Abstract

True success of Serious Games depends on consumers' realization of the inherent value of those products for various self-efficacy applications in life. Additionally, there exist numerous challenges for Serious Games developers from a market perspective including smaller consumer audiences, higher development cost, the need for embedded evaluation and assessment functionality, as well as insufficient business models and distribution channels.

This article aims at giving an overview on the field of Serious Games from a healthcare industry perspective. In doing so it identifies challenges, opportunities and resulting requirements towards business viability. Finally, this paper further outlines requirements for Serious Games R&D towards effectiveness as well as consumer acceptance and adoption.

The article represents an extension of the keynote paper by the author (Encarnação 2009) putting a special emphasis on discussing healthcare industry perspectives and requirements for Serious Games research and development.

Introduction

The jury is still out on whether the current slowdown in hardware and software sales in the gaming industry is just a well-deserved rest after an impressive sprint in the fall of 2008 or a sign that the world-wide recession makes consumers focus more on life essentials than on dispensable luxury items like game consoles and entertainment.

However, the continuing success of the Nintendo Wii technology and market news about major non-obvious partnerships in the entertainment games market, seem to highlight a trend towards finally exploring more purposeful uses of game play in order to increase access to niche markets.

It is by far no longer a secret that the risk factors of many costly chronic diseases such as diabetes, coronary heart disease, chronic obstructive pulmonary disease (COPD) are significantly increased in audiences that exhibit prevalent behaviors of modern society such as mal-nutrition and lack of exercise – often leading to obesity – and smoking. (WHO 2004). Similarly, the close relationship between cognitive decline and reduced physical activity in aging populations has been studied in depth.

It is, therefore, not surprising, that the healthcare industry has taken notice, due to increasing cost and public pressure to keep its audiences healthy rather than wait for
treating their chronic diseases. Kaiser Permanente Amazing Food Detective, Cigna’s free distribution of HopeLabs’ ReMission Cancer Adherence game, and Humana’s Horsepower Challenge children pedometer program are early indications that healthcare providers are looking into new ways of motivating and inspiring healthy behaviors. Gaming technology with its proven potential to capture the attention of varying audience over extensive periods of time has been recognized to also hold the promise to also provide a platform for behavioral change – making it a truly serious proposition.

The Rise of Serious Games

In 2007, Eliane Alhadeff – a recognized Serious Games blogger and market observer (Alhadeff 2007) – predicted the Serious Games market to grow to 2 billion dollars in revenues, initially based strongly on corporate training, healthcare simulation, and learning games, who she predicted to become mainstream by 2012. Whether these predictions still hold up in the current recession and with the increasing cost for game development is not clear, however recent announcements at least indicate that the entertainment market has taken notice of the growing potential of Serious Games as well as the increasing interest of casual gamers in games with a purpose. What the Wii success taught us is that in addition to traditional hardcore gamers, casual gamers are forcefully entering the game consumer market and they do not see their purpose in life sitting all day inactively in front of a console. Across all demographics, those casual gamers don’t and might never see themselves as gamers and are attracted by activities that add additional value to the mental, physical, intellectual or social well-being. Furthermore, due to the social component of this game play – 59 percent of gamers play with other gamers in person – there is a unification happening between hardcore and casual gamers.

Consequently, a new type of game is evolving, which aims at seducing the new casual gamer generations through active, social, cognitive or educational play without requiring them to pass through a steep learning curve during seemingly endless hours of game play. Products like Wii, WiiFIT, eyeToy, Konami’s DDR, and Microsoft Natal on the hardware and peripheral side, and WiiSports, Guitar Hero, RockBand, and EA Active’s Virtual Trainer on the software side are clearly indicating a new direction for the entertainment games market.

Furthermore, trend-setting collaborations are emerging such as EA’s partnership with toy manufacturer Hasbro to launch family classics, Hasbro’s competitor Mattel closing an exclusivity deal with Neuorsky -- the leader in consumer brain computer technologies -- towards launching a new category of brain games and toys that operate using the power of concentration, Jerry Bruckheimer’s opening of a games studio in partnership with MTV games, and Warner studios’ purchase of midway games. All those developments show the convergence of the traditional entertainment video games markets with other entertainment genres, channels, and leisure offerings in response to having to serve a broader, more diverse, and more demanding gamer audience. Gaming is becoming a ubiquitous part of life and is in this sense providing new opportunities for Serious Games to evolve and being takes seriously.

