Preface

With revolutions in patient, trainee, and public expectations, the global healthcare sector is increasingly adopting emerging technologies such as serious games to meet the needs of stakeholders. Typically developed using computer game technologies associated with entertainment, serious games can provide a platform for combining high-fidelity multimedia content with novel interfaces and a wide range of pedagogic approaches. Areas such as e-Learning, defence, marketing, and training are already benefitting from game-based solutions, and healthcare is rapidly emerging as another leading area for their use.

Across the healthcare sector, there is growing interest in improving and sustaining interaction and engagement using these technologies. An increased focus on tackling the attitudes and behaviours that underpin chronic conditions has seen serious games deployed to wide audiences, with examples in this book describing their use for cases such as nutrition and lifestyle choice. The need for efficient and effective education of healthcare professionals has also seen game-based approaches employed in a diverse range of forms to address training needs, whilst in a clinical setting, games have been used to improve therapeutic outcomes for patients. Fundamental to the success of serious games across these areas is the ability of designers to realise the power of games to engage and immerse the player, whilst conveying learning outcomes in a demonstrably effective fashion. Research, therefore, must play a key role in identifying the strengths, weaknesses, and best-practices in the use of serious games in the healthcare sector, providing decision-makers with the evidence they need to consider their value as a solution.

Serious games capitalize on their ability to reach target audiences who are already engaging with interactive, rich graphic games recreationally, allowing them to convey instructional outcomes to audiences resistant to more formal methods. Novel approaches to game development can potentially enhance learning, engagement and treatment outcomes, though success depends on the ability of designers to make informed choices when faced with a range of decisions: pedagogic approaches must be carefully selected and balanced against the need to provide engaging gameplay; decisions on fidelity and iteration must be pragmatically evaluated against costs as well as learning needs; and, crucially, stakeholders must be empowered with the understanding and tools they need to collaborate effectively throughout the development process.

_Serious Games for Healthcare: Applications and Implications_ reviews the development and application of game technologies for health-related serious games. It provides cutting edge research from both academia and industry, informing readers about the current and future advances in the area. Encapsulating the knowledge of commercial and noncommercial researchers, developers, and practitioners in a single volume benefits not only the research and development community within the field, but also serves public health interests by improving awareness and outcomes. This book describes key trends, summarizes existing work, and shares both success stories and critiques, providing a state-of-the-art reference for current practitioners, as well as serving to inform, and, where appropriate, encourage potential adopters.
The primary audience of this book is composed of innovative professionals and researchers in healthcare, as well as developers of game-based learning solutions seeking to enter or working within the field. This includes academic and industrial researchers, game professionals/developers, and health and social services professionals who wish to understand designing, developing, and deploying video game technology in healthcare settings, as well as the trends and commercial potential of such an innovative approach.

The content of this book is divided into three sections: the first reviews key trends surrounding the application of virtual and games technologies within the healthcare domain, providing insights into current research and development as well as deployment. This particular section sets the context for the following sections that delve into the key design attributes and report on findings based on established case studies in the field. In section 2, a range of design and development approaches are described, as well as a review of key ethical considerations. These approaches demonstrate both the diversity and commonalities amongst design and development methodologies in the sector, as well as reporting the hands-on experience of researchers and developers. Finally, section 3 presents a range of developed examples targeting health professionals, parents, and the general public.

SECTION 1: KEY TRENDS IN SERIOUS GAMES FOR HEALTHCARE

The section opens with an interesting perspective on the general use of virtual technologies to support healthcare. This chapter sets the scene of how virtual worlds have been explored in the field, acting as the predecessor of serious games initiatives. In this chapter entitled “Virtual Worlds in Healthcare: Applications and Implications,” Heinrichs, Davies, and Davies report how virtual worlds share many similarities with serious games, including the use of the same technologies to construct and view the virtual environments. However, virtual worlds focus less on the gaming aspect of the application, and in particular, are characterized by a much broader multiplayer (multiuser) experience. The chapter describes a series of areas that benefit from virtual worlds, particularly health support and awareness, therapy, first response and clinical practice. This chapter makes a strong argument about how virtual worlds, can be an alternative or complementary technology to the work on serious games described in the other chapters, and how it will advance healthcare applications.

