Preface

Whenever one plays a game, and whatever game one plays, learning happens constantly, whether the players want it to, and are aware of it, or not. And the players are learning "about life," which is one of the great positive consequences of all game playing. This learning takes place, continuously and simultaneously in every game, every time one plays. One need not even pay much attention. (Prensky, 2002)

Games are serious learning tools. But can games teach exactly what and when you want them to? What about simulations? Are they like games? Why talk about games AND simulations in online learning…and why in "online learning?" How do these fit together and to what end?

Rather than thinking about games and simulation, it is more productive to think about the distinct elements, namely:

- *Simulation elements*
- *Game elements*
- *Pedagogical elements.* (Aldrich, 2005)

Research and development of digital games and simulations in online learning is in its infancy. Digital games and simulations explicitly designed for education have only been available on disks and CDs since the 1980s and available on the Internet since the 1990s. Now in 2006, two decades into their evolution, games and simulations are beginning to show new promise for the future of learning.

The old promise was that when a computer is involved in playing a game or running a simulation, a lot of the slowness and drudgery is taken out of score keeping, rolling dice, marking positions, operating a model, and replicating causes. This allows players to concentrate on strategy and tactics, which is good, because concentrating on higher order skills brings people closer to the essence of learning how to learn.

Beyond efficiency and focus, the old promise was also about the enhancing effect of integrated multimedia: snazzy graphics, exciting sounds, compelling stories, and interactivity! Games without computers involve dice, spinners, paper, markers, game boards, and cards. Digital game-based learning involves highly engaging hypermedia often including player-defined nonlinear texts with audio and video. These media elements motivate players through experiences that have the gripping force of a first-person story.

But the new promises are even more exciting. We are just beginning to understand and document, through a blend of IT and social research, how game and simulation elements can take advantage of the global network infrastructure to add live data, new social contexts, and distributed processing on far-flung knowledge databases. These promising new capabilities allow the player to be part of an extended, living community of inquiry and practice.

Can these elements be brought together by design without, as Prensky, Clark, and others warn, "sucking the fun out of everything?"

The field of educational and serious games is strewn with a mixture of entrepreneurs and academicians who are experimenting, building prototypes, and laying the foundations for future research and development. Not all is clear in the dust kicked up by this activity, but there is plenty to think about and several promising leads. We have gathered some of it here for you to scan and spend time with as your interests lead you.

Since you are reading this, you must be among those who are curious to find out what others are thinking and doing with games and simulations in education. For you, we do not have to talk about "why games?" or "why simulations?" You already know that they are valuable pursuits. Playing them or experimenting with them leads to learning. Including them in online learning, you sense, will add excitement at least, and at best, more powerful and effective experiences that deeply engage learners and create memorable, lasting impressions.

For you, it is clear that advanced information technologies should be more aggressively exploited to improve education. You know that educators are underutilizing the vast potential of information technology to transform schooling, teaching, and learning. While current educational policies seem bent on subjugating people into submission to standards, you understand that we need to better understand how students learn with advanced technologies. Then we need to design and use better tools to take advantage of this understanding. It is perfectly clear to you that games and simulations are central to the future of education.

But we are not "there yet." The touted promises of a new learning society founded upon easy access to educational resources on the telecommunications infrastructure seem to have faded. Where is the "sprawling, wired city full of researchers, teachers, students, and members of the community" pursuing diverse directions (Johnson, 2002)?

Many people have not yet made the connection between computational science, which has completely changed how science is conducted, and education that could be using those same computational and informational technologies. Yet, this is where simulations live and breathe. In addition, many people seem to be afraid of what would happen if all learning were as effective and fun as possible. Yet, this is where most of early learning takes place and where, if the truth be told, we would all rather spend our time than in a didactic "course" with a test at the end of the tunnel. What can be done to help these people see a path to the future of learning?

These people need to be shown, convinced, and supported in their consideration of the promise of games and simulations in education. They need to see research and development frameworks that are grounded in generally accepted educational theories. They need to read

about prototype projects that are experimenting their way to the future, and they need to develop a hunger to have their own institutions engage in this work.

The kinds of questions on their minds are: What sort of new research and development is emerging around games and simulations? What kinds of learning are involved, and how do we know if users are "getting it?" What is the unique added value and potential for learning and assessment in the digital environment? Are there examples that can inspire researchers to think more deeply, and see a new horizon for e-learning?

