Games and Simulations in Online Learning:
Research and Development Frameworks

David Gibson
CurveShift.com, USA

Clark Aldrich
SimuLearn Inc., USA

Marc Prensky
games2train, USA

Information Science Publishing

Hershey • London • Melbourne • Singapore

Acquisition Editor: Michelle Potter
Senior Managing Editor: Jennifer Neidig
Managing Editor: Sara Reed
Development Editor: Kristin Roth
Copy Editor: Kim Berger
Typesetter: Marko Primorac
Cover Design: Lisa Tosheff
Printed at: Integrated Book Technology

Published in the United States of America by
Information Science Publishing (an imprint of Idea Group Inc.)
701 E. Chocolate Avenue
Hershey PA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@idea-group.com
Web site: http://www.idea-group.com

and in the United Kingdom by
Information Science Publishing (an imprint of Idea Group Inc.)
3 Henrietta Street
Covent Garden
London WC2E 8LU
Tel: 44 20 7240 0856
Fax: 44 20 7379 3313
Web site: http://www.eurospan.co.uk

Library of Congress Cataloging-in-Publication Data

Games and simulations in online learning : research and development frameworks / David Gibson, Clark Aldrich and Marc Prensky, editors.
p. cm.
Summary: “This book examines the potential of games and simulations in online learning, and how the future could look as developers learn to use the emerging capabilities of the Semantic Web. It explores how the Semantic Web will impact education and how games and simulations can evolve to become robust teaching resources”--Provided by publisher.
ISBN 1-59904-304-1 (hardcover) -- ISBN 1-59904-305-X (softcover) -- ISBN 1-59904-306-8 (ebook)
1. Education--Simulation methods. 2. Computer games. 3. Computer-assisted instruction. I. Gibson, David. II. Aldrich, Clark, 1967- III. Prensky, Marc.
LB1029.S53G36 2007
371.33’4--dc22
2006019128

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

Chapter XVI

Designing Online Games Assessment as “Information Trails”

Christian Sebastian Loh, Southern Illinois University Carbondale, USA

Abstract

Online retailers make successful use of sophisticated online tracking mechanisms to profile their customers in order to understand their buying habits. Online multiplayer games make use of similar technologies to keep track of gamers’ activities, for better management of in-game resources and to settle disputes. However, educators looking to online games as a learning tool lack a similarly powerful strategy to help them reconstruct users’ gaming decisions in order to understand the learners and make effective use of games as a teaching/learning tool. Moreover, it is necessary to develop an assessment component for online games to measure its effectiveness, or the return of investment. This chapter outlined a strategy to design the much-needed assessment into online games as “information trails.”

Introduction

Follow the White Rabbit. ~ Trinity, *The Matrix* (1999)

The anonymity during the early days of the Internet prompted cartoonist Peter Steiner (1993) to pen, "On the Internet, nobody knows you are a dog." Today, the Internet is far more advanced and far less anonymous than it once was. For example, because Web users expect certain conveniences, like the "Back" and "History" functions, when surfing the World Wide Web (WWW), Web browsers must be sophisticated enough to keep track of the user's online activities. As people click on the Web links to "jump" from one Web page to another, they inevitably leave behind a series of online "footprints" detailing their actions and movements. When harvested from the Web servers, such information becomes the evidence of users' interaction with the WWW services.

The pervasiveness of computing devices, the increasing ownership of personal computers, the near ubiquity of the Internet, and the prevalent use of *cookie* technology have made it easy for Web sites to "remember" and correctly identify every returning visitor (Coleman, 1999). Instead of "blanket marketing" to the once faceless, nameless online customers, retailers can now "target" their online marketing efforts by uniquely profiling each customer based on their browsing behaviors when using the company Web site. The online advertising industry has indicated that they will mine even "more information about individuals" in time to come (Glasner, 2005a). Even though privacy and ethics are legitimate issues, because such information is already being collected of everyone who uses the Internet, the purpose of this chapter is to recommend harnessing the technology rightly for use in education.

The following section presents an overview of online tracking technology, followed by a discussion about online games and education. This is followed by the conceptual framework for the information trail and how the information trail may be designed into games for assessment. Last but not least, a case study using an existing online game is described before the final concluding remarks.

Online Tracking Technology

Tracking Customers in Online Commerce

Peter Drucker (1994) once predicted that an age of "Knowledge Economy" is coming when *knowledge* will become a much sought after and tradable commodity. In today's world, personal data obtained from Web sites' "user registration" (e.g., demographic data, e-mail addresses), Web server logs (e.g., browsers used and IP addresses at time of login), cookies (e.g., categories of merchandise favored, referrer Web sites), and user feedback (e.g., from usability and satisfaction surveys) have all become acceptable sources of revenue. Even virtual game items and monies, such as Linden dollars (currency used in an online game

community known as Second Life), are being traded as if they are real commodities (Ackerman, 2004). The knowledge economy has indeed arrived.

Web sites providing just-in-time information (e.g., major newspapers, magazines, and blogs), online commerce sites, and special interest communities are increasingly requiring "user registration" before granting access to their sites. Even though many of these registrations are giveaways—requiring only a valid e-mail address for account activation, others have become subscription-based. Online stores, such as eBay and Amazon, require additional information such as credit card numbers and mailing addresses to facilitate the sales and delivery of their merchandise. These stores also make use of *cookie* technology to identify returning registered users during an online transaction, and to keep track of the merchandise placed in users' online shopping carts.

Advertising firms also employ *cookie* technology in collecting marketing data about Web users' browsing habits and online buying behaviors. Large e-commerce companies have in place elaborate strategies to track users' movement in order to create an accurate profile of their customers—profiles that are likely to include age, occupation, demographic data, IP addresses, and other online traits, such as buying and dining habits, favorite Web-links, chat rooms, movie preferences, and so forth. Done correctly, online profiling can be a valuable tool that allows Web companies to achieve better hit-rates (Glasner, 2005b) and to encourage more online buying through *targeted marketing*.

Amazon.com, the current leader in online tracking technology (Associated Press, 2005a), is known for successfully using its online profiling tool to reach out to its customers. Using sophisticated online tracking technology, Amazon.com monitors its customers' and visitors' online activities by recording the sequences of Web links they click on from the moment they enter the company's Web site until they leave. Accuracy of the customer's profile is maintained and updated each time one makes use of Amazon.com to search for merchandise and make purchases. The liberal use of tracking tactics enables the online retailer to shower its customers constantly with new book recommendations and catalogs of merchandise created just for them! Other online retailers are quickly catching on to Amazon's proven marketing strategy. The explosion of the online music and video market brought about by Third Generation (3G) cellular phones and Apple's iPods will continue to push targeted marketing and online tracking technology to the next level of sophistication. One industry that stands to benefit from all these technological advances is online gaming, for it is also in constant pursuit of new ways to entice more gamers who will pay-and-play.

Avatar Tracking in Online Games

The video game industry has long engaged in information collection, well before the advent of Internet and online games. In the days of DOS games, users' registration records and sales figures from game retailers provided the industry with the customers' information they needed. Because the act of playing already constituted agreement with the terms and conditions set by the game publishers, the extent of information collected during game play (if any) is often undisclosed to the gamers.

The launch of online games played in an online, persistent, virtual world—otherwise known as Massive(ly) Multiplayer Online Games (MMOG)—opened the floodgate to player (or

avatar) tracking. In order to ensure smooth game play at all times, the MMOG game engines must not only keep track of the coming and going of a massive number of avatars and what they do during game play, but also what the avatars carry in their inventories, including weapons, armors, gold, quest items, and missions received. Almost all MMOGs required the download of proprietary *game clients* instead of effecting game play within Internet browsers to better control and unobtrusively collect vast amounts of in-game information necessary for dispute resolution, and policing against cheating and loophole exploits. The use of game clients would, of course, grant the game company the legal rights to collect avatars' information throughout the whole duration of the game.