For patients recovering from debilitative conditions, games can play a useful role in making the repetitive actions needed to restore physical and cognitive function more engaging and enjoyable. The
third chapter, entitled “Rehabilitation Gaming,” reports on recent innovations in the application of serious gaming for such purposes. Nap and Diaz-Orueta argue that the main benefit is the engaging factor of a gaming environment towards the promotion of motivation to engage in rehabilitation, the objectivity of rehabilitation measurements, and the personalization of the treatment. This chapter focuses on the use and effectiveness of such a game-based intervention and illustrates the possibilities and potential in future healthcare based on the increasing evidence that gaming can positively contribute to the rehabilitation and recovery process.

The fourth and final chapter in this section “First-Person Shooter Game Engines and Healthcare: An Examination of the Current State of the Art and Future Potential” describes how emerging gaming technologies are making high-fidelity, immersive virtual worlds more accessible and cost-effective than ever before. In this chapter, Gatzidis reviews a range of modern gaming engines typically used for first-person environments, and their suitability and applicability to healthcare training. His review uncovers a range of existing examples of the use of entertainment gaming technology in healthcare, and opens the way for practitioners seeking rapid, efficient technologies and techniques for creating high-fidelity, interactive content. Ultimately, this chapter contributes to the increasing recognition that the use of gaming technology can allow for the creation of high-fidelity and immersive environments at a fraction of the costs previously associated with bespoke development approaches.

SECTION 2: DESIGN AND DEVELOPMENT

Ethical and patient safety considerations must come foremost in the development of any healthcare intervention. Hence, the Design and Development section is introduced with a consideration of “Ethics in the Design of Serious Games for Healthcare and Medicine.” This chapter discusses the principal considerations for researchers, designers, and developers of game-based approaches in healthcare research and development. Vivekananda-Schmidt stresses that as with any emerging application of information technology in the sector, ethical considerations must not be overlooked; the case for this consideration is made clear in this chapter, which identifies a range of considerations unique to the application of gaming technology in the healthcare sector and discusses their implications. As such, an essential reference is provided for early-stage ethical review of serious game projects, regardless of whether their target audience comprises healthcare professionals, patients, or the general public. To help practitioners resolve these issues, the chapter delivers useful guidance on their nature and how they may be related directly to design considerations.

One of the most useful sources of information in serious games design can be the findings of prior user studies. In the sixth chapter, “Difficulty and Scenario Adaptation: An Approach to Customize Therapeutic Games,” the authors study games used to aid rehabilitation through the provision of a motivating environment in which exercise can be conducted. Rehabilitation is essential for stroke patients, as the strokes can cause damage in a patients’ neurological system and can result in loss of mobility in limbs. This chapter expands on existing therapeutic games via the use of adaptive environments that could dynamically alter the intensity and challenge of serious games to be appropriate to the patients’ needs while maintaining enough interest to encourage further progress. The authors present a user study using a game adapted from the story of “Around the World in 80 Days.” The user study compares the effect of adaptive difficulty with a completely random difficulty setting. While participants in the study were not patients but healthy adults, it is foreseen that such a study serves as a pilot for future research.
Results demonstrate a significant effect for the adaptive difficulty. This work indicates the potential of how technical research aspects, in this case adaptive strategies, can advance serious health applications.

Needs analysis is also essential in Serious Games design. In the chapter “Serious Game for Relationships and Sex Education: Application of an Intervention Mapping APPROACH to development,” Brown, Bayley, and Newby discuss an Intervention Mapping approach towards ensuring the efficacy of serious game designs when applied to healthcare issues. The discussion is based on the application of the approach in the development and design of a Serious Game addressing relationships and sex education needs in British adolescents, which includes needs assessment, intervention mapping (evidence review, identification of a programme goal, performance objectives, and associated determinants), and change objectives. The fashion in which these are translated into a concept and content for a Serious Game, evaluation plans grounded in the planning process, and a commentary on challenges experienced are also provided.

