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# Discoveries in Gaming and Computer-Mediated Simulations

New Interdisciplinary Applications



**Richard E. Ferdig**

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# Discoveries in Gaming and Computer–Mediated Simulations:

## New Interdisciplinary Applications

Richard E. Ferdig

*Research Center for Education Technology – Kent State University, USA*

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**REFERENCE**

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*For Cherilyn, Owen & Ethan*

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*Catherine Johnston, Harvard University, USA*

*Chris Dede, Harvard University, USA*

While utilizing GPS-enabled handheld computing units, we have developed and studied augmented reality (AR) curricula to help middle school students learn literacy and math. In AR, students move around an outdoor physical environment, interacting with virtual characters and artifacts on their handheld computer. These invisible objects and characters provide clues to help solve a mystery, guiding the students through a process of inquiry and evidence building. The first AR curriculum we developed, Alien Contact! is based on a scenario where aliens have crash landed near the students’ middle school. Students, working in teams, learn math and literacy skills in the course of determining why the aliens have come to earth. This study describes the design heuristics used during the initial development and deployment of Alien Contact!, the results of two formative evaluations of this curriculum, and the impact these findings have had on revising our design heuristics for a subsequent AR curriculum about beached whales, called Gray Anatomy.

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We argue that the effectiveness of simulations for science education depends on design features such as the type of representation chosen to depict key concepts. We hypothesize that the addition of iconic representations to simulations can help novice learners interpret the visual simulation interface and improve cognitive learning outcomes as well as learners' self-efficacy. This hypothesis was tested in two experiments with high school chemistry students. The studies examined the effects of representation type (symbolic versus iconic), prior knowledge, and spatial ability on comprehension, knowledge transfer, and self-efficacy under low cognitive load (Study 1, N=80) and high cognitive load conditions (Study 2, N=91). Results supported our hypotheses that design features such as the addition of iconic representations can help scaffold students' comprehension of science simulations, and that this effect was strongest for learners with low prior knowledge. Adding icons also improved learners' general self-efficacy.

### **Chapter 3**

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<i>Miguel Sicart, IT University of Copenhagen, Germany</i>	

This article presents a typology for classifying computer games designed to create ethical gameplay. Ethical gameplay is the outcome of playing a (computer) game in which the players' moral values are of relevance for the game experience. The article explores the different types of designs that create these types of experiences, and how they are characterized. The author provides an analytical framework for classifying games according to the experience they create and how they create it. The article is informed by both game design theory and postphenomenological philosophy, and it is intended to provide a theoretical framework for the study of the design of ethical computer game experiences.

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Achiever and Explorer player types are well known in MMOs and educational games. Players who enjoy being a winner, but dislike hard challenges ("Self-Validators") are a heretofore ignored but commonly occurring player type. Self-Validators worry about and are distressed by failing. They can simply avoid playing overly difficult games for entertainment. But in a required learning game, Self-Validators' excessive worry about failing can interfere with learning. The authors consider whether and how eight very different modern games accommodate Explorers, Achievers, and Self-Validators and discuss implications for entertainment and learning game design and research. Seven of eight diverse games analyzed primarily served either the Explorer or Achiever player type. Self-Validators were partially accommodated in some Achiever-oriented games, through user-selectable difficulty. Design with all three types in mind would encourage inclusion of features that enable players to optimize their preferred style of play.

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<i>Ben Medler, Georgia Institute of Technology, USA</i>	

Recommendation systems are key components in many Web applications (Amazon, Netflix, eHarmony). Each system gathers user input, such as the products they buy, and searches for patterns in order to determine user preferences and tastes. These preferences are then used to recommend other content that a user may enjoy. Games on the other hand are often designed with a one-size-fits-all approach not taking player preferences into account. However there is a growing interest in both the games industry and game research communities to begin incorporating systems that can adapt, or alter how the game functions, to specific players. This article examines how Web application recommendation systems compare to current games that adapt their gameplay to specific players. The comparison shows that current games do not use recommendation methods that are data intensive or collaborative when adapting to players. Design suggestions are offered within this manuscript for how game developers can benefit from incorporating the lesser used recommendation methods.