We hope that this book provides some food for thought concerning these questions. We hope the book contributes to your thinking by presenting themes for research and development of educational games and simulations from a variety of perspectives, stretching you in new ways perhaps, or confirming your own creative ideas and insightful hypotheses about how games and simulations are changing education. Here is a brief overview of the chapters in this collection.

Göknur Kaplan Akilli, in **Chapter I**, *Games and Simulations: A New Approach in Education?,* provides a brief review of the literature, which she organizes around questions that define games, simulations, instructional design, and instructional development models. Her review situates the problem of instructional design models as out-dated frameworks that came into being before the age of ubiquitous games and simulations. She criticizes the current state of design, points to more promising theories, and ends by introducing us to the FIDGE model as a possible framework for a more game-like instructional design model.

Katrin Becker, in **Chapter II**, *Pedagogy in Commercial Video Games,* after tying games to deep learning and urging educators to "learn about learning from games," gives a point-by-point overview that relates game and simulation elements to several well-known learning theories. For example, Gagne's nine "events" are reviewed, with examples from popular games; Riegeluth's "elaboration" theory is presented with Becker's reflections. Bruner's psycho-cultural tenets of learning and Merrill's principles of instruction receive similar treatment. Learning style and intelligence theorists like Gardner, Keirsey, Felder, Kolb, and Gregoric are included in her argument that "good games are good for learning." But, Becker warns, a demonstration of good pedagogy in games does not add up to a prescription for creating good learning games. We should not impose instructional design onto a game or we will get what Prensky calls the "dancing banana" effect—game-like trappings on drill and kill pedagogy. Games are a completely new technology calling for completely new instructional design approaches.

Several writers present social analyses of multi-user virtual environments, which leaves us with a growing sense that networked virtual worlds are a new kind of learning ecosystem waiting to be tapped for education. The next four chapters explore this idea.

Joel Foreman and Thomasina Borkman share their experience in in **Chapter III**, using a commercial off the shelf game—The Sims—to teach a Sociology course. They wonder what would happen if colleges staged more of their large introductory courses within massively multiplayer virtual environments.

In **Chapter IV,** Lisa Galarneau and Melanie Zibit extend the theme of the new social environment of MMOGs by outlining the 21st century skills that are promoted through online games. The skills for the new millennium are shaped by global ubiquitous access to the tools of communication, collaboration, and creative decision-making needed by knowledge workers. They first discuss the new skills from a variety of perspectives—the SCANS report in the U.S. and Perelman's *School's Out* in the 1990s, the international OECD competencies,

and Goleman's "emotional intelligence" in 2000. They then demonstrate how online games in MMOGs can serve as a "practice arena" for the skills.

James G. Jones and Stephen C. Bronack, in **Chapter V**, *Rethinking Cognition, Representations, and Processes in 3D Online Social Learning Environments,* take the social analysis of 3D spaces further by pointing out their tendency to encourage peer-based informal learning. The elements of immediacy, movement, artifacts, and multimodal communications are highlighted within a larger conception of learning known as "social constructivism." The theory provides numerous core concepts such as cognitive scaffolding, situated learning, and authenticity, which are provided in 3D virtual reality spaces. The authors then provide a framework for creating and sustaining an effective learning environment in such spaces, by outlining how various users and roles relate and interact. Two case studies are presented that give concrete life to their ideas.

In **Chapter VI**, Karen Barton and Paul Maharg use another case example, the Glasgow Graduate School of Law's simulation "Ardcallough" to frame what they see as a new "trading zone" in virtual space. Their chapter *E-Simulations in the Wild: Interdisciplinary Research, Design, and Implementation* points out that a simulation is more than a likeness of reality; it is a purposeful, focused view that presents the user with a complex conceptual, as well as operational, challenge. They present a spectrum framework that at one end is "bounded" and at the other, an "open field of practice" and is consistent with discovery learning that guides the learner through self-directed activity to construct their own understanding. The trading zone of the 3D space provides a variety of transactions, which other authors in this volume "mine" for assessment information. Perhaps most refreshing, the student experience is largely absent the "normal academic forms of study and communication." Now that is progress!

What do the users think of MMOG spaces, games, and simulations as learning tools? The next two chapters provide different views.