Chapter 8, “Nutrition Games,” demonstrates the needs and specifications that can be supported by games design and development. In this chapter, Frederico highlights the need for nutrition game development, reviews current nutrition games and research, and directs attention to applicable resources on this topic. She argues that there is a dire need for nutrition education assistance and help to alleviate nutrition problems in the world ranging from under-nutrition to over-nutrition. Serious games is seen as a potential solution based on existing reports on gaming strategies being successful with a multitude of health issues, such as smoking and exercise, but little has been done on the topic of nutrition. Frederico concludes that there is a huge potential for serious games that mix art and science.

The audience of serious games plays a key role in determining the mechanics and technologies that should be deployed in order to engage and sustain participation. In the chapter “Active Video Games: Potential for Increased Activity, Suggestions for Use, and Guidelines for Implementation,” Chamberlin, Maloney, Gallagher, and Garza report that active video games such as those enabled through the innovative user interfaces of the Nintendo Wii and Microsoft Kinect have drawn considerable media attention as a means for promoting a more active lifestyle amongst young audiences. However, the promise of these games often contrasts with research findings showing limited benefits when compared to other activities and approaches. This chapter provides a comprehensive review of existing literature surrounding the topic, demonstrating both the potential such games might have, as well as their limitations and the need for developers of future applications to pay heed to the need for rigorous research into the efficacy of the solutions they create. This includes the noteworthy consideration of context, and the social environments in which these games are used.

This section concludes with an overview and consolidation of the considerations presented by the other chapters, written from the perspective of a researcher with extensive experience working in the area. Aptly entitled “The Role of the Researcher in Making Serious Games for Health,” Kato highlights the demanding and multifaceted role of the researcher in the development of a serious game for healthcare. Often, they must convey the need for a rigorous approach to understanding the efficacy of a game to a wide range of stakeholders, whilst managing tensions between technology and research, as well as conflicts of interest. This chapter provides insight drawn from the author’s own extensive experience, identifying potential pitfalls and giving guidance for researchers on how to avoid, address, or resolve problems before they arise. As such, this is an indispensable guide for the initial stages of a project, giving researchers and stakeholders alike a depth of insight into how best to integrate research into the design, development, deployment, and assessment of serious games in healthcare.
SECTION 3: ESTABLISHED CASE STUDIES

A particularly noteworthy characteristic of serious games is their potential to address problems which more conventional training methods have yet to fully resolve. One such case is infection control on hospital wards, which despite effective training programmes still represents a significant ongoing cost to health services as a result of lapses in policy adherence. “A Serious Game for On-the-Ward Infection Control Awareness Training: Ward Off Infection” describes an attempt to address this problem through the provision of on-the-ward training in the form of a serious game, noting that healthcare audiences are increasingly receptive to such forms of training (with 77% of 223 nurses surveyed playing games on a regular basis), and yet despite this promise, low usage of the game in a trial across 13 hospital wards is observed. The authors focus on the reasons underlying this low usage, providing a valuable resource for developers of serious games targeting a similar audience or context, and describing ways in which future interventions might capitalize on their findings.

The next case study, “Smart Phone Video Game Simulation of Parent-Child Interaction: Learning Skills for Effective Vegetable Parenting,” explores the use of smart phone video game to address issues surrounding the lack of vegetable intake in a child’s diet. The authors suggest that preference is an important determinant of this intake, and food preferences are initiated early in life; however, parents of preschoolers commonly report difficulties in getting their child to eat, or even taste, vegetables. They studied a smart phone application (app) game prototype, developed to help parents of preschool children use effective ‘vegetable parenting’ practices, a term referring to parenting practices (effective and ineffective) related to preschoolers’ vegetable consumption. This chapter presents the extensive formative research, describes the game app, and explains the behavioral science foundation. The authors suggest that the smart phone parenting app could be easily, inexpensively, and widely distributed to large numbers of parents to maximize its public health effect. This chapter demonstrates how innovations in technology and in serious games might promote change in effective parenting, potentially increasing child vegetable intake, or even decreasing childhood obesity.