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Market 3D engines have all the capabilities needed for developing full-featured 3D simulation and game environments. However, for those in education and small-business, it remains a formidable task to acquire the resources needed to purchase or create a development platform with cutting-edge capabilities. Leveraging existing and open-source software libraries can greatly enhance the main application development, freeing developers to focus more on the application concept itself rather than the needed supporting pieces. This chapter explores the nuances of successfully mixing core code with these third-party libraries in creating a fully functioning development environment. Many steps with accompanying checks-and-balances are involved in creating a game engine, including making choices of what libraries to use, and integrating the core code with third-party libraries. By offering insights into our open source driven process, we help inform the understanding of how game engines may be generated for other educational and small-budget projects.

## Section 2

### Learning Outcomes of Games and Simulations

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<i>Elizabeth A. S. Bagley, University of Wisconsin-Madison</i>	
<i>David Williamson Shaffer, University of Wisconsin-Madison</i>	

A growing body of research suggests that computer games can help players learn to integrate knowledge and skills with values in complex domains of real-world problem solving (P. C. Adams, 1998; Barab et al., 2001; Gee, 2003; Shaffer et al., 2005; Starr, 1994). In particular, research suggests that *epistemic games*—games where players think and act like real world professionals—can link knowledge, skills, and values into professional ways of thinking (Shaffer, 2006). Here, we look at how a ten hour version of the epistemic game Urban Science developed civic thinking in young people as they learned about urban ecology by role-playing as urban planners redesigning a city. Specifically, we ask whether and how overcoming authentic obstacles from the profession of urban planning in the virtual world of a role playing game can link civic values with the knowledge and skills young people need to solve complex social and ecological problems. Our results from coded pre- and post-interviews show that players learned to think of cities as complex systems, learned about skills that planners use to enact change in these systems, and perhaps most important, learned the value of serving the public in that process. Two aspects of the game, *tool-as-obstacle* and *stakeholders-as-obstacle*, contributed to the development of players’ civic thinking. Thus, our results suggest that games like Urban Science may help young people—and thus help all of us—identify and address the many civic, economic, and environmental challenges in an increasingly complex, and increasingly urban, world.

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In this chapter, we share a model of game-based learning for use in the context of classroom learning in school. The model is based on the dialectic interaction between game play and dialogic engagement with peers and teacher on one hand and a developmental trajectory of competence-through-performance on the other. It is instantiated in the context of a learning program related to citizenship education using the computer game Space Station Leonis. We argue for the importance of values in all learning, based upon a theory of becoming citizens that is founded on process philosophy. We relate values to dispositions as articulated manifestations of values and describe how the Leonis learning program helps to achieve dispositional shifts befitting citizenship education in a globalized and multi-cultural world.

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This chapter presents an empirical study of social setting as a determinant of player involvement in competitive play. We conceptualize player experience as roughly comprising of components of involvement and enjoyment. Involvement relates to the attentional pull of games encompassing feelings of immersion, engagement, and flow. Enjoyment taps into the fun and frustration of playing. A few recent studies indicate that co-players boost player enjoyment, yet the effect on involvement is still

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largely unknown. In line with enjoyment, involvement could increase with the sociality of settings. On the other hand, the presence of others provides a potential distracter and threat to involvement in games. Results of an experiment where social setting was manipulated within groups indicated that players' involvement remains constant or even increases with mediated or co-located co-players compared to solitary play. Hence, co-players do not break the spell of a game, but become part of the magic circle.

## **Chapter 10**

Game-Based Representations as Cues for Collaboration and Learning ..... 163

*Matthew J. Sharritt, University of Hawai'i at Manoa, USA*

*Daniel D. Suthers, University of Hawai'i at Manoa, USA*

Literature suggests that games can support learning in schools by enabling creative problem solving, allowing dynamic resource allocation, providing a motivating, immersive activity, and supporting explorations of identity. A descriptive, inductive study was carried out to identify how high school students make use of the video game interface and its representations. Results demonstrate that specific cues direct attention, helping to focus efforts on new or underutilized game tasks. In addition, consistent and well-organized visualizations encourage learning and collaboration among students by providing shared referential resources and scaffolding coordinated sequences of problem solving acts during gameplay. Conversely, when affordances are inconsistently represented, students' focus can shift from problem solving at the goal level (game strategy, etc.) to problem solving at the game interface level (which is frustrating their goals). In general, the design of game representations and behaviors can help guide or hinder student learning.

