause. www.educause.edu/educatingthenetgen/

In this chapter of *Educating the Net Generation*, Dede explored how emerging media affect learning styles, with a particular focus on virtual environments and augmented realities. He found learning situated in these environments important because of the capacity for transfer of learning to real problems. Like James Paul Gee he found that individual and group identities can also be developed in virtual or augmented environments. He explicitly mentions *Whyville*, *Quest Atlantis*, and the commercial MMORG *Everquest* in his discussion. He also cited Steinkuehler's research into the social spaces of MMORPGs. Dede's article also contained examples from his own research into the applications of MUVEs (multiuser virtual environments) in education, and his results were promising. Like Klopfer and Yoon (see below), Dede pointed out that professional development and support will be needed to implement these technologies for educational purposes.

DeKanter, N. (2005). Gaming redefines interactivity for learning. *TechTrends*. 49 (3) 26-31.

DeKanter, vice president of Muzzy Lane Software, was interested in using technology to develop peoples' skills, and he believed that networked game simulations can provide a constructivist learning environment. Such games can provide a context for learning by making learning tasks authentic and anchoring them to a larger task or problem. DeKanter also discussed ways in which networked game simulations can provide opportunities for inquiry and collaboration, and ways in which they can provide support for constructivist teaching and learning. One example of such a game is Muzzy Lane Software's *Making History*. Though DeKanter writes from the perspective of a commercial developer, his unique experience in developing a multiplayer video game simulation for educational purposes is valuable.

Dickey, M. D. (2005). Engaging by design: how engagement strategies in popular video games can inform instructional design. *Educational Technology Research and Development*. 53 (2) 67-83.

Drawing explicitly on constructivist and cognitive research, educational psychologist Michele Dickey discussed ways in which "the strategies of design which lead to engagement" (p. 67) in video games might by put to use by instructional designers. She discussed point of view, narrative, setting,

characters, and interactive elements, or hooks. Throughout the article, Dickey gives special attention to the importance of multiplayer games. This article does not represent a formal study, but does present a rich scholarly review of literature.

Emrich, Alan. (2005). The gamer generation: and why baby boomers shouldn't worry about them. Inspired by the book Got Game, John C. Beck, Mitchell Wade (Harvard Business School Press, 2004). Available http://www.alanemrich.com/SGI/Week_10/SGI%2010%20GAMER%20GENERATION.PDF

Ludologist Alan Emrich summarized key differences between the way Baby Boomers and the Gamer Generation grew up, between their resulting psyches, and the way they operate in the business world (or school). In addition there is a discussion of the sexism, violence, stereotypes, and isolation issues related to video games which is neither the usual panic inducing line of reasoning, nor the equally unsophisticated debunking argument. Though this article does not represent a formal study, Emerich's report is a valuable overview of the issues regarding video games and society.

Gee, J. P. (2005). What would a state of the art instructional video game look like? *Innovate.* 1 (6).

http://www.innovateonline.info/index.php?view=article&id=80

Linguist and cognitive scientist James Paul Gee suggested that "the best commercial video games are already state of the art learning games" (p. 1) because they allow learning to take place situated in activities and experiences. However, he advocated for the importance of teachers, and for a balance between telling everything to learners and letting them experience everything on their own. Gee provided a vision and broad framework for those interested in harnessing the power of video games for educational purposes. However, because his theories are based primarily on his own (rich) experience with games rather than on a formal study, much work needs to be done in order to test and verify his theories, and in order to realistically implement his recommendations.

Jenkins, H., Wright, W. (2005) "Buy these problems because they're fun to solve!" *Telemedium: the journal of media literacy*. 52 (1 & 2) 16-19. Madison, WI: National Telemedia Council.

This article is a transcription of the conversation between Henry Jenkins, director of the MIT Comparative Media Studies program, and Will Wright, creator of successful games such as *SimCity* and *The Sims*, at the Education Arcade conference at E3 on May 11, 2004. Like Caperton (above), they discussed the importance of *fun* in games, in education, and in problem solving

in general. Wright imagined a very different education for students, one in which a game might be marked up with links to web-based information with an option for students to annotate he information. Wright concluded with a series of visionary questions followed by the suggestion that students are already living the education of the future when they get home from school. Though this article does not represent a formal study, it does provide a valuable window into the thinking of a leading academic and a leading developer in the field of games in education.