What’s in a Game, Seriously?!

Looking at the whole space currently referred to as Serious Games, it is clear that this term is being attributed to many different aspects of video game design, development,
hardware and game play. Just considering the health and wellness space, a whole suite of Serious Games applications are being investigated in academia, government and by independent developers (see Table 1).

Table 1. Preliminary Games for Health taxonomy based on (Sawyer 2007)

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Maybe this is just another indication for a widespread acceptance of the increasing awareness around Serious Games opportunities. However, it complicates attempts to look at it from a scientific perspective towards identifying needs, requirements, gaps and research potential in a multi-disciplinary environment.

While there have been efforts to take a structured look at the various application areas for Serious Games (cf. Sawyer et al. 2008), identifying what differentiates a Serious Game from a game that is providing mere entertainment value seems daunting. What makes matters worse is that the aforementioned successes of recent activity games led to the adoption of the term Serious Games by marketers, attributing it to any possible positive impact the game play might have – whether intended or not.

The following section is, therefore, an attempt to separate Serious Games from other types of games as well as to delineate Serious Games design considerations from coincidental similar design outcomes.

Drivers and resulting design features

In general, there are two main purposes for Serious Games: skill augmentation and behavioral change (e.g., Lieberman 1997). Both are equally valid, however create distinct requirements and approaches when it comes to design considerations and design features, especially due to the relative immaturity of the field.

Drivers for Serious Games targeting skills augmentation are the need for a more skilled workforce as well as safety improvements, thus addressing the weaknesses and shortcomings of a contemporary educational or training system and trying to exploit the strength of games for certain types of education and training. Consequently, design features include the manipulation of time, frequent repetition, the addressing of specific skills, and the gathering of related data towards proven mastery. Often the exposure to unacceptable risks or danger is an important design feature, introducing the stress, pressure and frustration required to make skills transfer effective.
Towards behavioral change, however, the drivers are the identification of needs not yet met by standard procedures or too costly to address by standard means. Consequently, other main drivers are peer-reviewed research as well as innovative and visionary individuals in academia, industry, government and non-governmental organizations, who are willing to take the risk to enter (and advocate) unchartered territory. While here too, the manipulation of time, frequent repetition and gathering of data are core design features, it is the focus on improving and maximizing self-efficacy that fundamentally changes the experience and game play.

**Educational Games**

Despite the previous postulation of Serious Games as effective media for education and training, there is a fundamental difference between Serious Games that educate by experience and Educational Games that communicate educational content in a game-like manner. Serious Games in this context develop connections between contributing artifacts, raise awareness, and are immersive in nature, whereas Educational Games develop specific skills, address and test specific knowledge, and are repetitive in nature. Not surprisingly, the latter are mostly developed for the public sector spear-headed by companies like Leap Frog and Vtech, while Serious Games for education are advocated by public institutions, business colleges and other non-profit organizations that are striving for a compelling experience with potential educational value.

**Virtual Worlds**

The emergence of massively multi-user online worlds or MMOW has led to the confusion of those virtual worlds with massively multiplayer online games or MMOG, which have in recent years successfully provided compelling and immersive game experiences to its audiences. However, MMOW such as Linden Lab’s Second Life, Microsoft’s Club Penguin or Numedeon’s Whyville are platforms which certainly can be the interface to multiplayer distributed online Serious Games. With the freedom they are providing the user to interact, choose alternatives and provide input as well as their high level of instrumentation to give evaluation feedback to users and designers alike, they might actually be a reasonable basis for the earlier mentioned spectrum of life-related game activities that casual gamers are susceptible to. However, they shouldn’t be confused with the game-experience focused, highly scripted and thus from a Serious Games perspective somewhat limiting MMOG such a Blizzard Entertainment’s World of Warcraft, which trade participatory narrative for a better (mostly visual) experience. Whether such distinction will hold up in the future needs to be seen since increasing online provision of game play as well as consumer input to game design and game scenarios might eventually overcome these disparities.