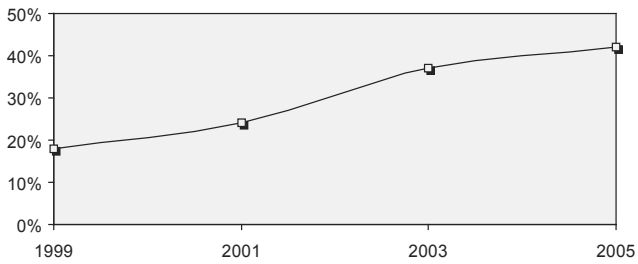
Game consoles, such as the Xbox, made use of unique machine identifiers to pinpoint each sold unit within the network, making it extremely easy for the parent company to monitor gamers' playing patterns. Xbox 360, Microsoft's next generation console, implements a *Gamer ID card* system as part of its new Xbox Live profile, containing gaming feats, trophies, high scores, motto, demographic data, even a player's photograph, for all to see (Game Informer, 2005). The company Web site (http://www.xbox.com/en-US/xbox360/ xbox360console.htm) contained the following information: *"Set up a Gamer Profile, visit the Xbox Live Marketplace, even send voice messages… experience multiplayer games and tournaments, intelligent matchmaking, voice communication… and much more"* (paragraph 4). By capitalizing on the online gamers' need for social interaction with other human players, either to play along with or against one another (Croal, 2002), game publishers have successfully escalated customer information collection and profiling into a desirable gaming experience.

The Business of Video Games and Education

The video game industry predicted that it would eventually outpace the "Internet (advertising), television, radio, motion pictures, music, and newspapers" as the fastest growing industry in the country (Interactive Digital Software Association, 2002). Today, the video game industry is a 10-billion dollar industry. More and more video game players are turning to online games (see Figure 1). Of those who play games online, about 56% are male. Some 34% of the online gamers made use of a wireless device, such as a cell phone or a personal digital assistant (PDA), to play games. About 10% of the total online games played are of the MMOG kind, with an additional 10% being browser-based games using Flash or Shockwave (Entertainment Software Association, 2005; Interactive Digital Software Association, 1999, 2002, 2003).

In the short term, game publishers promised even more Internet-capable games in an attempt to cash-in on the runaway successes of MMOGs (e.g., Lineage and EverQuest) and player-versus-player (PvP) games (e.g., Unreal and Halo). In the longer term, industry driving forces are currently pushing for mobile phone games, to be powered by either Macromedia Flash or Java (more precisely, J2ME), as the next impending wave of change (Trento, 2005; Ward, 2005). Because of its tremendous potentials in economic impact and outreach, the video game has not only captured Hollywood's attention but also that of the academe (Carlson, 2003).

Figure 1. Percentage of gamers who play online games (reported by ISDA & EDA)



On the education front, the study of the video game is fast maturing into a legitimate academic discipline with more than 50 higher education institutions across the nation offering game-related courses at both the undergraduate and graduate levels (Associated Press, 2005b; Hill, 2005). Several dissertations (e.g.,, Heckel, 2003; Squire, 2004) and books (including this one) (e.g., Aldrich, 2004; Gee, 2003; Prensky, 2001) have been published on various aspects of video games and learning. Other initiatives include the Daedalus Project (http://www.nickyee.com/daedalus/) by Nick Yee, the Education Arcade project (http://www.educationarcade.org/) led by Kurt Squire, and the Game-to-Teach (http://cms.mit.edu/games/education/proto.html) collaboration between Massachusetts Institute of Technology and Microsoft Research.

Educators and researchers have begun the dialogue to discuss the value of "serious play" (Rieber, 1996) in learning, and the potential of games in and for education (Loh, Rieber, Wiley, Van Eck, & Holschuh, 2004). Additional scholarly activities include the initiation for special interest groups (SIGs) within the Association for Educational Communications and Technology (AECT) and American Educational Research Association (AERA) to provide on-going forums for discussion; and professional conferences focusing on video games and learning, including the following: (a) Serious Games Summit, (b) Education Arcade Conference, (c) Games, Learning and Society, (d) the Annual Symposium for Instructional Gaming by AECT, and (e) the International Workshop on Digital Game and Intelligent Toy-based Education (DGTE) by the IEEE Computer Society.

Online Games and Education: Issues

Although there is much potential in using video games for education, and with no shortage of interest, its use in the classrooms, particularly K-12, is still very limited (Rieber, 1996). One problem that received much publicity in the media is, of course, the violence and questionable materials found in certain game titles (e.g., Anderson & Field, 1983; Sherry, 2001), even "E" rated ones (Thompson & Haninger, 2001); which led many researchers

and educators to focus on developing more video games that are educationally appropriate (Rosas, Nussbaum, Cumsille, Marianov, Correa, Flores, et al., 2003). However, for many educators, parents, and administrators, he more troubling issue about using games in the classrooms is that of assessment. This is because traditional classroom assessment quantifies student learning through the matching of learning outcomes with indicator-activities stated in the learning objectives. For instance, after a lesson on simple addition, if a child is able to show in some ways—be it verbal, mental calculation, finger-counting, written computation, or correctly choosing the answer from multiple choice (amongst many other assessment methods)—that 13+15 is equivalent to 28, the child is said to have learned how to *add*, particularly if the child was unable to do so before the lesson. Conversely, if the child picked a wrong answer, or was unable to supply the correct answer for whatever reason, the child has failed to demonstrate his or her knowledge in summing 13 and 15. A high rate of failures in one sitting will normally result in the child receiving a poor "test score" for that assessment. Because games are created primarily for the purpose of entertainment, it is almost impossible to design traditional assessment such as the one described above into games without taking out the "fun." Readers are probably well familiar with many early *edutainment* games that had been criticized as pedagogic exercises in disguise (Rosas et al., 2003).

It is imperative that, if and when included, an assessment feature must not detract from the gamers' enjoyment of game play. Yet for the game to be useful for learning, it must have features that will allow teachers to quantify the amount of learning that occurred as the students engage in play! Using online games for learning complicates the design issue with the complexity of technology. Even the task of score keeping within an online environment is a highly elaborated design-level task that requires a lot of pre-planning, often involving a massive and scaleable online database. Even when available online games are already developed with information collection in mind, very little of the information collected can be of use to educators directly because there is no easy (and legal) way of retrieving the in-game data.

Assessment and Online Games

The purpose of assessment is manifold. Most commonly, assessment is carried out by classroom instructors as a means to collect early and frequent feedback from their students for the improvement of teaching and learning, and to prescribe just-in-time remediation if needed. Because assessment can take the form of "any method" (Dietel, Herman, & Knuth, 1991), it may range from the subjective opinion of a teacher, to a student's blog, to a transcript of students discussion in an Internet chat session, to the test score of a national standardized test. Nevertheless, stakeholders (e.g., parents, principals, school administrators, and policy-makers) remain steadfast in viewing *test scores* as the main indicator of learning.

Within a test score-oriented educational culture, setting aside time in the classrooms for (online) games seems ill advised. At best, it will receive a lukewarm support from stakeholders; at worse, it will become an unnecessary burden for classroom teachers who are usually strapped for time to complete stipulated curriculum. If game playing is to receive any support from schools, there will need to be some ways for the educators to record and report on the students' progress when playing games, so as to justify to the stakeholders that gaming is a legitimate way of learning, and not a waste of precious classroom time and resources.