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*Brock Dubbels, University of Minnesota, USA*

The experience of a successful adolescent learner will be described from the student's perspective about learning the video game Dance Dance Revolution (DDR) through selected passages from a phenomenological interview. The question driving this investigation is, "Why did she sustain engagement in learning?" The importance of this question came out of the need for background on how to create an afterschool program that was to use DDR as an after school activity that might engage adolescents and tweens to become more physically active and reduce the risk of adult obesity, and to increase bone density for these developing young people through playing the game over time. The difficulty of creating this program was the risk that the students would not sustain engagement in the activity, and we would not have a viable sample for the bone density adolescent obesity study. Implications of this study include understanding the potential construction of learning environments that motivate and sustain engagement in learning and the importance of identity construction for teachers to motivate and engage their students. In addition to the analysis of sustained engagement through the four socio- and cultural-cognitive theories, four major principals were extracted from the operationalized themes into a framework for instructional design techniques and theory for engaging learners for game design, training, and in classroom learning.

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*Constance Steinkuehler, University of Wisconsin-Madison, USA*  
*Barbara Z. Johnson, University of Minnesota-Duluth, USA*

Modding communities are particularly ripe environments for rethinking what it means to be IT literate in the contemporary world. Mods are, as we argue, computational literacy artifacts, exemplifying not merely computer literacy but also the ability to understand and use computational models and processes to conceptualize and solve problems. In this article, we describe modding practice in the context of the best-selling computer game to date: World of Warcraft. By analyzing such activities as a form of computational literacy practice “in the wild,” we demonstrate how modding illustrates what it means to be technically literate in the contemporary participatory sociotechnical world. Based on our analysis, we argue for reconsideration of computer literacy as computational literacy, authorship as collaborative and negotiated rather than individually achieved, and digital media literacy practice as one involving design and production, not merely passive or critical consumption.

**Chapter 13**

What Players Like about Video Games: Prediction of Video Game Playing through Quality  
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*René Weber, University of California Santa Barbara, USA*  
*Patrick Shaw, Scientifically Proven Entertainment, USA*

Video game developers make multimillion dollar decisions based on hunches, personal experience, and iteration. A theoretical model of video game player behavior – how one chooses, plays, and evaluate games – can provide an important framework for these decisions. According to social cognitive theory, one’s behavior can be understood as the result of expected outcomes resulting from direct and observational learning processes. Video game players use symbolic representations (quality perceptions) of their direct and observed experiences with video games to build expectations of whether playing a specific video game will satisfy their needs. A series of in-depth interviews and a subsequent survey with students of a large mid-western university was conducted to enumerate groups of similar players (player types), and video game quality perceptions. Both concepts were used to provide empirical evidence for a model to predict video game playing. Results show that, in prediction models, the best player types are those that include player type-specific quality perceptions.

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*Nicholas Fortugno, Rebel Monkey, USA*

Game designer Nick Fortugno’s keynote speech at the Meaningful Play conference talked about the conundrum of whether serious games can or even should be fun. Fortugno looks back at historical works of popular culture that exerted transformative effects on society. He examines three current persuasive games and offers his thoughts on what it will take for a game to achieve societal transformation.

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<i>Christian Sebastian Loh, Southern Illinois University-Carbondale, USA</i>	

As serious games gain momentum in the academic arena, no doubt more educators and instructional technologists will begin considering the possibility of making their own games for instruction. As developers of instructional resources, instructional technologists need to steer clear of producing more ‘video’ games, and instead, developing more ‘serious’ games that incorporate both learning and assessment. The research community needs to learn from tested processes and best practices to avoid repeating old mistakes. The model for serious game making presented in this article has been used successfully for the creation of an award winning project, and will now be shared for the benefits of fellow researchers, educators, and instructional technologists.

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## Chapter 16

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<i>Feng Liu, University of Florida, USA</i>	
<i>Baird Whalen, University of Florida, USA</i>	

Video games are becoming more popular; there has been a particular rise in interest and use of massively multiplayer online role-playing games (MMORPGs). These games utilize avatar creation; avatars can be seen as the technological instantiation of the real person in the virtual world. Little research has been conducted on avatar creation. Although it is has been anecdotally postulated that you can be anything you want online, there is a dearth of research on what happens when participants are told to create avatars, particularly avatars within given contexts. In this study, we used the Second Life avatar creation tool to examine what would happen when participants were told to create avatars as heroes, villains, their ideal self, and their actual self. Data analyses reveal that characters often refuse to change permanent aspects of their features, instead modifying only temporal aspects. This research has provided support for the quantitative review of avatar characteristics as predictors of vignette groupings.