In **Chapter VII**, Jonathan Beedle and Vivian H. Wright offer us *Perspectives from Multiplayer Video Gamers,* a research report based on a survey of gamers. Their literature review provides a synopsis of a familiar narrative. Games are big and are growing fast. Unfortunately, research thus far has focused mostly on the potentially detrimental aspects, and many of the "educational titles" are just bad teaching. However, a growing body of theory, research, and experience indicates that people learn in brand new ways when interacting with games and simulations. If you believe this and want to teach with games and simulations, there are "modding" tools that allow you to customize the applications to some extent. The list of potential benefits of learning with games leads to four questions about motivation, problem solving, communication, and creativity. Will video game players say that they believe that games increase critical thinking skills via these four avenues? Their results speak for themselves.

As we worked to build a classroom simulation—a flight trainer for future teachers—we began to wonder if the generation of teachers coming through the system at this point in time shared attitudes and experiences with the "gamer generation" as talked about by Prensky in "Digital Game-Based Learning" and by Beck and Wade in "Got Game." **Chapter VIII**, by and David Gibson, William Halverson, and Eric Riedel, titled *Gamer Teachers* gives a preliminary answer of yes. The literature review outlines the major concerns that seem to block or hinder the use of games and simulations in teaching and includes our take on a self-test (you can take it and give it to others) that was suggested by Prensky's list of cognitive styles of the gamer generation. The chapter provides a handful of hints for designing games-based

learning experiences, organized to coincide with a cognitive science summary framework from Bransford, Brown, and Cocking. Our results tend to corroborate what others have found, not so much as an age gap between generations, but a "playing gap" depending on one's game experiences. A big unanswered question is whether gamer teachers—and there are quite a few—will turn to games to teach once they are in the classroom.

Continuing with the theme of "teaching teachers how to teach," Brian Ferry and Lisa Kervin relate their experiences in **Chapter IX**, *Developing an Online Classroom Simulation to Support a Pre-Service Teacher Education Program*. Their chapter presents a straightforward step-by-step account of building a software prototyping team in higher education. The team developed a virtual kindergarten teaching application that has shown promise for engaging future teachers in the complexities of teaching decisions. The chapter will be valuable to any group that wants to develop a teaching application, especially a game or simulation about teaching. They provide a glimpse into budgets, planning processes, people, and roles in the development effort, and share the teaching framework at the heart of their simulation. A notable stage of their development included the use of a complex systems representation tool—STELLA—to explore dynamic relationships among the variables they were proposing to model.

Gerald R. and Mark Girod (father and son) and programmer Jeff Denton give us **Chapter X**, *Lessons Learned Modeling "Connecting Teaching and Learning,"* provides a second example of a development process in teacher education. Their effort is based on the "teacher work sample methodology" developed at Western Oregon University over 30 years ago. A classroom simulator called "Cook School District" models how students learn as a result of instructional strategy choices made by users. The chapter presents an informative look into the logic structure of the application and highlights eight lessons the team learned during the development process. For development teams wishing to make a contribution to teaching through a game or simulation, this team's work is a "must read."

Sara Dexter, in **Chapter XI**, *Educational Theory Into Practice Software*, presents a new perspective on teacher development by sharing a unique and powerful case-based reasoning application that has both game-like and simulation elements. The core of the application is a problem space or case, which is a collection of multimedia elements that collectively present a narrative of a specific simulated school Web site. The chapter outlines how the application works and shares some of the challenges and directional changes faced during its development. Among the lessons learned, and shared with other projects in this book are new learning and assessment theories, and a rapid prototyping approach to programming.

The next two chapters use real space as part of the virtual experience for players by integrating wireless and GPS technologies into the game and simulation. From their experience at the Swiss Federal Institute of Technology in Zurich, Steffen P. Walz and Odilo Schoch talk about *Pervasive Game Design as an Architectural Teaching and Research Method* in **Chapter XII**. The game they designed grew from the idea that architectural students of the future should be able to design both physical and virtual "hybrid reality" spaces. Their development story centers on a place-based game designed in collaboration with architectural students. The game transforms the university's campus into a giant wireless game board. Key positions in physical space issue forth questions that are best answered in collaboration with other players in the real space.