As one begins to consider assessment with online games, it is important to bear in mind that the strength of computer-based assessment still lies very much in repetitive and mechanical tasks, at least at this point in time, meaning it would be *easier* and *faster* for the computer to judge the quality of learners' *choices* (that A is the correct choice) rather than evaluating their *opinions* (why B is not the correct choice, or as good as A). Of course, given the right technology, it is possible for the computer to "record" human interaction as qualitative data for analysis, for example, peer-to-peer chat, after-play blog, thinking aloud, eye movements across the computer screen, and other physiological reactions. Although qualitative data is highly valuable in understanding students' intention and reasoning in making choices within the online games, the data collection and analysis procedure may not be readily assimilated into the information trail conceptual framework. The following section presents the conceptual framework for the *information trail* and its use in assessment with online games.

The Conceptual Framework for Information Trail

If online games must collect information trails for assessment, one must carefully contemplate what kind of in-game data must be collected. More importantly, the incorporation of the information trail should rightly occur in the pre-planning stage (e.g., storyboarding), and never as an afterthought. Using the motion picture *The Matrix* (Silver, Wachowski, & Wachowski, 1999) as an analogy, an instructional game designer (in the role of Morpheus) must carefully plan for the placement of *nodes* (in-game events, e.g., "Follow the white rabbit"), to intrigue and evoke the curiosity of the learners (in the role of Neo) to come along the trail (navigational path) that was predetermined to eventually lead them to the learning objective (discovering what the Matrix is). And as Neo became increasingly immersed in the process of self-discovery, Morpheus would begin to guide him through various learning adventures and mind games. (If only real-world learning were as easy as depicted in the movie: as a direct computer up-link to the brain.)

Trails and Nodes

Consider this scenario: If a child went missing, a detective who was in-charge of the case might enlist the help of specialized agents, such as a canine or a DNA test kit, to uncover scents and hidden clues undetected by human senses at the site of investigation. Based on the broken twigs, torn fabrics, footprints, and other trails left behind by the child, the detective might be able to piece together a likely scenario of what had happened to the child, and even point out the path traveled by the child. The basic idea of the information trail is very similar to virtual detective work and path finding.

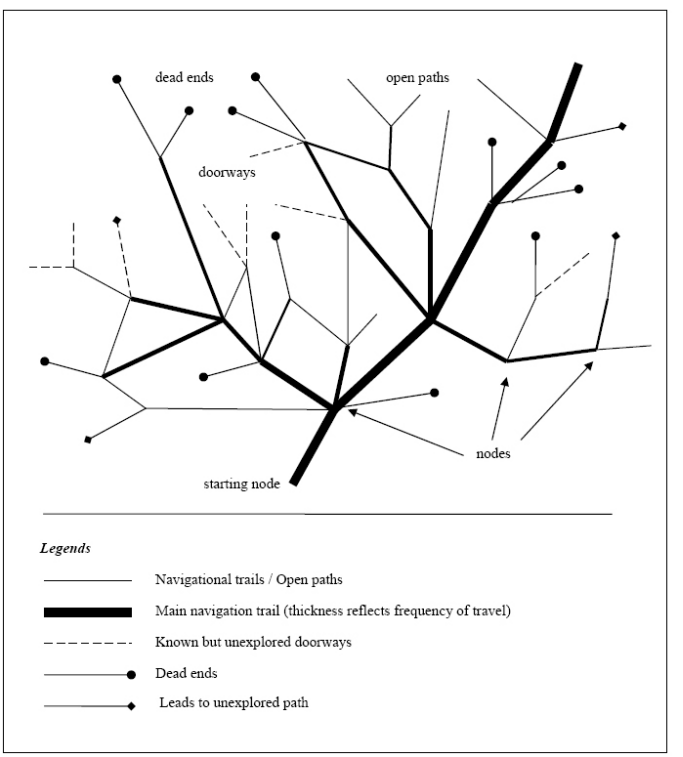
Conceptually, the information trail can be defined as a series of agent-detectable *markings* left by another *moving agent* within an information ecology. Operationally, the information trail is the long track of information markings left behind by "people" as they traverse the Internet. Strictly speaking, the *moving agent* is not the human, but his or her online extension. As people traverse the Web, it is their streams of decisions to click on Web links that become

the manifestation and representation of their online personas. In the context of games, the moving agents would be the avatars, and nodes are designated areas where special in-game events occur; examples include the Boss room in *Legends of Zelda* series, the (game-saver) typewriter in the *Resident Evil* series, the resurrection altar in *Guild Wars*, and hot-zones such as traps, doors, treasure chests, and others.

Associated with the idea of the trail is the notion of *nodes* (Wheeldon & Levene, 2003), or special points of interest where the moving agent interacts with the information ecology (e.g.,, the many mission-givers in *Dungeon and Dragon Online: Stormreach*). Figure 2 shows a main navigational trail with numerous nodes that divert into (a) unexplored doorways, (b) unexplored pathways (e.g., mission received), (c) dead ends, and (d) new paths that are yet-to-be explored.

Within the context of information trail, nodes are special designated zones that could serve as branching points for new trails. Using *The Matrix* as an example, a node can be a white rabbit tattoo, or the choice of a red or a blue pill. It is the point in time when the players are required to make a choice that could potentially lead them down a different path. Readers who are interested in navigational path finding may want to explore *information foraging theory* (Pirolli & Card, 1999), *information scents* (Chi, Pirolli, Chen, & Pitkow, 2001), and *Web data-mining* (Borges & Levene, 1999).

Figure 2. A navigational path model



Rethinking Games as Avatar Tracking Systems

Researchers in the field of education are familiar with using Web server logs as assessment tools, and even empirical data for research purposes (e.g., Burton & Walther, 2001; DeBra, 1997; Garrison & Fenton, 1999; Zalane, 2001). Educators interested in using online games for learning need to re-visualize games as avatar tracking systems that allow instructors to better profile players' actions for assessment. An avatar tracking system accessible by educators could help:

- Create better profiles of learners.
- Track how often learners interact with the learning materials (in this case, the online game).
- Assess students' learning based on their achievement in the games.
- Collect quantitative and qualitative data about the students' learning behavior,
- Document meaningful data about the students' learning style.
- Retrieve performance indices of learners based on their interaction with the game-based learning objectives.
- Reward appropriate learner behavior with *free* in-game tokens, such as trophies, badges, special armors, extra lives, and so forth, for all to see.
- Understand student trends of thought and weaknesses to take or suggest appropriate remedial actions.

Depending on the learning and teaching philosophy behind the online game, the information trail can range from:

a. Open-ended and non-linear (constructivist approach) to close-ended and completely linear (instructivist approach),
b. Hands-on manipulation (such as virtual frog or virtual chemical lab) to hands-off observation (watching a colony of ants or pre-recorded media),
c. Guided approach (with virtual mentor and pedagogic agent) to free roaming (exploratory), and,
d. Team-based game play (collaborative learning) to single player mode (individualistic).

Games as Learning Systems

While the demarcation between game and simulation is not always clear (Gredler, 1996), they are treated as the same in this chapter. Every game has a goal, and it is the learner's prerogative to learn the rules and activities depicted, either to play the game or to operate the simulator. In a first person shooter (FPS), the ability to kill all moving targets, and at

the same time to stay alive, is one of the major goals of the game. In many FPS games, the player's goal is to train up to the point where he or she is strong and agile enough to defeat the Boss and win the game. In online games, such as EverQuest, players' goals can be short term, as in defeating the dragon in tonight's campaign, or long term, as in becoming the Guild Master with 300 guild memberships. Therefore, most games are in essence *closed* learning systems (as a truly open gaming system with no clear in-game goal is likely to result in many confused and frustrated players).