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<i>Mark Bell, Indiana University, USA</i>	
<i>James J. Cummings, Indiana University, USA</i>	
<i>Matthew Falk, Indiana University, USA</i>	

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We report results of an experiment on prices and demand in a fantasy-based virtual world. A virtual world is a persistent, synthetic, online environment that can be accessed by many users at the same time. Because most virtual worlds are built around a fantasy theme, complete with magic, monsters, and treasure, there is considerable skepticism that human behavior in such environments is in any way “normal.” Our world, “Arden,” was designed to test whether players in a typical fantasy environment were economically “normal.” Specifically, we tested whether fantasy gamers conform to the Law of Demand, which states that increasing the price of a good, all else equal, will reduce the quantity demanded. We created two exactly equivalent worlds, and randomly assigned players to one or the other. The only difference in the two worlds was that the price of a single good, a health potion, was twice as high in the experimental world than in the control. We allowed players (N = 43) to enter and play the environment for a month.

### **Chapter 18**

Virtual Worlds for Teaching: A Comparison of Traditional Methods and Virtual Worlds for Science Instruction..... 315

*Catherine Norton-Barker, Cornell University, USA*

*Margaret Corbit, Cornell University, USA*

*Richard Bernstein, Cornell University, USA*

Immersive virtual worlds structured for education have the potential to engage students who do not respond well to traditional classroom activities. To test the appeal and usability of virtual environments in the classroom, four ninth grade science classes in a rural Upstate New York school were randomly assigned to learn an introductory genetics unit for three class periods in either an online, multi-user, virtual world computer environment or in a traditional classroom setting using lecture, worksheets, and model building. The groups were then reversed for a second three-day trial. Quizzes were given before, at midpoint, and at the end of the study. Both groups demonstrated significant knowledge gain of the genetics curriculum. This study demonstrates that self-directed learning can occur while exploring virtual world computer environments. The students were enthusiastic about using virtual worlds for education and indicated a strong preference for a variety of teaching methods, which suggests that offering mixed modalities may engage students who are otherwise uninterested in school.

### **Chapter 19**

Playing Myself or Playing to Win? Gamers’ Strategies of Avatar Creation in Terms of Gender and Sex..... 329

*Sabine Trepte, Hamburg Media School, Germany*

*Leonard Reinecke, Hamburg Media School, Germany*

*Katharina-Maria Behr, Hamburg Media School, Germany*

Who do people want to be in virtual worlds? Video game players can create their avatars with characteristics similar to themselves, create a superhero that is predominantly designed to win, or chose an in-between strategy. In a quasi-experimental study, players were expected to prefer their avatars to have their sex, but to create avatars with gender attributes that best meet the requirements of the game. In the main study, participants created an avatar they would like to play with by choosing from a list of (pre-tested) masculine and feminine avatar features. Additionally, participants chose their avatars’



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biological sex. The results reveal a mixed strategy: On the one hand, the avatar's features are chosen in accordance with the game's demands to facilitate mastery of the game. On the other hand, players strive for identification with their avatar and thus prefer avatars of their own sex. Participants rated those game descriptions and gaming scenarios more entertaining which require avatar features in line with their own sex role.

**Chapter 20**

Investigating Perceptions of Avatar Creation for Use in Educational MUVES ..... 353  
*Joseph DiPietro, University of Florida, USA*

The purpose of this qualitative inquiry is to extend the investigation of perceptions and experiences of users creating avatars for interactions in online learning environments. Using Linden Lab's *Second Life*, volunteers created three-dimensional representations of themselves, called avatars, under the premise of participating in a hypothetical online class. Avatar creation sessions were book-ended with pre- and post- interviews focused on participant perceptions of various elements of self-representation and interactions as situated in online environments. Human computer interactions (HCI) of avatar creation were also explored. Findings indicate users created avatars that mirrored their respective physical appearances as closely as possible and were collectively adamant in feeling morally obliged to do so.

