Preface

The notion of “gaming” and the effective development of games first took hold in the computer entertainment industry. Indeed, today institutions such as the University of Utah and the University of Southern California have successful graduate programs in computer game development. Not long after the emergence of computer gaming, educators and trainers began to consider how the principles of successful gaming could be applied to the educational arena, broadly defined. Research in serious gaming for educational applications has focused on numerous areas: (a) gaming and cognition (Lamb, Cavagnetto, & Akmal, 2016; Rice, 2007); (b) gaming for classroom based learning (Abdul Jabbar & Felicia, 2015; Squire, 2003, 2008; Van Eaton, Clark, & Smith, 2015); (c) design and development of games for training (Arnab et al., 2015; Pill, 2014; Rosario & Widmeyer, 2009); and (d) gaming and society (Foreman, 2004). The diversity of research programs in the area of serious games for educational applications has made it difficult for students, and even faculty, to perceive the field from a unified perspective.

In this volume we have attempted to provide a unified presentation of the field of serious gaming for educational applications. We have divided our presentation into four sections: (a) theoretical perspectives; (b) cognitive and psychological perspectives; (c) instructional design perspectives; and (d) teaching and learning perspectives. With regard to the theoretical perspective underlying serious games for educational applications, we present material concerning the cognitive, metacognitive, and affective factors underlying games in educational contexts. Material is also presented concerning knowledge transfer. Concerning cognitive and psychological aspects of gaming, we present chapters concerned with spatial skills, critical thinking, systems thinking, and social problem solving. These chapters move beyond the underlying theory to actual applications of serious gaming to develop cognitive processes and skills. Instructional design for educational games is considered in chapters concerning fantasy game design, design for complex problem solving, design to enhance intrinsic integration of domain specific knowledge, and design to enhance the motivational properties of educational games. Finally, the teaching and learning applications of games are illuminated in chapters focused on the use of augmented reality in informal learning, the importance of narrative and stories in educational games, the characteristics of adolescents and young adults who engage in game play on mobile devices, how educational games can be used in professional development with educational professionals, how educational games can be used to enhance health and well-being, and how to balance the entertainment and educational aspects of serious games (including a typology for categorizing serious games).

The value of this volume is that synthesizes the many aspects of serious games for educational applications, and presents a clear theoretical foundation (e.g., classifying research on serious games according to its focus: cognitive, metacognitive, or affective). It considers serious game development not only from a theoretical perspective, but also from the various applied perspectives necessary to cre-
ate effective educational games (cognitive goals of gaming, instructional design principles required to implement effective games, the role of motivation in game design, and how such serious games can be used to achieve teaching and learning goals). In addition to creating the intellectual context for serious games used for educational applications, we have tried to make this volume broad in terms of where are the research was done. The book presents research conducted in North America, Europe, and Asia. We feel that this allows us to present the reader with a truly international view of the field.

THE CONTRIBUTION OF THIS BOOK

This edited volume is marked by its unique contributions to the educational and research communities. Firstly, it brings together multiple perspectives in educational gamification by focusing on cognitive, metacognitive, and motivational aspects in the game-based learning. Secondly, the book is significant both theoretically and practically. At the theoretical level, it contributes to the knowledge base by highlighting the theories and principles in game-based learning. At the practical level, the book offers an array of teaching and learning strategies as well as design approaches for the design and development of educational games. As such, the book bridges the theories with practices in educational gamification with a focus on effective use of games in teaching and learning. Thirdly, the book reflects the collective effort of researchers from a broad range of academic institutions and research organizations – from private to public comprehensive, and from state and national to international which makes the book appeal to readers both from the United States and the international educational communities at all levels.

This volume is appropriate for use as a text in graduate and undergraduate courses in programs such as instructional design, educational technology, communications and media, game design, teaching and learning, educational psychology, and applied computer science. In some cases, the book could serve as a primary text (e.g., in educational technology, multimedia learning, or seminars on educational gamification). The text is also appropriate as an adjunct for more general courses in education, cognition, and communications. Professionals in applied areas, such as K through 12 teachers or university instructional designers, may find the information helpful in their professional applications. Finally, for faculty and graduate students pursuing research in the area of educational and computer gaming, the text provides a current sampling of research and theory in the field, and presents this information in an integrated way. We hope you will enjoy reading this book as much as we have enjoyed making it.