If games are regarded as closed learning systems, then the players may be viewed as learners within the systems (i.e. learning agents interacting with the rules within a finite system). How do developers of the games assess the efficacy of the players, or learners of the game system? Because (electronic) games are programs of some sort, mathematics is involved. A winning scenario is a set of fulfilled conditions, most frequently determined by the values of game variables and formulas. For example, suppose in a game, two players, taking on the roles of a paladin and a dragon, engage in a battle. If the life point reaches 0 for the dragon, but is greater than 0 for the paladin, then the dragon avatar loses and the paladin avatar wins.

Game makers planning to incorporate the information trail must first consider what information needs to be monitored during game play before developing the game. Because "storyboarding" is the stage where game flow is commonly decided, it is rightly the place to decide information capturing as well. The instructional designer will need to discuss *event hooks* with script/story writers to plan for adequate tracking to happen. For example, if in a game about the Solar System, the blue ball is taken to mean the Earth, and Sarah picking up the blue ball is taken to mean, "Sarah recognizes the Earth is blue when viewed from outer space," then the action of picking the blue ball is the event hook. The hook is attached to the online database in such a way that when Sarah, the avatar, picks up the blue ball, the event would trigger a value change in the variables associated with "recognizing the Earth is blue" from null to yes, or (0) to (1).

In programming parlance, variables are normally written like this: *myFirstVariable*. Several words that describe the variable are meshed into one word, with the first word beginning in small letter, and subsequent words in capital letters, for easy reading. This is *yetAnotherExample*. Using Tetris as the example, several game variables must first be initialized (or set to 0) whenever a gamer begins a new game, including (a) *score*, (b) *highScore*, (c) *startTime*, (d) *endTime*, (e) *level*, (f) *userName*, amongst many others. The value of some variables, such as *score* and *level*, may change or increase with the passage of time, while others, such as *highScore* and *userName*, will need to be entered when the winning (or losing) scenario is reached. Variables may exist singly, or in an array. The *hallOfFame*, for example, comprises of an array of variables, in sets of two (*playerName* and *highScore*), denoted in the following format:

```
hallOfFame { playerName1, highScore1;
        playerName2, highScore2;
        playerName3, highScore3;
        playerName…, highScore…; }
```

Depending on the purpose of the game, different variables may need to be added, or programmed to behave differently. In a game scenario where the player's team must defend a position for five minutes against an onslaught of enemies (as in Command and Conquer) or non-player characters (NPC), it may be necessary to include *countdownTimer*, *gameOver*, *lifePlayer*, *lifeNPC*, and *winCondition* variables as part of the code, which can look like:

countdownTimer = 5 x 60; (as number of seconds or milliseconds)
lifePlayer = 500;
lifeNPC = 50000; (may also be expressed as arrays of characters)

If
{ lifePlayer = 0; then *gameOver* = true; }

If

{ *countdownTimer* = 0; AND *lifePlayer* ≠ 0; then *winCondition* = true; }

else

{ *gameOver* = true; }

As suggested by the above algorithm, there can only be one condition for winning: the player must still be alive (*lifePlayer* ≠ 0) when time limit is over (*countdownTimer* = 0). Different programmers may, of course, choose to name their variables differently, or use a vastly different algorithm to reach the end goal. It is suffice to note that a discussion about game programming is beyond the scope of this chapter. Nevertheless, readers should reckon that all computer and video games consist of information collection schemes and that these schemes must be thought out carefully by the developers—even in games as simple as Tic-Tac-Toe and Tetris. In an educational setting, such schemes must be carefully designed for close matching between learning objectives and performance indicators.

Designing Assessment into Games

As stated earlier, educators and researchers must carefully consider the in-game data to be collected so that the information trail laid down can later be used as evidence for assessment. A carefully designed avatar tracking process will open the door for educational assessment in online games. When designing online games for instruction, it is important for educators to work with game developers and instructional technologists to incorporate appropriate learning objectives into the games. The general lack of successful instructional games might well be an indicator of how difficult the process really is. For the assessment system to work, one should design the system "from the very start around the inferences one wants to make, the observations one needs to ground them, the situations that will evoke these observations, and the chain of reasoning that connects them" (Mislevy, Steinberg,

Breyer, Almond, & Johnson, 2002, p. 364). Online games need to be carefully designed and developed with pre-planning to incorporate information trails as the means to game assessment, embedding event hooks for data collection, and user tracking at the appropriate nodes, if they are to be of use for instruction.

Having considered the pedagogic and technological consideration (Salen & Zimmerman, 2004), a game should also be fun to play (Koster, 2005). It is important that educators be mindful of the literature on the impact of motivation on learning and instructional design (e.g., Csikszentmihalyi, 1975; Keller, 1987; Keller & Suzuki, 1988), and to seriously consider including the element of fun in game development. Many educators' handbooks and educational textbooks actually refer to games as "activities," which has resulted in many "edutainment" titles in the past. A game is necessarily more than just an activity (Loh & Botturi, 2005) because a game that is not fun to play is doomed to fail.

Apart from being fun to play, an instructional game must allow an instructor to assess the learners. While it is fairly easy for programmers to create games that will generate much data, instead of simply performing data dumps, an instructional game designer must consider what *useful* information is. Many good programmers pride themselves in elegant programming—using the least amount of code to do the job efficiently—and refrain from GIGO, or "Garbage In, Garbage Out." In other words, unnecessary codes should be eliminated (or better yet, never introduced) so that the program will operate optimally.

"Follow the White Rabbit"

In software development, a typical programming workflow would include (a) analyzing the problem, (b) deconstructing the problem into appropriate data flow diagrams, (c) outlining the algorithm in the data flow diagram with *pseudocodes* (written in structured English for describing the problem), (d) testing for proof-of-concept, (e) code writing (programming), (f) testing and revising. Games programmers follow a similar workflow, but must additionally have a good understanding of *data representation*, or the ability to represent game world or levels using data structure.

The field of instructional technology makes use of a very similar instructional design (general) model known as ADDIE, which encompasses Analysis, Design, Development, Implementation, and Evaluation, for the design and development of instructional materials. Instructional technologists interested in developing online games for instruction will need to transfer their skills from task analysis to game flow analysis, as well as to translate learning objectives into learning nodes in the online games. Each learning task may contain a series of *nodes* (white rabbits) within the game information ecology for the embedding of an information collection mechanism (see Figure 2). An *instructional game designer* will carry out the following design tasks:

a. Analyze the instructional or learning problem at hand.
b. Break down the overall learning problems into achievable and measurable objectives using data flow diagrams.

c. Consider the pedagogic dimension (Reeves, 1997) of each objective to establish a close-match with the game design.
d. Design and outline the algorithm using pseudocode.
e. Test for proof-of-concept using storyboard.
f. Develop the instructional game in-house (or farming-out the development job).
g. Usability and *beta* test.
h. Design a teacher interface for the extraction of player progress report.
i. Implement the instructional game and collect feedback from players and instructors for evaluation.
j. Revise the game if necessary, plan for new or additional features in future release.

Extracting the Information

Having developed the game with the concept of the information trail, how does one go about retrieving the data? Moreover, what does the collected data tell us about the players? Let us consider two fictitious first grade classrooms where students are learning to distinguish the colors Red, Green, Blue, and White. In the first classroom, Mrs. Jones has decided to assess the learning of her students by asking them to group objects with similar colors together. For every attempt that was performed correctly, her students will receive a score in her score sheet. The teacher of the second classroom, Miss Lee, has instead chosen to use an online version of Bejeweled (http://zone.msn.com/en/bejeweled/) as the assessment tool.

When Miss Lee introduced the game in class, she allowed each student 15 minutes to practice using the game. She then provided the students with the Web site so that they may access the online game from home: to practice grouping objects of similar colors together. She also distributed a unique pair of user IDs and passwords to each of her students, and cautioned them to keep the password confidential and to not share it with anyone else. Now, Miss Lee can distinguish each of her students by name instead of allowing the students to access the online Bejeweled Web site anonymously.