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# Preface

## INTRODUCTION

Electronic gaming and computer-mediated simulations have risen to the forefront of research and practice in many fields ranging from education to sociology and from computer science to business. Researchers and practitioners argue some very interesting and important points. First, there is research emerging that suggests games and simulations help audiences teach and learn. Inquiries have ranged from learning K-12 content to the impact of videogames on violent behaviors. Regardless of the positive or potential negative construct, there is evidence of a connection between the input of games and/or simulations and a desired or undesired output. If such evidence exists, it is important and critical to understand more about the connections and the constructs.

Second, there is a wealth of popular press—and some academic literature—that highlights the common occurrence of games and simulations in the lives of people essentially throughout the lifespan. Many young children play games daily; elderly audiences often use simulations for physical and mental rehabilitation. Again, if games and simulations have become so ubiquitous, researchers, practitioners, and even policymakers want to know more about how to harness their potential.

This book sets out to capture a snapshot of some important things we know about games and computer-mediated simulations. This is not meant to be a handbook of everything that has been written about games and simulations. On the contrary, this tome was created to highlight the work that has emerged through a year-long snapshot of articles published in a leading, peer-reviewed journal. This chapter begins with a brief background about the journal, and then provides an overview and summary of the 20 chapters in this book. In doing so, it describes the four main themes throughout this book and how the chapters have pushed the field related to that theme. The chapter concludes with some recommendations and goals for future research, policy, and practice.

## IJGCMS

The *International Journal of Games and Computer-Mediated Simulations* (IJGCMS) was launched in 2009 (<http://www.igi-global.com/ijgcms>). The journal is devoted to the theoretical and empirical understanding of electronic games and computer-mediated simulations. The journal is interdisciplinary in nature; it publishes research from fields and disciplines that share the goal of improving the foundational knowledge base of games and simulations. The journal publishes critical theoretical manuscripts as well as qualitative and quantitative research studies, meta-analyses, and methodologically-sound case studies.

The journal also includes book reviews to keep readers on the forefront of this continuously evolving field. Occasional special issues from the journal provide deeper investigation into areas of interest within either gaming or simulations.

One main goal of this peer-reviewed, international journal is to promote a deep conceptual and empirical understanding of the roles of electronic games and computer-mediated simulations across multiple disciplines. A second goal is to help build a significant bridge between research and practice on electronic gaming and simulations, supporting the work of researchers, practitioners, and policymakers.

There are five guiding principles supporting this mission as well as the editorial policy of IJGCMS. The first important principle is quality and rigor. IJGCMS follows a double-blind review process to ensure anonymity and a fair review. Research articles that are published may contain either quantitative or qualitative data collection & analyses. However, articles using either method must present data to support and justify claims made within the article. Articles that simply summarize data without presenting it or the analytical techniques used, are not considered. Theoretical manuscripts are also published. However, these theoretical reviews must create new knowledge by synthesizing and critiquing past research. Simple summaries of existing literature without thoughtful and considerate analyses are not considered.

A second important principle is the notion of IJGCMS as an interdisciplinary journal. There are numerous fields and disciplines that undertake research related to games and simulations. Psychology, Education, History, Journalism, Literature, Computer Science, Engineering, Fine Arts, and Medicine are just a few of the areas where one could find gaming and simulation research. Unfortunately in academia, the notion of standing on the shoulders of giants has often meant taken a historical perspective on one's line of research. Gaining a historical backing is an important part of moving the field forward; however, failing to consider parallel work in other fields is failure to address and accept the complex natures of games and simulations. IJGCMS publishes articles from any discipline as long as the content of the work is related to games and simulations. Including multiple fields helps researchers recognize their similarities as well as introducing them to colleagues from distinctly different backgrounds.

In addition to having an interdisciplinary focus, a third principal of this journal is its international focus. There are over 18 countries represented on the Editorial Board of IJGCMS. There is no justifiable reason why our research should have disciplinary OR geographical boundaries. Drawing on work from international authors provides two interesting opportunities. First, readers are able to see one topic from multiple perspectives. For instance, how are researchers from various countries working on science simulations? Second, readers are able to see variations across countries. For instance, what are the current research topics and sets of expertise in various countries around the world?

Innovation is a fourth principle guiding the work of IJGCMS. Gaming and simulation researchers often create new concepts and technologies in their work. IJGCMS is a journal where authors who create new tools and techniques go to publish their findings; it is also a resource for readers who want to keep up with the latest and most cutting edge technologies. Special, focused issues with guest editors will also promote in-depth analyses at conceptual or technological innovations (proposals for special issues are welcomed at any time).