Kirkley, S. E. and Kirkley, J. R. (2005). Creating next generation blended learning environments using mixed reality, video games, and simulations. *TechTrends*. 49 (3) 42-53.

Instructional designers Kirkley and Kirkley addressed "the challenges and issues of designing next generation learning environments using current and emerging technologies" (p. 42). Throughout the discussion they were concerned with how to "balance design tensions between meeting learning objectives and creating engaging and fun learning environments" (p. 42). They discussed elements of context, collaboration, and support for student learning, and they included a section about the importance of fun in constructivist learning environments. The article concluded with a discussion of a game authoring tool for instructional designers which is under development by

Kirkley and Kirkley. This article does not represent a formal study and the authors write from the perspective of commercial developers, but their development experience and their background in academic research contribute to the value of this discussion.

Klopfer, E., and Yoon, S. (2005). Deveoping games and simulations for today and tomorrow's tech savvy youth. *TechTrends* 49 (3) 33-41.

Eric Klopfer, director of the MIT Teacher Education Program, and Susan Yoon, a post-doctoral fellow in same program, were explicitly constructivist, opening their article with their interested in an authentic learning context and in collaborative learning (p. 33). Later, they also explicitly discuss the importance of inquiry-based learning (p. 40). Parts of the article are reminiscent of Prensky and Gee's work, and the authors also drew on the work of Dede (above), the MIT Teacher Education Program, Games to Teach, and the Education Arcade. Finally, Klopfer and Yoon do not ignore the importance of professional development and assessment when these ideas are implemented in a real-world school, especially in the political climate of *No Child Left Behind*. Though this article does not represent a formal study, the authors write from a rich background in the formal development of new educational software tools and pedagogy to support these tools.

Noble, A., Best, D., Sidwell, C., Strang, J. (2000). Is an arcade-style computer game an effective medium for providing drug education to schoolchildren? *Education for Health*. 13 (3) 404-406.

With a subtly constructivist perspective, the authors explored an "interactive approach" (p. 404) to drug education for children. In a formal study they tested the effects of "an interactive CR-ROM based arcade-style motorcycle racing game" (p. 405) on students' understanding of the drug cocaine. Through analysis of interview responses gathered from 101 students aged 10 or 11, the authors concluded the game was successful in transmitting their message to the students, in large part because of "high levels of acceptability, even enthusiasm" from the students (p. 405). They did, however, caution that implementing the program would require "careful piloting and ongoing management" (p. 406).

Pillay, H. (2005). An investigation of cognitive processes engaged by recreational computer game players: implications for skills of the future. Journal of research on technology in education. 34 (3) 336-450.

Working from a constructivist perspective, Pillay explored "the value of computer games as a means for enhancing educational instruction" (p. 338). His formal study aimed to "analyze the cognitive processes engaged in while playing recreational computer games to help us understand how they might

affect students' performance in subsequent tasks within a computer-based learning environment" (p. 340). With some qualifications, he was able to suggest that "playing recreational computer games may increase the time efficiency in accomplishing set educational tasks and obtaining correct solutions" (p. 345). The most serious limitation of his research was that he explored only the transfer of skills from games to other computer-based activities, and not to other non-computer-based activities. Also, the games used in this study were unsophisticated games that were very like the other computer based academic activities. Still, as an exploratory study, this research was valuable.

Williamson, B., and Facer, K, (2004). More than 'just a game': the implications for schools of children's computer games communities. *Education, Communication, & Information.* 4 (2/3) 255-270.

"Drawing on recent research on children's use of information and communication technology out of school, and on complementary research within media, cultural, and youth studies" (p. 255), Williamson and Facer provided an overview of "policy, industry, and educational research perspectives" (p. 256), which are focused "on exploiting the potential of games' interfaces in schools" (p. 256). However, they were more interested in "how children's existing habits when playing computer games are situated

within social contexts and practices, and how these practices, rather than the games software on which they are centered, might provide insights of relevance to more formal educational settings" (p. 256) They discussed playing games in peer groups (p. 259), expert gamers (p. 260), wider social resources for learning about games (p. 262), social contexts for learning in online games (p. 263), gender (p. 261), socio-economic status (p. 261), and "the potential applications of games practices to the formal educational setting" (p. 264). This included references to Gee, Prensky, MIT's Games-To-Teach project, and the Education Arcade consortium among others. Their closing discussion also included online role-playing as an example of "*authentic practice within social context*" (emphasis in the original, p. 267). Though this article does not represent a formal study, the authors, both from the NESTA Futurelab in the UK, provide a valuable overview of the topics above.