Conceptually, there is no difference between the two assessments because students from both classes are asked to recognize and group objects of similar shape and color together. However, operatively, while Miss Jones applies a scoring rubric whenever Tim correctly matches white circles together, Miss Lee may have a problem expressing the criteria of her assessment and interpreting Johnny's online Bejeweled score as evidence of learning to the principal or to Johnny's parents, even though it is conceivable that Johnny must also exercise strategy planning skills in playing the online game and has consequently demonstrated more "learning" than Tim. Administrators and parents are likely to want answers to some of the following questions:

- How many times did Johnny attempt the matching assessment?
- How many colors were used in the assessment for Johnny?
- How many times did Johnny correctly perform a match?

- How many times did Johnny incorrectly perform a match?
- Did Johnny receive any remedial instruction on the matching task?
- How often did Johnny make use of remedial materials?

Although the answers to the questions listed above can be found among the many variables used within the game, it would be nearly impossible for Miss Lee to extract the information directly from the commercial version of Bejeweled. However, suppose that Miss Lee's brother, Nathan, is the programmer of the online version of Bejeweled; she may request that a special extraction program (teacher interface) be developed to allow her to "read" certain in-game variables and use them to compile a "progress report" for each of her students (Table 1 showed the report for Johnny). This report may further be accessed by administrators, and Johnny's parents, and may contain Johnny's ranking in the "Hall of Fame," rate of improvement, and bonus awards received, if any.

An administrator who reads the report (Table 1) can easily deduce that Johnny was first introduced to the online game in class on June 5 (Monday), when he played for 15 minutes from 9:10 am to 9:25 am. During the week, Johnny spent a total of 430 minutes on the online game, which amounted to 36 rounds of playing. It was rather obvious that Johnny's usual login time was around 8:00 pm, perhaps after dinner and before his bedtime. His biggest improvement occurred on Day 3, when he spent 75 minutes on "beating" the game and nearly doubled his score from the day before. Over the week, his achievement score improved greatly from an initial 20% to the final score of 87.5%. Because Johnny appeared to have some difficulty in telling the color red from the color green (consistent lower combined scores than

Table 1. A 'mock' progress report for Johnny D. Smith (Johnny)

Name of student: Johnny D. Smith			*ID: Johnny*		*Teacher: Anne Lee*					
Login Log for the week: June 5-11, 2005										
Day	*Login*	*Logout*	*Time spent*	*Round*	*Scores*					
					Red	*Blue*	*Green*	*White*	*Total*	*Final Grade*
June 12	*7.27 pm*	*8.47 pm*	*80 min*	*9*	*69/90*	*89/90*	*72/90*	*85/90*	*315/360*	*87.5%*
June 12	*9.01 am*	*9.58 pm*	*57 min*	*4*	*28/40*	*36/40*	*25/40*	*33/40*	*122/160*	*76.3%*
June 11	*8.05 pm*	*8.48 pm*	*43 min*	*5*	*32/50*	*40/50*	*40/50*	*38/50*	*150/200*	*75.0%*
June 10	*8.05 pm*	*8.55 pm*	*50 min*	*3*	*16/30*	*28/30*	*18/30*	*23/30*	*85/120*	*70.8%*
June 9	*8.22 pm*	*9.07 pm*	*45 min*	*3*	*18/30*	*22/30*	*15/30*	*20/30*	*75/120*	*62.5%*
June 8	*8.08 pm*	*9.23 pm*	*75 min*	*6*	*30/60*	*40/60*	*31/60*	*43/60*	*144/240*	*60.0%*
June 7	*8.05 pm*	*8.35 pm*	*30 min*	*2*	*4/20*	*10/20*	*6/20*	*10/20*	*30/80*	*37.5%*
June 6	*8.15 pm*	*8.35 pm*	*20 min*	*2*	*6/20*	*10/20*	*6/20*	*10/20*	*16/80*	*20.0%*
June 6	*5.20 pm*	*5.35 pm*	*15 min*	*1*	*2/10*	*3/10*	*2/10*	*3/10*	*10/40*	*25.0%*
June 6	*9.10 am*	*9.25 am*	*15 min*	*1*	*2/10*	*3/10*	*1/10*	*2/10*	*8/40*	*20.0%*

blue and white), Miss Lee recommended Johnny for an optical check-up and subsequently discovered that he was suffering from a very mild case of red-green color-blindness. Miss Lee’s innovative use of the online game for learning gained her the approvals she needed from the parents and her principal.

“Useful” Data

Having enjoyed the success of the online Bejeweled, Miss Lee decided to ask her brother, Nathan, to add even more features to the online game system. Miss Lee learned from Nathan that the online game contained numerous variables. Nathan insisted that as a trained professional, she must decide what variables are meaningful to her and therefore, should be extracted for use in the reports.

After careful consideration, she asked that the following weekly report be created (see Table 2) in addition to the progress reports she already received. Nathan was able to create the following report using information retrieved from the online game’s Web server log. Armed with the report, Miss Lee was able to skim through the data and use it to help her revise her teaching strategy and monitor her students’ usage of the online games as weekly learning tasks.

At a glance from the report summary, Miss Lee knew that 10 of her 12 students had logged in at least once for the week, except Timmy55 and Lucy98. Miss Lee took note that this

Table 2. A customized report by Miss Lee that was extracted from the Web Server log

Date	*IP Address*	*Location*	*Login Time*	*Logout Time*	*User ID*	*YTD Log-in*
6-7-2005	*122.52.6.156*	*CompLab1*	*9.12am*	*9.38am*	*Johnny*	*326 min*
6-7-2005	*122.52.6.152*	*CompLab1*	*9.15am*	*9.32am*	*SusanD*	*733 min*
6-7-2005	*122.52.6.154*	*CompLab1*	*9.13am*	*9.39am*	*Tom34*	*287 min*
6-7-2005	*122.52.6.134*	*CompLab2*	*9.00am*	*10.00am*	*LeeAnn*	*476 min*
6-7-2005	*122.52.2.100*	*Library*	*11.12am*	*11.50am*	*Johnny*	*364 min*
6-7-2005	*166.44.26.10*	*Public*	*1.12pm*	*1.50pm*	*NancyP2*	*60 min*
6-7-2005	*166.210.34.15*	*Public*	*4.05pm*	*5.10pm*	*Rq662*	*138 min*
6-7-2005	*122.52.2.138*	*Library*	*5.12pm*	*6.14pm*	*Jones*	*24 min*
6-7-2005	*138.24.99.111*	*Public*	*9.12pm*	*9.54pm*	*Johnny*	*406 min*
Etc…	*Etc…*	*…*	*…*	*…*	*…*	*…*
Summary:						
Total number of students: 12			*Student with 0 time: Timmy55, Lucy98*			
Highest frequency: SusanD			*NewUser: Jones (added on June 7 2005)*			
Etc…						

week's highest login award went to SusanD, and made a note to e-mail SusanD with an unlock code to a special in-game bonus token. She would have to send Timmy55 and Lucy98 a reminder to "login and have fun," a much better alternative to "Remember to do your homework." Miss Lee recalled that some of her students were opposed to playing the online games when she designated them as "homework."

Just last week, Miss Jones, a fellow first-grade senior teacher, had requested to be added as a user to Miss Lee's online game system, so that she, too, could find out about using online games as a learning tool in her class. Miss Lee observed that Miss Jones had accessed the Web site from the school library, on June 7, 2005, at 5:12 pm. Miss Lee smiled when she noticed one of the parents, RQ662, had logged in for the first time. Miss Lee hopes NancyP2's dad will become one of her strong supporters in using online games for learning.