Finally, IJGCMS is focused on implications. Developing a strong research foundation for games and simulations is important, but only to the extent that the research impacts others. One of the main items reviewers are asked to consider when reviewing for IJGCMS is: "What are the implications of this work on other research, policy, and practice?" Each article author is asked to include direct implications for others working in similar areas, regardless of whether they be researchers, practitioners, or policy-makers.

Recommended topics for the journal include (but are not limited to) the following:

- Cognitive, social, and emotional impact of games and simulations
- Critical reviews and meta-analyses of existing game and simulation literature
- Current and future trends, technologies, and strategies related to game, simulation development, and implementation
- Electronic games and simulations in government, business, and the workforce
- Electronic games and simulations in teaching and learning
- Frameworks to understand the societal and cultural impacts of games and simulations
- Impact of game and simulation development use on race and gender game and simulation design
- Innovative and current research methods and methodologies to study electronic games and simulations
- Psychological aspects of gaming
- Teaching of games and simulations at multiple age and grade levels

During its inaugural year, IJGCMS had three ‘regular’ or general issues and one special issue. Some work in gaming and simulations gets published in journals like IJGCMS. However, a tremendous amount of cutting-edge research in this area is first presented at conferences. In an attempt to capture these findings, IJGCMS often partners with conferences and organizations to create special issues focused on the leading research from the conference. The special issue for 2009 was from a conference called *Meaningful Play* (<http://meaningfulplay.msu.edu/>) held at Michigan State University. According the website, Meaningful Play “is a conference about theory, research, and game design innovations, principles, and practices. Meaningful Play brings scholars and industry professionals together to understand and improve upon games to entertain, inform, educate, and persuade in meaningful ways.”

IJGCMS’ editorial board consists of four separate groups (<http://www.igi-global.com/ijgcms>).

1. The international advisory board consists of a panel of leading experts from around the world. The advisory board provides insight and helpful recommendations to the editor; they are also available for suggestions and recommendations of future journal goals and special issues.
2. IJGCMS has a panel of associate editors. Each submission goes to one associate editor. Having a smaller number of associate editors has provided a way to maintain consistency in reviews.
3. Submissions also then go to two editorial review board members. As such, each submission receives three double-blind, peer reviews. The associate editor and the editorial review board members are matched as closely as possible based on the topic of the submission and the expertise of the reviewer. However, the reviews are double-blind. In other words, the authors do not know the identity of the reviewers assigned to their paper, nor do the reviewers know the author.
4. Finally, IJGCMS publishes a book review with almost every issue. The fourth group is a panel of co-book review editors who help select books, solicit reviewers, and edit reviews.

Journal special issues are also peer-reviewed. This can be done in a number of different ways. Often, for conference special issues, submissions are reviewed once at the submission stage, where they are accepted or rejected for presentation. Accepted papers are then offered the chance to submit for journal submission, where they are again reviewed either by the conference review panel or IJGCMS’ own review board.

The four issues for 2009 produced a total of 20 peer-reviewed papers. In preparing this book, authors were given the opportunity to update their paper with new data, new findings, or related articles since

the original publication of their paper. The purpose and goal of this book is to highlight the work of those authors, presenting findings that will impact the field of gaming and simulations in multiple ways.

The book itself is divided into four sections, which represent the four main themes that emerged upon a closer analysis of the chapters. As with most categorization schemes, chapters can cut across multiple themes. However, these themes help present a coherent look at some of the cutting-edge research in this area.

- Section 1: Design of Games and Simulations
- Section 2: Learning Outcomes of Games and Simulations
- Section 3: New Theoretical Considerations of Games and Simulations
- Section 4: Creating and Living in Virtual Worlds

It should be noted that the purpose of this summary is to highlight the main ideas identified in each chapter. It is not intended to take away from the rich insights or deep conversations included in each chapter. For instance, one of the goals of IJGCMS is to publish articles that directly impact policy, research, and practice. Each chapter in this book contains a rich description of the ‘so what?’ for those working in various fields. A thorough reading of each chapter will provide such detailed information.

## **Section 1: Design of Games and Simulations**

As previously indicated, there are multiple fields that are interested in games and simulations. Design is an area of games and simulations that is often addressed regardless of whether the conversation originates in computer science or psychology. During 2009, there were six articles that focused prominently on design.