Winograd, D. (2005). Chris Dede on emerging technologies that enable distributed-learning communities. *TechTrends*. 49 (1) 39-40.

Winograd, an assistant professor of Academic Computing and Educational Communications York College in the City University of New York, recounted Dede's keynote at the AECT Conference in Chicago. Dede discussed ways in which multi-player video games could provide a context for learning and a framework for collaboration. He had previously been interested in the potential

of Massively Multiplayer Online Role Playing Games (MMORGPs), such as *Everquest*, but spoke in Chicago about Multi-User Virtual Environments Experiential Simulators (MUVEES). While the games may provide support for student learning, Dede pointed out that educational technologists will need to serve as change agents and provide support for the implementing teachers. This article does not represent a formal study, but as an educational technologists impressions of Dede's theories it is a valuable resource.

Application

Introduction

The breadth portion of this Knowledge Area Module (KAM) presented a working theory of instruction based on the constructivist cognitive development theories of Jean Piaget, Seymour Papert, and David H. Jonassen. It concluded with the suggestion that to facilitate constructivist cognitive development, a digital game-based learning environment should provide opportunities for context-embedded, inquiry-driven, and socially negotiated (or collaborative) learning. In addition, the breadth section included the suggestion that the support necessary and appropriate for individual students to succeed in such an open-ended environment must also be provided.

The depth portion of this KAM then presented a critical examination of digital game-based learning theories in light of this working theory of constructivist instruction. Sections related to context, inquiry, collaboration, and support therefore appeared in the discussion of each author. The work of Prensky, Gee, and Aldrich supported the notion that digital games and simulations can provide a context for learning and opportunities for inquiry. With the exception of some issues raised by Aldrich, the work of all three authors also illuminated the power of games to facilitate collaborative learning. In addition, each author, but particularly Gee and Aldrich, explored other potential educational benefits of games which can be described in terms of helping learners develop the twenty-first century skills of digital-age literacies, inventive thinking, effective communication, and high productivity. In most cases, each of these elements is

best exemplified by the genre of role playing games and/or massively multiplayer online role playing games (MMORPGs). The accompanying annotated bibliography, and additional readings, also informed the design of this application portion of the KAM.

The purpose of this application section was to prepare a three hour hands-on professional development session for providing educators with guidance in using digital game-based instruction, informed by theories of constructivist cognitive development, to facilitate student learning. This session will be delivered face to face via a Power Point slide show with segments of presentation, facilitated discussion, and hands-on experimentation with an educational video game, the World Food Program's *Food Force*. This companion document includes sections describing the rationale behind the session, the justification for elements of the session design, and a conclusion explaining how the theory of the previous sections is put into to practice. (Note: Though the actual delivery of this professional development session is beyond the scope of this KAM, it will be designed for use as a pilot class for educators in the Technology Center at the Orange County Department of Education, to be delivered on December 13, 2005.)

Rationale

This professional development session is an effort to help teachers better reach and better serve a generation of students who are fundamentally different than those who came before. Prensky (2001) pointed out that "learners have changed" (p. 35). Today's k12 students were born into an era of cell phones, ubiquitous Internet access, and video

game. Their formative experiences have led them to experience the world differently, to think differently, and to learn differently (Prensky, 2001b). He also offered a powerful metaphor for the difference between students and their teachers. Students are *digital natives*, while teachers are *digital immigrants*, who may have trouble learning the language and culture of the natives – and may speak with an *accent*, such as printing out an email to read it (Prensky, 2001a). To extend the metaphor further, this course is meant both to help teachers become aware of this generational gap, and to help them bridge the gap to become card carrying resident *digital aliens*. The hope is that teachers might change their teaching style, perhaps even by incorporating video games, in order to address the students in their *native tongue*.

There is little doubt that a good deal of *incidental* learning is taking place when students play video games. They even reject games that are too easy; they have to be learning for the game to be fun. This course is also an attempt to help teachers harness the powerful multimedia technology of video games and put it to work for what Jonassen calls *intentional* learning in the context of formal education, driven by the assessment of content area standards (Jonassen, Howland, Moore, and Marra, 2003).

However, achievement of the standards is not the only thing valued by many educators, parents, community members, and businesses. This course aims to help teachers discover ways in which video games might help students to develop twenty-first century skills of digital age literacies, inventive thinking, effective communication, and high productivity (North Central Regional Educational Laboratory and the Metiri Group, 2003).