Extending the Gaming Idea

During one of the staff meetings, some other teachers had asked Miss Lee if her brother could customize the online Bejeweled, to allow for the following:

a. Teacher modifiable conditions
   - Miss Jones would like to modify the game condition for her students who were targeted for remediation—for example, student A's online game session would contain 30% more Red and Green gems than other students.
   - Mr. Roland would like to reward a few of his students—who have attempted over and beyond what they were asked to do—with special in-game tokens. For example, one of his students practiced some 300 rounds and raised her achievement score from 15% to 95% in seven days. He would like to award the student with a special in-game item not obtainable elsewhere to give her due recognition, and at the same time, make playing the online game more fun and rewarding.

Miss Lee's 1st grade students have the following requests:

b. Student modifiable conditions
   - Instead of the 16x16 grid, Tim would like to play a more challenging game using a bigger grid of 25x25.
   - Mary would like the online game to use only pastel-colored gems, and she would specifically like them to be Pink, Baby Blue, Lilac, and Aquamarine.
   - "Quick-finger" Jason would like his session of the game to carry a shorter response time so he will feel more challenged.
   - "Painter" Joe preferred to see real gemstones instead of the current graphics used in the game. He has asked his father to scan photographs of real gemstones to

help make the gems look more realistic, which prompted Nathan to add a "skin" feature for the online game

- Two students who play Pokémon on GameBoy Advance (GBA) have requested a head-to-head feature where two players can compete simultaneously on-screen.
- Having visited DirectSong's Web site (directsong.com), Johnny would like to replace the background music of the online game with his collection of music from his favorite anime.

A Superintendent who was present at the staff meeting immediately recognized the potential of the system, and requested that Nathan expand the database to include:

- Names of teachers
- Names of schools
- Names of school district
- Names of states
- Difficulty level of the game
- Subject categories
- Game ratings by teachers
- Game ratings by students
- Amount of time taken in playing the game
- Calculation of difficulty quotient: % of accuracy/time taken to play
- Feedback

The Superintendent was convinced that he could bring this game system to the rest of the classrooms within his school district and had decided to apply for external funding to set up a game server to better manage and analyze all the information collected.

While Miss Lee, Nathan, and the first grade students are all fictional characters, it is indeed possible for the video game developers to create "thin-client" versions of popular MMOGs that fit the educational context. These games can be less complex and smaller in scope, with simplified missions that allow the incorporation of classroom learning objectives and authentic learning tasks. Most importantly, these games must provide instructors with the necessary access into in-game database for extraction of useful information as evidence for assessment. Readers interested in making sense out of complex data for assessment may want to further explore the area of *Network-based Assessment* (Gibson, 2003) and *Evidence-center Assessment* (e.g., Mislevy et al., 2002).

Other Considerations

Implementing online games for learning is not a bed of roses. There will certainly be issues to be contended with, such as the issue of privacy. Privacy policy will need to be drawn up to detail how information is collected and intended for use within the system and to obtain special consent from parents' or guardians of children under 13 years old. Can the information tracked and collected be disclosed, under what circumstances, and to whom? What security systems must be put in place to safeguard the information collected? Since the avatar data collected are likely be stored in an online database, it would be prudent to keep in-game variables apart from identifiable personal information to avoid corruption of database and to protect the hacking of online database and ensuing identity thefts.

Education assessment has always been plagued by cheating, online games notwithstanding. Because games can be a very powerful motivator, educators must guard their students from becoming *grade obsessive*—placing undue importance in test scores and grades (Romanowski, 2004), another common rationale for classroom cheating. Interestingly, when the games become too challenging, many players would resort to cheating in order to "beat the system." It would do well for educators to work with the MMOG developers in the video game industry to control and minimize this problem.

Case Study: Experiencing "Guild Wars"

This section presents a case study using a commercial off-the-shelf online game called Guild Wars, to walk the readers through some of the salient points in this chapter, including avatar tracking in online games, nodes and navigational paths, and possible ways of incorporating information trails. One of the unique features of Guild Wars is the abolishment of the monthly subscription fee commonly associated with MMOGs. This feature could help to extend the number of players engaging in a multiplayer online universe, possibly into some classrooms. The author will describe some of his first-hand experience of GW and suggest what an educational version of GW might be like with information trails embedded into the game for assessment of learning.

Pre-Game Avatar Tracking

After installing the game, a would-be player was shown the "Registration" screen. Several posts of breaking news and updates were shown, followed by a warning as follows:

> *Warning: If you download Guild Wars add-ons like bots, skill calculators, etc., you're likely to have your account stolen. These programs often contain key-loggers that capture passwords and cannot be detected by virus-scanners.*

This was interesting because it once again attested to the reality of the Knowledge Economy and the increasing trend of information tracking and capturing in the online world. Would the "stealers" of game accounts be referred to as *information rogues*, or *terrorists*?

The registration screen was followed by an "Enter Address" screen with the following message:

> *Enter your Mailing Address*
>
> *Regulations in many countries require that we ask you for your mailing address.*

One wonders which countries would require the mailing addresses of online players, and under what regulations? Besides, how could the "law enforcers" from these countries ensure the mailing addresses were not bogus information?

This was then followed by the "Enter E-mail" screen, which concluded the registration process. The user received the following message, somewhat akin to a privacy statement:

> *We will send a message containing your account information to this address. We will never send you spam, and we will never sell or distribute your e-mail address.*

Compared with the mailing address, an e-mail address is more likely to be authentic, especially if gamers are expecting to receive a confirmation e-mail from the game company. The IP address of the computer used in registration is likely to be logged at this point, and would be tagged with the registrant's e-mail address as well as the serial number of the game. This information is, no doubt, used for user verification and to prevent game owners from creating more than four avatars per account. While IP address alone may not be hard evidence enough against a player, one copy of the game being used at multiple IP addresses is a highly suspicious activity and may flag the player's account for monitoring.

In-Game Avatar Tracking

After successful registration and login using an appropriate ID and password, a player's avatar would magically appear outside a town where Sir Tydus was to be found. The Ascalon kingdom is at war with the Charr, and Sir Tydus' charge is to recruit brave warriors to Ascalon's defense. However, before Sir Tydus would receive the player into the academy, a player must first receive some basic training. This is akin to a tutorial that helps the player become familiar with the game mechanics. Special in-game trainers might be found in strategic locations to offer missions to the players for level advancing. Every successful mission accomplished would unlock certain dormant skills to give each player a unique combination of skills and to make him or her strong enough to join Sir Tydus for some "real adventures."

One can find "Collectors" in almost every town. These Collectors would ask for a specific number of items (e.g., three fins, four bake husks) in exchange for special in-game items. Many of these items are found only in specific locations, such as on a riverbank, or up on a hill. The "Collector" mission is highly suitable for a simulative classroom because students who are interested in getting the special items from the Collectors must learn how to count. Moreover, they must also learn how to read, and additionally be able to recognize the items of interest. Such skills are also useful in science (recognition of plants and animals) and geography (map reading and topography).

A little girl named Gwen can be found on the outskirts of the first town. If spoken to, Gwen would ask the player to retrieve a lost flute. She enjoyed receiving small gifts, including "small girl's cape" and "red iris flowers," obtainable at the local market and the open field, respectively. A simulative classroom for young children may make use of non-violent missions such as these to teach younger learners the value of friendship, art, music, counting, reading, and even trading. On the other hand, adult players are likely to prefer the hack-and-slash missions for character advancement.

Identifying Nodes and Navigation Paths

All "named" objects within a game are potential *markers* for *information trails*. In GW, for example, merchants, collectors, Sir Tydus, monsters, and even the "red iris flower" are *markers*. Some markers can be designated as *nodes*, or points of interest along the information trail. These nodes are easily identified because they often become congregation sites for game players. In GW, for example, important merchants are often surrounded by a large group of players who are trying to barter for merchandise.

