INTRODUCTION

Since the 1970s, digital entertainment games have had a transformational impact on how we spend our free time. These games provide engaging and enjoyable activities and have become the world’s most popular leisure activity. More recently, interest has turned to Serious Games, games that are intentionally designed for the purpose of learning, skill acquisition, and training. Serious Games are similar to games-based learning and the terms are sometimes used synonymously. However, it is more widely accepted that games-based learning is a subset of serious games and focuses on the use of games in educational contexts, while serious games are defined more broadly.

Despite the optimism about the potential of Serious Games, there remain a number of key challenges that need to be addressed to fully understand and demonstrate their applicability and limitations. While many papers have been published recently discussing the potential of Serious Games, there is still a gap in the literature concerning rigorous empirical evidence for their effectiveness in learning and training. At the same time, there are a number of gaps in the literature around three key areas:

1. **Psychology**: Serious Games provide activities that combine having fun with the more serious aims of learning or behaviour change. Theory and research in psychology are relevant to explaining the complex, subjective experiences such as flow, immersion, and presence that keep players engaged in games as well as explaining the different kinds of learning. For example, basic research in cognitive psychology can help to explain how players allocate attention to and remember information, construct simplified representations of mediated reality, and make decisions about different possible courses of action in games. Psychological research on individual differences such as gender, age, ability, personality, and learning styles may also be relevant in studying how players might use games most effectively. Understanding of psychological characteristics is important not just in studying players but also for designing realistic behaviours and characteristics of Non-Player Characters (NPCs).

2. **Pedagogy**: The use of games, virtual worlds, and simulations in learning must be based on established pedagogical theory. Games differ in their characteristics and the underlying models of learning that they will support. To encourage the use of games in learning, it is essential to develop a better understanding of the tasks, activities, skills, and operations that different kinds of games can offer and examine how these might match desired learning outcomes both within and out of the classroom. However, there is no uniform pedagogy within serious games; earlier games tended to be based on a behaviourist model while later games incorporate experiential, situated and sociocultural pedagogical models.
3. **Assessment**: Assessment of the learning experience is a key part of any learning process, allowing instructors to track the performance of students. Therefore, serious games used in education should incorporate or facilitate assessment and evaluation processes. However, the interest for assessment in serious games goes further. Games are complex software artefacts that receive continuous input from the user and return immediate feedback. This exchange can be observed and logged, gathering vast amounts of information about how the students are interacting with the game.

These aspects of Serious Games will be covered in this edited book.

**MISSION AND MAIN OBJECTIVES OF THE BOOK**

The aim of this book is to disseminate knowledge on both the theory and practice of Serious Games, and to promote scholarly inquiry and the development/adoPTION of best practice in this area. The main objectives of the book are as follows:

1. To provide an understanding of three major topics (psychology, pedagogy, and assessment) underlying the successful use of Serious Games.
2. To help to provide a more coherent understanding of these key topics underlying the design, use, and evaluation of Serious Games, which will help to defragment the literature.
3. To provide an avenue for the publication of cutting-edge research that will inform both novice and expert readers about leading and emerging serious games pedagogy, technologies, and their applications to teaching and learning.
4. To showcase examples of current and emerging practice in innovative pedagogy and assessment and to discuss some of the key emerging psychological principles underlying serious games.
5. To contribute to the development of best practice in Serious Games through the evaluation and documentation of the successes and pitfalls of various techniques, approaches, and strategies.

While the focus of the book is on serious games, many of the issues discussed are also relevant to entertainment games.

**INTENDED AUDIENCE**

The intended audience for the book is broad, ranging from educationalists and researchers at all levels of education and training, particularly those with an interest in how serious games can be utilised to enhance teaching and learning. Game design is an interdisciplinary enterprise, involving those with a technical interest in game design, educationalists interested in learning and pedagogy, psychologists interested in motivational features of games, and sociologists interested in the impact of new technology on work practices. Researchers within the many subject areas in which games are being developed including health, business, engineering and science, and humanities will also be interested in the potential of games to support learning and change behaviour.
The book may also be adopted to support educational technology and e-learning courses at an undergraduate or postgraduate level. In addition, the book will be of interest to companies involved in the development of Serious Games applications, as it will provide an insight into some of the key challenges facing the industry and approaches to tackling these challenges.

Through a combination of theoretical pieces as well as practical cases or examples of “best practice” in the field, the novice reader will benefit from expert knowledge and learn from the experiences of both researchers and practitioners. Experts will stand to gain from reading the book to stay abreast of the latest developments and trends in this still nascent area and to obtain exposure to diverse perspectives and approaches to Serious Games.