### **Lessons Learned about Designing Augmented Realities (O’ Shea, Mitchell, Johnston, & Dede)**

In this chapter, O’Shea and his colleagues discussed the design and development of an augmented reality curriculum. Their project, *Alien Contact!*, was created to teach math and literacy to middle and high school students. The technology enables students’ real world position to correlate with the virtual location in the simulation. Working in teams, students must explore the world and collect data to determine why the aliens have landed. Evaluation of the curriculum has provided evidence that students are more motivated during the implementation of the content, but there were significant logical limitations. Given these limitations, the authors then report on the development of *Gray Anatomy*, a subsequent augmented reality curriculum. This is really the core of what this chapter can offer educators and developers. Augmented reality presents important educational opportunities, but developers must consider cognitive overload, unintended competition, the need to have flexible roles, helping students find multiple answers vs. the ‘correct one’, the length of the curriculum, and how to get classroom teachers involved. The authors conclude that having educators recognize student-owned technologies will also help implementation.

### **Design Factors for Effective Science Simulations: Representation of Information (Plass, Homer, Milne, Jordan, Kalyuga, Kim, & Lee)**

Plass et al. proposed that the effectiveness of science education simulations depend on important design features. Using this hypothesis, they ran two experiments with high school chemistry students. They

did indeed find that design features can help scaffold student comprehension. They also noted this was particularly true for learners with low prior knowledge. The authors provide three important findings for our field. First, learner's prior knowledge needs to be considered in selecting representations in the simulation. Second, adding iconic representations can increase both comprehension and learner self-efficacy, particularly for students with low-prior knowledge. Third, iconic representations may be more suited than symbols to reducing cognitive load, due in part to the close relation to the referent they represent.

### Beyond Choices: A Typology of Ethical Computer Game Designs (Sicart)

Sicart explored a typology for classifying games designed to create ethical game-play. Ethical game-play, according to the author, is the experience in which the outcomes require moral reflection beyond statistics or probability. Sicart presents a typology that includes open ethical design where players can influence the game through their values, and closed design where they cannot. In open design, there are open systems where the game adapts to the player values and open world where the world adapts. In closed design, Sicart presents subtracting, where the player interprets the game as an ethical experience (cued by design) and mirroring, where the player is forced to adopt the values of the game character. Given this framework, Sicart demonstrates the need to understand the ethical player, the ethical multi-player, and the design methods around these complex issues.

### Game Design and the Challenge-Avoiding, Self-Validator Player Type (Heeter, Magerko, Medler & Fitzgerald)

Heeter et al. argued that there are well-recognized player types such as *achievers* and *explorers*. Achievers are those who are motivated by extrinsic reward. Explorers, conversely, play because of curiosity and learning. However, the authors argue that there is another player type that is often ignored—that of the *self-validator*. Self-validators like extrinsic rewards, but unlike achievers, they dislike losing so much that they would prefer an easy challenge. Using eight games as examples, the authors then discuss the design features that might appeal to the different types of players. One main outcome of their work includes the need for designers and producers to play off these types, while not discouraging them. A second is the need for more research on the role of adaptive games.

### Using Recommendation Systems to Adapt Game-Play (Medler)

In this chapter, Medler argued that most game systems are designed in a one-size fits all approach. Conversely, there are a number of Web-based adaption systems that many users are already used to (e.g. Amazon's recommendation function). These systems include content recommendations (what did you do before?), collaborative recommendations (what do your friends like?), and hybrid recommendations that do both. The challenge for game-play, according to the author, is game-play requires constant and continuous adaptation. Further, game-play adaptation is used to challenge users (rather than recommend), is created implicitly (rather than asking users), and gathers/filters data in real time. In the end, Medler argues that game-based models have yet to take seriously the possibility of memory-based and complex collaborative-based filters. Exploring these features will lead to improved adaptive game-play.

## Leveraging Open Source Technology in 3D Game Engine Development (Stowell, Scoresby, Coats, Capell & Shelton)

Stowell et al. informed readers about how game engines may be generated for educational projects. In the chapter, they discussed the ‘nuances’ of mixing core code with third party libraries to create fully functioning development environments. They conclude with a list of suggested practices for the use of open source libraries to develop 3D game engines. Their main findings suggest that using such libraries is a good practice, but it involves keeping abreast of updates and changes from other developers. Using the libraries can be important for budget considerations, but require learning throughout the process.