Some *nodes* can be doorways to different sections of the game world, and may be activated by certain events, such as the completion of a special mission, or achievement of a particular level. These *nodes* may also provide clues to the next checkpoint (finding new nodes). In GW, players who have completed a mission are often required to return to the mission-giver for "experience points." Mission-givers (like Sir Tydus) may then redirect the players to a new section of the game by unlocking hidden abilities/special game items or assigning players with a new mission. Similarly, unique mission agents may be used to direct students to a different part of the game world by their class number, level of achievement, school district, subject of interest, ability, learning style, and other suitable criteria. Students can spawn multiple adventures using avatars "designed" for specific guilds, complete with interesting names such as Language and Poet Society, Chemist Clan, Guild of Traveling Bards, and Miss Lee's Little Lion Cubs.

Teacher's Interface

Instructors will need a special "interface" to extract and compile the information trails for *assessment* purposes. The interface should also be simple to use, probably a database-driven

online form, by which different pre-formatted templates will be made available to different groups of consumers, including students, teachers, administrators, and parents.

Much like Miss Lee's special reports (e.g., Tables 1 and 2), the purpose of the interface is to enable instructors to easily interpret in-game markers as empirical data for gamers' behaviors and achievement. In that way, even teachers who do not understand how the information trail works will still be able to call up a student's progress report in a moment's notice, without ever needing to know any computer coding or programming.

Game Guilds and Qualitative Research

While many online games have groups (loosely referred to as guilds, or clans) that enlist players for various missions and adventures, GW is unique in the way it implements *guilds*. Players in GW can form their own guild, just as they create their in-game characters or avatars. One guild member is identifiable from another by the color of the capes they wear, as well as the emblem of the Guild (much like use of logo and colored uniforms in competitive sports). Total strangers, colleagues, classmates, close friends, and even family members can login to GW simultaneously to journey as a group. Over time, the sharing of life experiences as a group affords the guild members a sense of camaraderie previously not possible in standalone games.

The Guild feature is useful for collaborative learning using learning tasks that range from pair-work, to small group, to an entire class (guild) of students. It will be possible for qualitative researchers to put on the guise of a player in order to become *participant observer* in a guild (Papargyris & Poulymenakou, 2005), or to play alongside the players in the role of a tutor or a master in order to collect rich data, or in the role of a comrade to triangulate certain observations. Educators finally have a viable context to embody the "sage on the stage" with "a guide by the side," effectively switching between constructivist and instructivist teaching styles at will.

Conclusion

It has been predicted that the imminent Semantic Web and its intelligent agents will bring great changes to our lives (Berners-Lee, Hendler, & Lassila, 2001). Judging by today's Internet technology, one can only expect that more information trails will be left behind by users, with more sophisticated tracking tools made available to track even more customer information. In order for the software agent technology of the Semantic Web to be effective, user profiles may have to be integrated into the Semantic Web altogether. Hopefully, knowledge peddling will be brought under control, with the information being accessible only by authorized software agents.

The advent of agent technology will make online games even more elaborate, with realistic non-player agents acting as gatekeepers of game flow. Using online games in traditional classrooms for daily teaching and learning is not inconceivable. Unless researchers begin to think of games as avatar tracking systems, and unless researchers consider the information

they could collect and track for the purpose of assessment, it will be difficult to use games directly in the classroom as a legitimate learning tool.

As I conclude this chapter, I would like to revisit the role-playing game that started it all, Dungeons & Dragons. Invented by Gary Gigax in the 1970s, and named after a dodecahedral (twenty-sided) dice, the "D20 game system" successfully attracted players from different backgrounds for 30 years (King & Borland, 2003). Because D&D was created for the tabletop (before the advent of computer), a Dungeon Master (DM) had to first design a game world on paper and then lead a group of adventurers on a game "campaign." Every event that happened during the campaign was a combination of chance (dice throwing) and the story-weaving ability of the DM. Due to the chance element of the game, sometimes the turn of events within the campaign made the imaginary play too hard or too easy, resulting in players losing interest. Hence, a DM had the power to referee the game to keep the story going and the adventure interesting and fun for the players. Referee actions included rewarding players with special items, introducing calamity, adding more monsters, and subplots—essentially doing whatever was necessary to balance the game play.

Teachers may eventually take on the role of DMs in educational online games and lead their students on weekly game campaigns to conquer new lands, slay dragons, rescue princesses, and learn mathematical and scientific formulas. Certainly a DM can also choose to lead a team on a *picnic* campaign to identify species of flowers and to count the number of *Bufo americanus* (frog) found. While it is perfectly acceptable to use a world created by others, as not all DMs can design game worlds, it is a requirement that DMs be good story-weavers. Similarly, teachers must design (the learning tasks) and lead the game campaign (conduct learning activities) within the online game world created by game programmers and designers. Teachers must be given the power as DMs to *reward* and *punish* gamers with in-game items or events, with the purpose to balance the learning experience for players. Although a DM toolkit is already available with the RPG game NeverWinterNight (http://www.gamespot.com/pc/rpg/neverwinternights/review.html), there is yet to be any report on educational research with the DM toolkit.

The *information trails* left by gamers will provide a DM with the gamers' statistics, revealing their strengths and weaknesses. It is the DM's prerogative to raise the gamers' abilities with appropriate *side* missions, so that the players can survive the ultimate challenge and win the campaign. While some D&D campaigns can be notoriously difficult to win, a good DM's responsibility is to ensure that every player has a wonderful time of adventuring. One expects no less from a teacher. Even as D&D seeks to reinvent itself with MMOG (http://www.ddo.com), it is time for classroom teaching and learning to do the same by closely examining online games for pedagogical ends.

Note

The author has been awarded a Faculty Seed Grant of $20,000 in May 2006 to being work on the "Information Trails for Game Assessment" project. More information is available at the Collaboratory for Interactive Learning Research (CILR) Web site, http://idt.siu.edu/cilr.

Acknowledgment

I would like to thank Kane Gilmour for his help in reading the drafts and providing feedback.

Reference

Ackerman, K. (2004, August 24). *Linden lab and transactions in second life*. Retrieved June 18, 2005, from http://www.frictionlessinsight.com/archives/2004/08/linden_labs_and_html

Aldrich, C. (2004). *Simulations and the future of learning: An innovative (and perhaps revolutionary) approach to e-learning*. San Francisco, CA: Pfeiffer.

Anderson, D. R., & Field, D. (1983). Children’s attention to television: Implications for production. In M. Meyer (Ed.), *Children and the formal features of television* (pp. 56-96). Munich, Germany: Saur.

Associated Press. (2005a, March 27). *Amazon knows who you are*. Retrieved June 10, 2005, from http://www.wired.com/news/ebiz/0,1272,67034,00.html

Associated Press. (2005b, September 23). *A generation of game boys, girls*. Retrieved September 26, 2005, from http://www.wired.com/news/culture/0,1284,68964,00.html

Berners-Lee, T., Hendler, J., & Lassila, O. (2001, May 17). The Semantic Web. Retrieved June 14, 2005, from http://www.sciam.com/article.cfm?articleID=0004814410-D2-1C70-84A9809EC588EF21

Borges, J., & Levene, M. (1999, August 15). *Data mining of user navigation patterns.* Paper presented at the WEBKDD’99 Workshop on Web Usage Analysis and User Profiling, San Diego, CA.