ORGANIZATION OF THE THIS BOOK

The book is divided into four sections in a purpose to maximize the value for the readers as they move from the theoretical to the practical and from a focus on cognition, metacognition, and motivation to specific issues involving the design, teaching and learning with educational games.

Section 1 presents a theoretical perspective on educational gamification that focuses on the cognitive, metacognitive, and social aspects of serious games in educational applications. Section 1 consists of four chapters. A description of each chapter follows.

Chapter 1: In this chapter Mike Gardner and David Strayer (University of Utah, USA) provides an overview on important cognitive abilities that underlie learning: working memory and attentional capacity/executive function. Based on the general cognitive demands in learning, the authors made a
set of recommendations for game developers to follow when designing games for learners of different ages. The authors further elaborated on how transfer occurs from training environment (the educational computer game) to target environment (real world performance of the learned skill) with recommendations on optimization of transfer in game-based learning.

Chapter 2 presents the work by Douglas Hacker (University of Utah, USA) who focuses on the role of metacognition in game-based learning. The author, drawn from his several decades of research in metacognition, made recommendations on the design and development of educational games by taking in perspectives the role of metacognition in learning. The first recommendation examines the player’s self-awareness as a learner and how a sense of agency can be nurtured by serious games to promote self-regulated learning. The second examines the mediating processes within the individual that influence learning with games. The third examines the problem of transfer of learning. The chapter concludes with an examination of whether research in response to these recommendations can positively impact learning via the serious game.

In Chapter 3 Kimmo Oksanen of University of Jyväskylä, Finland; Timo Lainema of University of Turku, Finland; and Raija Hämäläinen of University of Jyväskylä, Finland, emphasized the social aspects in game-based learning. The authors proposed a framework in which the game-based learning process is approached by considering (business) simulation games as Computer-Supported Collaborative Learning (CSCL) environments and present an approach on how learning can be approached and evaluated from this perspective. In addition, they highlighted how simulation game mechanics appears to be a potential way to promote learners’ socio-emotional processes and give rise to social interaction and to structure collaboration among the learners in the game context.

Chapter 4 focuses on an important issue in Social Networking Sites (SNS) game-based learning, that is, learners’ knowledge transfer in the ill-structured domain. The authors (Robert Zheng and Thanh Truong of University of Utah, USA) offer a discussion of instructional strategies in SNS game-based learning framed around an extensive review of the literature pertinent to the strategies and approaches in serious games. Based on the discussion a framework was proposed for serious game design which reveals the interaction between and interrelationship among the variables in serious game learning.

Section 2 offers discussions on the cognitive and psychological perspective in educational games. The authors examine the relationship between spatial skills and video games, the critical thinking skills in game-based learning, and approaches to teaching social problem-solving skills with educational games. A brief discussion of the chapters follows.

Chapter 5 explores why and how to use video games for educational purpose to enhance spatial skills. The authors (HeeSun Choi and Jing Feng of North Carolina State University, USA) discuss considerations in designing video games to maximize the training outcomes of improving spatial skills by outlining existing research on spatial training using video games, highlighting the methodological issues in these research, and summarizing speculated underlying mechanisms of spatial learning. The chapter not only provides a comprehensive overview of learning spatial skills but also informs about the effective design of video games to accelerate the acquisition of spatial skills.

Chapter 6 presents a case on exploring the potential of using games in scientific domains to support critical thinking. The authors (Kirsten Butcher, Madlyn Runburg, and Roger Altizer of University of Utah, USA) have developed a beta version of Dino Lab that supports critical thinking through engagement in a simulation-based game. Dino Lab is organized around four key game stages that incorporate high-level goals, domain-specific rule algorithms that govern legal plays and resulting outcomes with embedded reflection questions and built-in motivational features. Initial play testing has shown positive
results, with students highly engaged in strategic game play. Overall, results suggest that games that support critical thinking have strong potential as student-centered, authentic activities that facilitate domain-based engagement and strategic analysis.