## Section 2: Learning Outcomes of Games and Simulations

Although the word “learning” is often thought of as K-12 or post-secondary content, learning can also mean what happens in out-of-school contexts. Learning can also define outcomes beyond content, to focus on skills, attitudes, and behaviors. During 2009, there were five chapters that focused prominently on learning outcomes.

### Promoting Civic Thinking through Epistemic Game Play (Bagley & Shaffer)

Bagley and Shaffer wrote about their interest in games and civic thinking. According to the authors, developing civic thinking goes beyond merely disseminating facts and information. It includes being guided by civic, social, and ecological values while applying real world skills to learning problems and opportunities. They proposed games as a way to provide a context for learning civic thinking. Using a game called *UrbanScience*, the authors guided students through urban planning through a series of mentored activities including a site visit, a survey, meetings, plans, and final proposals. Results from a study of middle school-age players found that gaming can provide a way by which students engage with complex civic problems. The authors contend that students learned by understanding the concepts of *tool-as-obstacle* and *stakeholders-as-obstacle*. The resulting implications are that developers consider building non-player-characters with pro-social obstacles and then get teachers to engage such games to help students address an increasingly complex world.

### Learning as Becoming: Values, Identity, and Performance in the Enaction of Citizenship Education through Game Play (Chee, Loke & Nanyang)

Chee et al. addressed the topic of citizenship in their study. They share a model of game-based learning using Space Station Leonis to teach students about citizenship education. Leonis includes a game, curriculum materials, learning processes, and then formative and summative assessments. The research participants from a government secondary school played the game, used a wiki, and then completed the formative assessments. Students were also asked to create an end-of-program campaign artifact to advocate for a certain position on a ‘hot-topic.’ The findings revealed that the program contributed to shaping students’ values in educationally-preferred directions. Their work provides evidence of the use of games and simulations for dispositional shifts that are important for life in a globalized and multicultural world. Finally, they provided evidence of the possible positive outcomes of game-based learning in classroom contexts.

### Rule of Engagement: The Presence of a Co-Player Does not Hinder Gamers' Focus (Gajadhar, deKort, & Ijsselstejn)

Recognizing the increasingly social aspect of digital gaming, Gajadhar et al. explored player experience, particularly as it related to enjoyment and involvement. Drawing on notions of flow, immersion, and engagement, the authors set out to study whether a player's focus was decreased with the involvement of others. Participants in this experience played *WoodPong*, and then completed a set of self-report measures around enjoyment, involvement, and social presence. The results indicated that additional players did not impact immersion, engagement, or flow. If anything, the authors argued that the increased social setting may have improved some outcomes. Their conclusion is that all models of game-play experience should take into account social play setting.

### Game-Based Representations as Cues for Collaboration and Learning (Sharritt & Suthers)

Sharritt and Suthers were interested in how high school students used commercial game interfaces in game settings. Their particular interest was how the visualizations and behaviors of the game interfaces impacted collaboration and activity to support learning. In their study, three video games were selected and then played by two students using a single computer. Their results demonstrated key features necessary for learning. Consistency in game behaviors was critical to success, as was participant scaffolding. Inconsistent behaviors led students away from problem-solving and goal achievement. Feedback was also important, triggering new strategies from players. Such feedback also reduced uncertainty for participants. Finally, game representations helped with cognitive offloading, helping players learn how to accomplish their goals.

### Designing Learning Activities for Sustained Engagement: Four Social Learning Theories Coded and Folded into Principals for Instructional Design through Phenomenological Interview and Discourse Analysis (Dubbels)

Dubbels used a qualitative approach to understand the experiences of an adolescent female as she learned about the video game "Dance Dance Revolution." His approach was to examine the game as an after school activity for helping teens become more physically active. Dubbels suggested the experience led to four main principles of play, including play as subjunctive mode, desirable activities, space, and desirable groups. In the end, the author argued that to sustain engagement, we must find a way to use these game experiences to help students turn play into meaningful experiences that resemble real-world rites of passage/initiation.

## Section 3: New Theoretical Considerations of Games and Simulations

Many of the articles published at IJGCMS focus on practical outcomes or empirical evidence to support hypotheses. There is an important need for articles that use both practice and data to push our theoretical beliefs about games and simulations. During 2009, there were four articles that aimed to push our theoretical beliefs and models of games and game-play.



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