OVERVIEW OF THE CHAPTERS

Section 1: Psychology and Serious Games

Serious games provide engaging activities that can help players to learn, acquire new skills, or change their behaviour. A key issue for serious games is how they can combine the engagement that games provide with effective learning. Psychologists have developed a wealth of theoretical and practical knowledge about learning, engagement, and behaviour, as well as a range of methods for studying these, which can help in developing a more coherent approach to understanding serious games. The diversity of the chapters in this book reflects the varied interests of psychologists in serious games. Chapter 1 provides an overview of key theories and constructs in psychology that are relevant to understanding serious games with a particular focus on those that are relevant to issues discussed in the chapters in this book.

Playing digital games is known to lead to a variety of perceptual and cognitive benefits, and there has been much optimism that serious games can support complex higher order thinking. Models of executive functions have recently been proposed as providing more coherent and coordinated accounts of cognitive processing. In chapter 2, Boyle et al. propose that applying Anderson’s model of executive functions to games can help provide a more integrated framework for understanding the psychological infrastructure that underpins the cognitive benefits and constraints of playing digital games.

Several authors have suggested that serious games have the potential to be at their most useful in supporting higher-level skills such as critical thinking and soft skills such as interpersonal and intrapersonal skills. Chapter 3, Rudnianski and Kravcik consider the problem of designing games from the perspective of the skill-set required in the area of intelligence analysis. The specific example of the competences required by MBA graduates is considered with a focus on the hard and softer skills of data processing, empathy, and critical thinking. Decision-making and cognitive biases are discussed in the light of Prospect Theory, the Theory of Planned Behaviour, and Game Theory. An overview of “Games of Deterrence,” a tool for representing argumentation based on game theory is discussed.

Usart and Romero argue in chapter 4 that it is useful to consider objective and subjective aspects of time as a factor in games. Objective time refers to the time that players take to carry out tasks in the game. Clearly, we might predict that the time that a learner devotes to learning, whether using a game or not, might be correlated with how much is learned. The subjective aspect of time (time perspective), refers to the player’s perceptions of time in the game. This is a cognitive aspect of players, defined as the manner in which individuals divide time into past, present, and future. Players’ perceptions of time is an important aspect of engagement in games since players frequently experience a distortion of their
sense of time when they are engaged in playing games. Usart and Romero present a case study where they monitor player time for individual and collaborative phases of the Metavals game in order to discuss both objective and subjective time assessment in SG.

In chapter 5, Ninaus et al. discuss the potential for using Neurofeedback (NF) and Brain Computer Interfaces (BCI) in games. NF and BCI both detect the user’s brain state, but in different ways. With BCI, brain signals are decoded to communicate with or control external objects such as a computer or computer game; with NF, users learn to modulate their brain signals directly coupled to feedback so as to ultimately affect behaviour. Ninaus et al. describe different neuroimaging techniques, such as Electroencephalography (EEG), Near-Infrared Spectroscopy (NIRS), and functional Magnetic Resonance Imaging (fMRI), and discuss their advantages and disadvantages as well as their application in games. Research on BCI and NF in combination with gaming is at an early stage but has potential in helping players to incorporate their brain states for a successful gaming experience.

Remmele and Whitton argue in chapter 6 that negative aspects of games, such as negative motives for playing games and negative behaviours in games, have been relatively neglected in the literature. They consider the “magic circle,” which separates the game world from the real world, where different rules, behaviours, and codes of conduct apply, and they provide an interesting analysis of how negative behaviours can disrupt the magic circle, abruptly taking the player back out of the game where different systems of rules apply. Remmele and Whitton describe how games can help players understand the rules systems that apply in moral and social learning. They also consider examples of negative behaviours in games, such as cheating, spoil sporting, and trifling, which can disrupt the normal rules of a game.

Chapter 7 explores how user engagement in games is influenced by players’ acceptance of Non-Player Characters (NPCs). In order for players to interact successfully with NPCs, these have to convey believable behaviours. The authors describe how research on the creation of computational models for NPCs in AI has been dependent on models developed in social sciences, especially psychological and sociological models. These models provide a basic understanding of human behaviours in specific domains that can be applied to generate believable behaviors in virtual, dynamic, and unpredictable environments. It also presents a series of examples describing theoretical models of emotions, emotion regulation, social identity, social power, and conflict resolution, and explains how these have been used in implementing autonomous NPCs.

Blasko et al. acknowledge that players differ along several dimensions, which are relevant to the enjoyment they experience and their learning in games. In chapter 8, Blasko et al. propose a categorisation of individual differences into personality and motivational factors, experiential factors, demographic characteristics, and cognitive factors such as learning styles, spatial skills, and working memory capacity. Consideration of these differences can help us to develop games that adapt to different players and provide personalised games and individualised learning.