In Chapter 7 the authors (Naomi Thompson, Kylie Peppler, and Joshua Danish of Indiana University, USA) discusses the design decisions made when creating the game mechanics and rules for BioSim, a pair of game-like participatory simulations centered around honeybees and army ants to help young children (ages kindergarten through third grade) explore complex systems concepts. The authors outlined four important design principles that helped align the games and simulations to the systems thinking concepts in student learning. The authors went on to highlight how these guiding principles can be leveraged to allow young children to engage with complex systems concepts in robust ways in educational games.

In Chapter 8 Rebecca Ang (Nanyang Technological University, Singapore) and her colleagues present a game-based approach to teaching social problem solving skills. The authors introduced the learning game called Socialdrome for use with primary school going children in Singapore. The game sought to intentionally teach children to identify and manage feelings, exercise self-control, solve social problems and negotiate conflict situations. The authors conducted a study on the Socialdrome and reported a formative evaluation of the game. This was followed by a second study in which the learning outcomes and user acceptance of the Socialdrome were reported. Some discussion about and recommendations for future work were made.

Section 3 focuses on the instructional design perspective in educational games. The issues being covered in this section include how to design game for complex problem solving, the motivational aspects in educational game design, and the assessment that measures learners’ engagement with educational games.

Chapter 9 presents a study by Jaejin Lee (Seoul National University, South Korea) and Min Liu (The University of Texas at Austin, USA) on the use of fantasy design in educational games to promote learning. The authors first reviewed the literature on fantasy designs and relevant principles along with the studies examining the use of fantasy designs to enhance learning. An experiment was then conducted, in which two sets of fantasy designs were implemented in a serious game, to examine the effect of different types of fantasy (portrayal fantasy vs creative fantasy designs) on learning and game engagement. The results using multiple regressions showed that portrayal fantasy design was more effective both for enhancing learning and engagement. Students who used portrayal fantasy models showed better improvement in their content knowledge and scored better on game engagement. Visualization analysis showed the portrayal fantasy group spent more time in using the tool containing all fantasy designs than the creative group. Findings and future research directions are discussed.

Chapter 10 explores game design as a complex problem solving process for learning. Mete Akcao- glu and colleagues (Georgia Southern University, USA) argued that problem solving is one of the most essential skills for individuals to be successful at their daily lives and careers. They pointed out when problems become complex, solving them involves identifying relationships among a multitude of inter-related variables, to achieve multiple different possible solutions. In their research, the authors examined if through an innovative game-design course middle school students improved in their CPS skills. Their results showed that students showed significant improvements in their CPS skills, especially in terms of system exploration, system knowledge, and system application. In addition, there was a statistically significant change in students’ interest for CPS after attending the GDL program. Discussions were made pertaining to the implications of the use of game-design tasks as contexts to teach CPS skills in formal and informal educational contexts.
Chapter 11 presents a research on designing intrinsic integration of learning and gaming actions in a 3D architecture game. Fengfeng Ke of Florida State University, USA conducted a design-based study that examines core game mechanics that enable an intrinsic integration of domain-specific learning. In particular, the study aims to extract the design heuristics that promote content engagement in the actions of architectural construction in Earthquake Rebuild, a 3D epistemic simulation game that aims to promote active math learning for middle-school students. Data were collected from iterative expert reviews and user-testing studies. Based on the study findings, the chapter presents qualitative, analytic speculations on the design of the game-play mode and perspective, the granularity level, the user input interface, and incentives for attentive content engagement that will reinforce the learning affordance and playability of the core game gaming actions.

Chapter 12 focuses on designing engaging educational games for cognitive, motivational, and emotional benefits. The concept of engagement is defined and its relationship with motivation and cognition are discussed. Design issues with many educational games are examined in terms of factors influencing sustained motivation and engagement. The authors (Xun Ge of University of Oklahoma, USA and Dirk Ifenthaler of University of Mannheim, Germany) then proposed a theoretical framework to design engaging digital games which includes three dimensions of engagement (i.e., behavioral, cognitive, and emotional). The author went on to elaborate on how to harness the appealing power of engaging games for designing engaging educational games. Various motivational features of game design and learner experiences are considered.