Burton, M. C., & Walther, J. B. (2001). The value of Web log data in use-based Web design and testing. *Journal of Computer-Mediated Communication, 6*(3). Retrieved June 7, 2005, from http://www.ascusc.org/jmc/vol16/issue3/burton.html

Carlson, S. (2003, August 15). *Can grand theft auto inspire professors?* Retrieved June 18, 2005, from http://chronicle.com/weekly/v49/i49/49a03101.htm

Chi, E. H., Pirolli, P., Chen, K., & Pitkow, J. (2001, March 31-April 4). *Using information scent to model user information needs and actions on the Web.* Paper presented at the SIGCHI ’01, Seattle, WA.

Coleman, G. (1999). *Online tracking: How anonymous is the Internet?* Retrieved June 10, 2005, from http://www.slais.ubc.ca/courses/libr500/fall1999/www_presentations/g_coleman/

Croal, N. G. (2002, November 25). *Sims family values.* Retrieved June 10, 2005, from http://www.msnbc.msn.com/id/3070145

Csikszentmihalyi, M. (1975). *Beyond boredom and anxiety: The experience of play in work and games*. San Franscisco, CA: Jossey-Bass.

DeBra, P. M. E. (1997). Teaching through adaptive hypertext on the WWW. *International Journal of Educational Telecommunications, 3*(2), 163-180.

Dietel, R. J., Herman, J. L., & Knuth, R. A. (1991). What does research says about assessment. Retrieved June 8, 2005, from http://www.ncrel.org/sdrs/areas/stw_esys/4assess.htm

Drucker, P. (1994). The age of social transformation. *The Atlantic Monthly, 274*(3), 53-80. Retrieved June 8, 2005, from http://www.theatlantic.com/election/connection/ecbig/soctrans.htm

Entertainment Software Association. (2005). *Essential facts about the computer and video game industry*. Washington, DC: Entertainment Software Association.

Game Informer. (2005, May). Microsoft talks next Xbox. *Game Informer, 15*(145), 19.

Garrison, S. J., & Fenton, R. J. (1999). Database driven Web sites in education. *Educational Technology, 39*(4), 31-38.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy* (2nd ed.). New York: Palgrave Macmillan.

Gibson, D. (2003). Network-based assessment in education. *Contemporary Issues in Technology and Teacher Education, 3*(3), 310-323.

Glasner, J. (2005a, May 2). *Ad execs want to track every move.* Retrieved June 8, 2005, from http://www.wired.com/news/ebiz/0,1272,67390,00.html

Glasner, J. (2005b, April 28). *Ads that know what you want.* Retrieved June 8, 2005, from http://www.wired.com/news/ebiz/0,1272,67365,00.html

Gredler, M. E. (1996). Educational games and simulations: A technology in search of a (research) paradigm. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (1st ed., pp. 521-539). New York: MacMillan.

Heckel, H. L. (2003). *Online social interaction: The case of EverQuest.* Unpublished master's thesis, George Mason University, Fairfax, VA.

Hill, M. (2005, September 25). *More colleges offering video game courses.* Retrieved September 26, 2005, from http://www.usatoday.com/tech/products/games/2005-09-25-video-game-colleges_x.htm

Interactive Digital Software Association. (1999). *State of the industry report.* Washington, DC: Interactive Digital Software Association.

Interactive Digital Software Association. (2002). *Essential facts about the computer and video game industry*: Interactive Digital Software Association.

Interactive Digital Software Association. (2003). *Essential facts about the computer and video game industry*: Interactive Digital Software Association.

Keller, J. M. (1987). Development and use of the ARCS model of instructional design. *Journal of Instructional Development, 10*(3), 2-10.

Keller, J. M., & Suzuki, K. (1988). Application of the ARCS model to courseware design. In D. H. Jonassen (Ed.), *Instructional Designs for Microcomputer Courseware* (Vol. I, pp. 401-434). Hillsdale, NJ: Lawrence Erlbaum Associates.

King, B., & Borland, J. (2003). *Dungeons and dreamers: The rise of computer game culture from geek to chic*. Emeryville, CA: McGraw-Hill/Osborne.

Koster, R. (2005). *A theory of fun for game design*. Scottsdale, AZ: Paraglyph Press.

Loh, C. S., & Botturi, L. (2005, October 18-22). *What's in a name? A discussion of what 'game' means to the field.* Paper presented at the annual conference of the Association for Educational Communications and Technology (AECT 2005), Orlando, FL.

Loh, C. S., Rieber, L. P., Wiley, D., Van Eck, R., & Holschuh, D. (2004, October 19-23). *Let's make R.O.O.M. for games.* Paper presented at the annual conference of the Association for Educational Communications and Technology (AECT 2004), Chicago, IL.

Mislevy, R. J., Steinberg, L. S., Breyer, F. J., Almond, R. G., & Johnson, L. (2002). Making sense of data from complex assessment. *Applied Measurement in Education, 15*(4), 363-389.

Papargyris, A., & Poulymenakou, A. (2005). Learning to fly in persistent digital worlds: The case of massively multiplayer online role playing games. *ACM SIGGROUP Bulletin, 25*(1), 41-49. Retrieved September 30, 2005, from http://doi.acm.org/10.1145/1067699.1067706

Pirolli, P., & Card, S. K. (1999). Information foraging. *Psychological Review, 106*(4), 643-675. Retrieved September 12, 2005, from http://www2.parc.com/istl/groups/uir/pubs/items/UIR-1999-05-Pirolli-Report-InfoForaging.pdf

Prensky, M. (2001). *Digital game-based learning*. New York: McGraw-Hill.

Reeves, T. (1997). *Evaluating what really matters in computer-based education.* Retrieved June 10, 2005, from http://www.educationau.edu.au/archives/cp/reeves.htm

Rieber, L. P. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. *Educational Technology Research and Development, 44*(2), 43-58.

Romanowski, M. H. (2004, summer). *Student obsession with grades and achievement.* Retrieved June 13, 2005, from http://www.findarticles.com/p/articles/mi_qa4009/is_200407/ai_n9424194

Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M., Flores, P., et al. (2003). Beyond Nintendo: Design and assessment of educational video games for first and second grade students. *Computers and Education, 40*(1), 71-94.

Salen, K., & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. Cambridge, MA: The MIT Press.

Sherry, J. (2001). The effects of violent video games on aggression. A meta-analysis. *Human Communication Research, 27*(3), 409-431.

Squire, K. (2004). *Replaying history: Learning world history through playing Civilization III.* Unpublished doctoral dissertation, Indiana University, Bloomington, IN.

Steiner, P. (1993, July 5). On the Internet, nobody knows you're a dog. [cartoon] *The New Yorker* (p. 61). Retrieved July 9, 2006, from http://www.cartoonbank.com/assets/1/22230_m.gif

Thompson, K. M., & Haninger, K. (2001). Violence in E-rated video games. *The Journal of the American Medical Association, 286*(5), 591-598. Retrieved September 30, 2005, from http://jama.ama-assn.org/cgi/content/full/286/5/591

Trento, A. (2005, March 25). Developing a cross-platform flash game for Dolce & Gabbana. Retrieved June 10, 2005, from http://www.macromedia.com/devnet/devices/articles/dolce_gabbana.html

Silver, J. (Producer), Wachowski, A., & Wachowski, L. (Directors). (1999). *The Matrix* [Motion Picture]. USA: Warner Brothers.

Ward, M. (2005, April 18). *Mobile games to "go interactive"*. Retrieved June 15, 2005, from http://news.bbc.co.uk/2/hi/technology/4449319.stm

Wheeldon, R., & Levene, M. (2003). *The best trail algorithm for assisted navigation of Web sites.* Paper presented at the 1st Latin American Web Congress (LA-WEB 2003), Santiago, Chile.

Zalane, O. R. (2001, June 27-28). *Web usage mining for a better Web-based learning environment.* Paper presented at the Conference on Advance Technology for Education, Banff, Alberta, Canada.