Ultimately, this course is meant to help teachers see that video games, particularly multiplayer roll playing games, can serve as consrtuctivist learning environments for students. As demonstrated in the breadth and depth portions of this KAM, such games can provide students with a context for learning, opportunities for inquiry, and frameworks for collaboration, in addition to the on-demand just-in-time support necessary to scaffold students' success in an open ended environment.

Design and Justification

The professional development session begins with several minutes of face-to-face processes to acclimate the participants with the instructor and with each other, and to engage their prior knowledge of the subject. After an introduction of the topic and presenter, participants are presented with a series of quotes from Seymour Papert and a 1st grade student with whom he worked. These introduce and illustrate the concept of "hard fun" and how it can be used as a focus for learning in a formal k12 education environment. This segment segues into the participants' self-introductions and first discussion on the topic.

The rationale articulated in the previous section is then shared with participants, followed by a review of relevant theorists. This serves as a breadth section of the course, an overview of the burgeoning field of video games in education. The review begins with the work of Jean Piaget, in order to ground the session in established constructivist theory, with which the participants, mostly teachers, will probably be familiar. Piaget's student, Seymour Papert is included for his theory of hard fun, his pioneering work with Logo, and his prescient thoughts on video games and learning.

Then, because of the immediate relevance to today's teachers, the session jumps forward to Marc Prensky's arguments about how learners have changed, how they can be engaged (and motivated), and how corporations are already doing this. Building on this, there is an overview of James Paul Gee's 36 learning principals, which good video games embody, but which schools often do not. These principles, particularly those focused on active critical learning and on self-knowledge or identity, provide participants with a big-picture view of the seriousness and scope of games potential in the classroom. The work of Clark Aldrich is also included so that his pragmatic perspective can serve as a counterpoint to Gee's more lofty theories. Aldrich's pioneering work with *Virtual Leader* is discussed as a model of what the future might hold. To offer an example that teachers might better be able to relate to, the session includes an overview of the teaching simulation, *simSchool*, which Zibit and Gibson (2005) suggest might be used to prepare pre-service teachers prior to student teaching.

The work of several graduate students is included as well. Nick Yee performed a series of studies over several years exploring the social spaces of Massively Multiplayer Online Role-Playing Games (MMORPGs), including discussion of their educational potential. Kurt Squire completed his dissertation with a study of classroom applications for *Civilization III*, a commercial off the shelf game discussed later in the session. Like Squire, Constance Steinkeuhler completed her dissertation with a focus on video games, and like Yee, she studied the social spaces of MMORPGs. Fiona Littleton is exploring the learning styles of gamers and non-gamers, and Mark Wagner, the author of this KAM, is studying the potential applications of MMORPGs in formal k12 education as part of his doctoral work. All of these authors are mentioned because of their relevance to

the preceding theories and to the discussions that follow. Others may be mentioned as well, as research in this area is being published at an increasing rate.

To complete the first hour of the session, participants are invited to reflect and comment on their own reading, listening, watching, and experiences in the light of the theories introduced during the session. There is then a five minute break before the next segment of the session.

The second segment is hands-on and serves as the depth portion of the session for the participants. At this point the session become more clearly constructivist in nature as well. Participants experience theory put into practice as they play the World Food Program's educational game, *Food Force*. This segment begins with a quote from Richard Halverson (2005), which establishes the rationale behind having teachers play games themselves. Squire (2005) also advocates for the development of a media literacy for games, not only in students, but also in policy makers.

Participants then spend most of the hour playing through *Food Force.* They are not asked to critique the game, because as teachers, they are not in a position to apply the knowledge gained from such an evaluation into designing a new game (Aldrich, 2005). Instead they are asked to consider reflection questions which focus on the experience of the player, and which encourage them to process and apply the theories discussed in the first hour.

After another five minute break, the third segment begins with a focus on pragmatic application of what participants have learned and what they can implement in their own classes. This segment begins with an introduction to web based games which are free, do not need to be downloaded (or installed), and can run on most computers,

even considerably out of date models. These games teachers can begin using with students immediately.