Section 4 presents research that focus on the teaching and learning perspectives in educational gamification. The topics covered include augmented reality for informal learning, mobile games for adolescent and young adults, gamified system for health related professional training, and game and pedagogical dimensions in serious games.

In Chapter 13 the authors (Eric Poitras of University of Utah, USA; Jason M. Harley of University of Alberta, Canada; Timothy Compeau of Brock University, Canada; Kevin Kee of University of Ottawa, Canada; and Susanne P. Lajoie of McGill University, Canada) studied how best to balance the needs of engaging visitors in meaningful and entertaining experiences, while at the same time exploiting the affordances of exhibits for instructional purposes. The authors examined the use of augmented reality in the context of informal learning environments, and the type of technology that can be used as a means to enhance learning. The research case studies were reviewed in terms of the design guidelines of instructional activities and applications. Recommendations for future research in this field were made.

In Chapter 14 Stephen T. Slota and Michael F. Young of University of Connecticut, USA focused on the effects of narrative in game-based learning environments. The authors discussed how narrative intertwines with human experience of the lived-in world and how it requires the application of a situated cognition framework to understand user-content-context interactions as dynamic and co-determined. The authors explored how learners can draw from a narrative-structured, game-based learning program to accomplish discussing in-context, on-the-fly dialogic interactions between narrative “producers” and “recipients.” The authors point out that game-to-real world transfer may rest in the effective leveraging of narrative to help recipients grapple with complex social, cultural, and intellectual issues.

In Chapter 15 Boaventura DaCosta (Solers Research Group, USA) and Soonhwa Seok (Korea University, South Korea) conducted a qualitative study exploring the factors pertinent to adolescent and young adult mobile game play. A total of 1,950 South Korean students self-reported their game play on mobile phones by answering a 92-item questionnaire designed to capture data on technology ownership; preference for game genre and titles; where and how often games were played; what factors influence
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Game selection, what game features were the most desirable, the rationale behind playing games, and psychophysical changes experienced as a result of playing; as well as, spending habits with regard to game purchases. The findings supported many of the claims made about the casual player, revealing that mobile games are predominately played for short periods of time, in between activities, and as a means to combat boredom. Results also revealed potentially positive benefits, to include improved mood and feelings of well-being along with better mental attention and focus.

In Chapter 16 the authors (Boaventura DaCosta of Solers Research Group, USA and Soonhwa Seok of Korea University, South Korea) conducted a quantitative factor analysis with the same data set. The findings supported many of the age and gender suppositions made about the casual player. New discoveries were also found to include positive benefits stemming from mobile games, such as improved mood and feelings of well-being along with better mental attention and focus.

Chapter 17 focuses on leveling up multiple player professional development. Oliver Dreon and Greg Szczyrbak of Millersville University of Pennsylvania, USA queried the approaches to use gamification to support the professional development of educators. They examined the impact of gamification on the participation and motivation of professors and faculty involved in an intensive professional development experience in a two week long professional development training. The chapter outlines the process of designing the game and the game elements used throughout its implementation. The chapter also examines some challenges the designers and participants experienced during the game implementation and provides several design considerations for professional developers who wish to gamify their faculty programs.

In Chapter 18 David Kirschner of Georgia Gwinnett College, USA presents a case study on the development of a gamified system for health activism. This chapter shows how students, researchers, and the community refined a definition of healthcaring while trying to change people’s health attitudes and behaviors through gamification. After contextualizing the project and discussing its foundations, the chapter offers a discussion on its results and implications for future research.

Chapter 19 discusses and analyses different models for guiding the design cycle of serious games with the aim of supporting not only the design process but also the implementation and assessment of serious games in education. Begoña Gros of University of Barcelona, Spain argued that designing serious games is a complex process because finding the right balance between the ‘serious’ and the ‘game’ dimensions is vital. The author further pointed out that if educational content prevails over the entertainment element, users’ motivation may decrease and this can have a negative impact on the effectiveness of learning. On the other hand, if entertainment predominates over content, this can also limit learning opportunities. The author then added, another major concern identified regarding the use of digital games in education is the difficulty in assessing effectiveness in achieving the learning goals. The author revolved her discussion around the above issues and presented suggestions for in-game assessment and adaptive serious games.

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February 15, 2016
REFERENCES