Tran provides in chapter 9 a broad ranging account of players’ motives for playing games. He then proceeds to examine the view that businesses are like games, concluding that this is an oversimplification of what a business is. He argues that MMORPGs support players in learning team and leadership skills that are key requirements for many jobs. He then examines how the Enneagram of personality and tests of Emotional Intelligence can help in personnel selection to assess the “o” factor, the knowledge, skills, and abilities that more established psychometric tests do not test. The Tavistock method is also examined as a means of collecting information about effective interactions in groups. These skills can be assessed by looking at gaming behaviours.
Early research looking at why players found entertainment games so engaging emphasised enjoyment, challenge, and competition, while neglecting social motives. However, the increasing popularity of Massively Multiplayer Online Games (MMOGs) and social network games has drawn attention to the importance of social reasons for playing games. Bachvarova and Bocconi describe in chapter 10 how game mechanisms used in social games, such as social interaction and the network effect principle, help to engage players in MMOGs and social network games. They also examine the combination of Web 2.0, games, and TV, and describe a prototype that was built to study the interdependencies between these. These social games can use their engaging power for purposes beyond pure entertainment, such as behavioral changes or learning.

Section 2: Pedagogy and Assessment

Chapter 11 explores the nature of “learning” in GBL and the cognitive and motivational processes that might underpin that learning by drawing on psychological theories and perspectives. The chapter first reviews changing conceptions of learning over the last few decades. Next, the chapter reviews empirical research on the learning outcomes that have been identified for GBL, with specific focus on cognitive benefits, school attainment, collaborative working, and the motivational and engaging appeal of games. Finally, the chapter presents an overview of the dominant theoretical perspectives/findings mostly associated with GBL to broaden understanding of the potential for GBL in the classroom.

The objective of chapter 12 is to present the view that games are not necessarily the exclusive domain of game professionals. Rather than requiring that teachers get acquainted with and use complex, technically demanding games, brief case studies are presented where teachers can build games themselves and games can be used by learners to create their own designs (i.e. games, worlds, or a-likes). For each case study, the learning objectives, the motivation to create the game, the design and the tools used, the game elements included, and the user experiences are discussed.

Chapter 13 provides important empirical evidence in the field of games-based learning and adaptive games-based learning by presenting the results of a randomised controlled trial to investigate learning effectiveness in relation to learning styles between adaptive games-based learning, games-based learning, and traditional teaching approaches. The chapter presents an extensive literature review to identify existing empirical evidence in adaptive games-based learning. The chapter then presents the results of the randomised controlled trial. The results suggest that games-based learning and adaptive games-based learning are suitable teaching approaches for teaching Structured Query Language (SQL) at Higher Education (HE) level.

The last 10 years have seen an explosive growth in the fields of online gaming, the largest of these games being the Massively Multiplayer Online Games (MMOG), such as World of Warcraft or City of Heroes, which attract millions of users throughout the world every day. The last 20 years have seen the growth of a new field of physics known as Physics Education Research (PER). This field consists of physicists dedicated to improving how we learn and teach the subject of physics. In chapter 14, the author discusses his personal quest to combine PER with a MMOG and create an online virtual world dedicated to teaching Newtonian physics.

Chapter 15 addresses one of the key challenges associated with serious games, namely how assessment is integrated into serious games. The chapter provides an overview of assessment, formative assessment, summative assessment, and embedded and external assessment. The chapter also presents the results of an extensive literature review identifying the main approaches of integrating assessment into serious
games. A number of case studies are then presented to discuss various forms of assessment integration including monitoring of states, quest types, use of assessment models or profiles, and micro-adaptive, non-invasive assessment of competencies, quizzes, and peer assessment.

Continuing the theme of assessment, chapter 16 makes the case for an integrated approach to assessment within learning games and the wider curriculum, drawing on elements within game design that provide natural opportunity for such integration. To demonstrate and evaluate such an approach, integrated assessment case studies (including a full study from the University of Leicester) are presented and discussed.

The final two chapters in the book (17 and 18) look not so much at assessment in games but at the evaluation of games. In the chapter 17, Mayer et al. explain that the emerging areas of serious games and games-based learning are complex and diverse and suffer from the absence of an overarching framework for executing and evaluating research. In this chapter, they propose a multidimensional framework for research and evaluation of games, suggesting that it should include an account of frames for evaluation (i.e. the philosophical positions to contextualise the research), the various kinds of evaluation methods that can be used, possible theoretical models to generate testable hypotheses, established tests, and measures of relevant variables and consideration of the ethical dimensions of games.

Chapter 18 complements the previous chapter by Mayer et al. by providing an overview of the different study designs that can be used to evaluate the learning outcomes of serious games, along with specific examples of these reported in the literature. Seven case studies are then presented of games that have been used by the authors to support their teaching in higher education across a range of subject disciplines, including business, health, and engineering manufacturing. These games had varied, and usually complex, learning objectives. Evaluations of the use of these games in teaching are discussed. These illustrate some of the pragmatic and ethical issues and constraints that arise for researchers and teachers in developing and using serious games in education.

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