Across the Atlantic at the Massachusetts Institute of Technology, Karen Schrier built a place-based game that uses the city of Lexington, Massachusetts as the trigger for events and interactions that help players revisit and relive the Revolutionary War. Players of "Reliving the Revolution" seek to answer the question "who fired the shot heard 'round the world?" Players experience a different version of history depending on their role as well as the places they visit as they seek to piece together a coherent story of that fateful event in American history. Becker calls this an "augmented reality game" that is focused on teaching critical thinking and historical inquiry. Her story in **Chapter XIII** relates valuable lessons about game development and redesign in the service of giving players opportunities to develop complex thinking skills. She offers a design summary as part of her lessons to pass along to others.

The last five chapters explore machine learning, network-based assessment, and intelligent agents. Related by today's experimenters and developers, these provide glimpses into tomorrow's potential for games and simulations in education.

Richard Van Eck, in **Chapter XIV**, *Building Artificially Intelligent Learning Games*, presents a two-part chapter. The first part reviews pedagogical principles in games and covers ground that will be familiar to this book's readers. He asserts that games employ elements that engage and teach through problem solving that embodies the tenets of learning theory and social constructivism. Traditional approaches to instruction are insufficient for game-based learning, but fortunately, new principles are available to form a framework for research and development. He then outlines four principles of learning in games and uses them as a foundation to raise key questions that guide the second part of the chapter. Artificial intelligence, pedagogical agents, and intelligent tutoring systems are offered as mechanisms for presenting content in ways that support the four principles of learning. He ends by calling for the creation of new authoring tools that will help guide the creation of principled learning games.

Chapter XV, *simSchool and the Conceptual Assessment Framework* (CAF), by David Gibson, uses the "simSchool" flight simulator for teachers as an example of building a game-like learning application with assessment in mind. Assessing learning that potentially occurs as a result of playing a game or working with a simulator requires a formalization of everyday reasoning. The CAF (Mislevy, Steinberg, & Almond, 2003) formalizes some of the key assessment issues involved in the process of making an inference based on the evidence gathered from artifacts created by a learner. These artifacts can be intended, as is the case of an essay, or unintended, for example, the order, timing, and configuration of resources used during a game or simulation session. Details are given about how simSchool embodies the formalized student, task, and evidence model features of the CAF. In simSchool, the CAF framework is used to organize the logic of the simulation model as well as to assess the user—a case that may best fit when the goal is to "teach a user by modeling a learner."

In **Chapter XVI**, *Designing Online Games Assessment as "Information Trails,"* Christian Sebastian Loh discuss some of the specific ways that user artifacts can form the basis for assessment. Comparative examples from online commerce ("cookies," "user profiles," "targeted marketing") help make the case that tracking technology is already used to build records over time, assess user preferences, and sell new ideas to users. He introduces the reader to the idea of "agent-detectable markings" left by a "moving agent in an information-ecology." Designers of game-based assessments will need "event hooks" that need to be worked into the instructional design processes and will need to learn to construct automated analyses, teacher modifiable conditions for analysis rules. The hooks themselves will need

to be adaptable so that as users make choices within the boundaries of a game, the meaning of an analysis can be adjusted. According to Loh, teachers may one day be seen as game masters who are co-constructing the world of inquiry and discovery, like a dungeon master leading a party to adventure.

Ron Steven's work on the UCLA IMMEX project has led to **Chapter XVII**, *Machine Learning Assessment Systems for Modeling Patterns of Student Learning*. As a concrete example of using player artifacts in assessment, Stevens presents a layered analytic model of how high school and university students construct, modify, and retain problem-solving strategies as they solve science problems online. Item response theory modeling provides initial estimates of problem solving ability at the individual level. Later, self-organizing artificial neural networks analyze hundreds of performance instances to form clusters of solution strategies. Hidden Markov Modeling is then used to develop "learning trajectories" across sequences of performances and to stochastically represent problem solving progress. He has found that students quickly zero in on preferred strategies, which remain stable for long periods of time, and that students working in groups do so quicker and use a more limited repertoire of strategies than do students working alone.

In **Chapter XVIII**, *Shaping the Research Agenda with Cyber Researcher Assistants,* Lyn Henderson concludes the collection with a reflection about the possibilities and open questions of using the powerful tracking, analytic and interactive aspects of games and simulations to empower learners and teachers.

We hope that these chapters promote increased serious use of games and simulations in online learning by offering new possibilities for framing research and development efforts.

David Gibson

Clark Aldrich

Marc Prensky

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