Then, because teachers have neither the time nor the resources to develop their own educational games, the focus will switch to commercial off the shelf (COTS) games that might be used in an educational setting. *Civilization III* is discussed because of its ability to teach social studies concepts, particularly non-linear cyclical or systems content (Foreman, J. & Aldrich, C, 2005). It is also chosen to illustrate the importance of failure and choice, and as an example of the benefits of complexity, flexibility, and replayability (Squire, 2005a). This leads to a discussion, based on Kurt Squire's work, of how games are no panacea and may not work for every learner. Participants will also be introduced to Apolyton.net, so that "educators who visit this site will discover information and resources that can support their own experiments with gaming technology as an instructional tool" (Downs, 2005).

The game *Making History*, a commercial effort designed for the educational market is also introduced. Mauriello, Stuckhart, DeKanter, Snow, and Squire (2005) provided tips for managing gaming in the high school classroom, which are shared with the participants, as are clips from a video of David McDivitt, a practicing history teacher who has piloted the game.

This is followed by a discussion of how a game as seemingly non-educational as a first person shooter (FPS) such as *Unreal Tournament* can also be used to teach, even with a subject as abstract as chemistry. This game also serves as an example of what it means to modify, or mod, a game, and how a teacher might take advantage of games that allow modding. Perhaps the most powerful example of a multiplayer role playing game

that can be modded is *Neverwinter Nights*, which is also shared with the participants during this segment.

Finally, teachers are introduced to the full potential of MMORPGs as constructivist learning environments. Thomas (2005) explored the extension of such games into the classroom and how the dynamics of gameplay created a new space for student interaction and learning. Unfortunately, these games are often designed for players 18 or older, so the example of the *Second Life* teen grid (for 13 to 17 year olds) will be shared as well. This game is particularly important for its rich avatar creation system, its support for user-created content, and it's open-ended play, complete with a sophisticated in-game economy. Conklin (2005) suggests a number of educationally appropriate uses for *Second Life*.

Again, several other COTS games will also be mentioned for their educational potential. For instance, Kadakia (2005) suggests the use of *Morrowind* to teach characterization, cause and effect, and storyline. For a relatively small cost, teachers can also begin using all of these games with students as well.

Despite the fact that teachers (and students) do not have the time or resources to create a state of the art video game, designing one can still be a powerful learning process for students, despite the fact that it may never be created. The process of identifying variables and the relationships between them can help students come to a deep understanding of a subject (Aldrich, 2005a). Jenkins (2005) offers guidelines for applying the theories of games, learning and media literacy to game design, though no game is designed in the MIT Games Literacy Workshop. Teachers may find these guidelines helpful if their students are to design games.

Actual implementation of the games can be beneficial too, as this would exercise students' technical literacy, effective communication (as they would work in teams), and high productivity (as they would be creating a real-world product with relevance to their lives). This must be done using tools and technologies readily available in schools. For example, Greenberg (2005) challenges students to "learn HyperStudio and make computer games that would teach the material [they are] studying" (p. 41). These resources are shared with participants as well.

In order to facilitate the transfer of participants' new knowledge to their own teaching, the final 30 minutes of the session include a structured brainstorm in which participants think on their own, then discuss in pairs, and finally share out to the group. They are asked to consider ways in which they might possibly use games in a class they teach. Time permitting, they will be encouraged to outline lesson plans as well.

The session concludes with several closing thoughts. Participants are asked Gee's question, "what would a state of the art instructional video game look like?" They learn that his answer is that commercial games are already there. This is followed by Aldrich's persuasive imperative for teachers to "just do it"… to stop thinking and talking about games in education, and actually implement these ideas in their classroom. Finally, for a dose of positive inspiration, they are left with Daryl Sterman's adage, "Go forth and do great things!"

Theory to Practice

The breadth portion of this Knowledge Area Module (KAM) presented a working theory of instruction based on the constructivist cognitive development theories of Jean

Piaget, Seymour Papert, and David H. Jonassen. This working theory is put into practice through this application portion of the KAM. It is presented to and discussed with participants during the first segment of the professional development session. Participants will then be able to apply this theory to their teaching, and to their own use of video games in the courses they teach.

The depth portion of this KAM presented a critical examination of digital game-based learning theories in light of this working theory of constructivist instruction. This, too, is presented to and discussed with the participants in this professional development session, and again participants will have the opportunity to apply the theories of Prensky, Gee, and Aldrich in their own classes.

In keeping with the underlying constructivist philosophy, this application portion of the KAM also provides participants with a hands-on segment during which they can experience and reflect on the role of these theories in practice. This hands-on segment is also something that participants can recreate for use with their own students.

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