In the chapter entitled “Simbody - An Interactive Simulator for Health Education,” the authors present a serious game used to address unhealthy life style choices. The authors argue that behavior increases the risk of suffering from deadly diseases such as cardiovascular problems, diabetes and cancer, and many other closely linked health issues such as obesity which is rising significantly in western cultures. The authors believe that education is paramount in attempting to achieve behavior change and break unhealthy habits. The proposed serious application termed SimBody is web based to improve availability and attempts to educate the general public on matters of health. SimBody illustrates how the lifestyle choices have an effect on an on-screen avatar’s progression of atherosclerosis potentially leading to a heart attack. A usability study was conducted to validate and improve the quality of the presented system. A preliminary evaluation of using SimBody against a control group who read literature from a website demonstrated a better retention of information for users using SimBody, although the authors do mention that different texts may yield different results. SimBody demonstrates how readily available serious applications can be another tool for promoting behavioral change and reducing health risks via education.

In the final chapter of Serious Games for Healthcare: Applications and Implications, Muller describes the creation of a game seeking to assist nurses who are not native language speakers in improving their knowledge of the English language. Nursing students for whom English is not a first language may struggle with clinical terminology as some of the phonemes may be missing from their native languages, and this may in turn lead to them struggling to cope with the large amounts of novel and similarly-sounding
clinical terms which they have to learn during nursing school. Furthermore, a lack of comprehension under stressful working conditions has the potential to lead to serious medical consequences. A game termed Medicina was developed to improve the phonological awareness of the user: participants playing Medicina would listen to a medicinal term and have to choose from five similar sounding words, including the word that they had just listened to. Muller conducted a user study with 25 volunteer participants from a first year of graduate nursing school whose first language was not English. Quantitative results demonstrate a substantial improvement in phonological awareness of the participants, reinforced by qualitative results based on participants’ comments. The use of Medicina demonstrates how carefully designed serious games, which can be relatively straightforward to develop, can prove a useful learning aid.

CONCLUSION

The key trends identified by this book reflect the relative infancy of game-based learning approaches when contrasted to more conventional pedagogies: in several instances, development methodologies themselves are a core focus of research. Amongst all chapters, understanding the user remains a central objective of these methods, either including them through participatory techniques, as described in Chapter 7, or through more concept-driven approaches such as that given in Chapter 2. Entertainment game design may prove a fruitful source of methods and methodology, given that entertainment game designers have long focused upon understanding and appealing to their players, and creating highly usable software. However, this must also be balanced against the key trait of perceived usefulness, often posited as central to the success of any e-Learning intervention; a trait which can prove more challenging to foster in healthcare professionals, as shown by Chapter 11.

Central to achieving this perceived usefulness is the need for research to accompany the development of any application of serious games in healthcare. For a game to be considered “serious,” its efficacy should be proven rather than simply intended, and games should not be afforded exemptions from the rigour applied to assessment of other approaches to education and training across the sector. Only then can decision makers be provided with the evidence needed to make informed selections of game-based approaches as ideal solutions to specific training needs or interventions. Important also will be the ability of researchers and developers to take forward the principles put forward by this book, ensuring that current and future game-based interventions are learnt from and contribute to a wider understanding of not just the contexts in which these games work, but also how and why they are capable of impacts and efficacies beyond existing approaches. The design and development methodologies put forwards in Chapters 6-9, coupled with the pragmatic advice given in Chapter 10 and ethical considerations in Chapter 5 grant a powerful toolkit for future developers and researchers within the sector.

The case studies included in this book show the diversity with which games are being developed and deployed, with widely varying groups of learners, contexts, and platforms; across the four case studies in this book, contexts range from web-based intervention through to on-the-ward training, whilst platforms range from desktop PCs to smart phones. As generations who grew up playing electronic games increasingly represent both professionals and decision-makers in the healthcare sector, increased receptiveness to this form of instruction is apparent. If this receptiveness is coupled with the research required to validate and refine the use of serious games across a wide range of applications, the sector promises to offer exciting potential to address issues existing methods have so far failed to satisfactorily
overcome. In a global healthcare sector increasingly pressed to tackle chronic diseases and behaviours amongst an aging population, the evidence put forward by this book, alongside the many past and current projects in the area it highlights, suggests serious games may form a critical part of a long-term strategy to address these challenges.

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