**Serious Games in the Context of Persuasive Technology**

True Serious Games aim at having a measurable impact on the player without the player necessarily being aware of the intended impact. In fact, if the intended impact has not been established by the playing individual but by a higher authority such as a parent, physician, supervisor or educational institution, then there is a natural resistance or lack of buy-in, which will ultimately affect the game appreciation and thus experience. In recent years, the research field of persuasive technologies has emerged addressing particularly this challenge. How can technologies be designed that effectively change people’s thinking and behavior without explicitly requiring the user working towards such change? B. J. Fogg’s research (Fogg 2003) is studying technology persuasion along a functional triad as depicted in Figure 1.
Based on this research, technology can be persuasive by any combination of increasing capability, creating a relationship or providing an experience. For instance, a tool can be persuasive by

- making target behavior easier to do;
- leading people through a process;
- performing calculations or measurements that motivate;

a medium can be persuasive by

- allowing people to explore cause and effect relationships;
- providing people with vicarious experiences that motivate;
- helping people rehearse a behavior;

and a social actor can be persuasive by

- rewarding people with positive feedback;
- modeling/demonstrating a target behavior or attitude;
- providing social support.

Applying this ‘lens’ of persuasive technology, one can easily see the strength of Serious Games in covering all three bases. Currently they are, however, predominantly depicted through implementations which provide experiences in which individual players are represented by social actors in the form of avatars and interact with other social actors in the of non-player characters (NPC). A more thorough discussion of video games in the context of persuasion has been published by (Bogost 2007).

Applying such methodology allows the evaluation of Serious Games in a way less tedious and restricted than trying to determine long-term behavioral change by means of short-term studies in controlled environments. While certainly less precise than through biometrical and physiological monitoring, such evaluations can be conducted before and throughout the design of the game rather than after its implementation.

**Opportunities and challenges**

Business processes in the traditional gaming industry follow business-to-consumer (B2C) models in the retail market or direct-to-consumer (D2C) models through emerging online distribution channels. In contrast, the significantly higher fragmentation of the Serious Games market requires the availability of very specialized distribution channels thus calling for business-to-business (B2B) models. Moreover, the traditional gaming industry’s success is based on the common public recognition that
games are entertaining. Therefore, development, marketing and distribution only need to cater to the preferences of various demographics to target significant sales success with large audiences in the tenth and hundreds of millions.

Serious Games, on the other hand, lack both, the public acceptance of being generally a value-add as well as large audiences to design and market towards. The proof of value-add has so far been stifled by the need for scientific evidence that a Serious Game had a skill augmentation or behavior change impact on its players. Furthermore, there were less people with a particular self-motivated need for improvement or change than with the inherent desire to have fun. This required the availability of dedicated sales channels and organizations and therefore a B2B model. However, such model lacked so far the market size, on the one hand, and a robust and diversified value chain on the other to meet all audiences’ needs and thus exploit all commercial opportunities.

Times might, however, be changing in favor of Serious Games. The financial, educational, and healthcare crises worldwide are affecting large audiences and are creating the public awareness that change is inevitable and must be a combination of public and individual effort and responsibility. Associated shortfalls in schools, the workplace, social communities and individual behavior such as poor education, mass layoffs, bankruptcy, physical inactivity, malnutrition, and drug-abuse are affecting large demographics. Ironically, those problems affecting the masses are taking the stigma of resulting individual problems such as depression, obesity, illiteracy, unemployment, and poverty. Simultaneously, the field of Serious Games research and development has matured and was able to produce some compelling highly publicized evidence on particular game interventions, which created public and individual awareness around the potential of Serious Games (e.g., Baranovski et al. 2008, Kato et al. 2008). Consequently, several private and non-government organizations have invested in rapidly evolving the field of Serious Games from a mere academic field of study to a profitable industry. In anticipation, the established game industry has realized the trend and is beginning to start strategic directions as previously discussed in order not to be left out.

However, when it comes to business opportunities in healthcare, there is still a lack of understanding of the drivers as well as preconception that create barriers for even promising Serious Games to create value propositions.

Five Myths about the (US) Healthcare Industry

1. **Healthcare providers have significant profit margins that justify high-risk research investments**

   With increasing cost through medical advances, increase in chronic diseases based on unhealthy behaviors in modern society and an aging population, profit margins in the US have shrunk to between 2% and 5%. While premiums are collected at the beginning of a plan year and can – if managed wisely – create additional revenues through interest, much of the revenues are used towards paying for healthcare.

2. **Healthcare providers should be advocates of long-term research**

   Almost exclusively cost-oriented member and sponsor audiences as well as a strongly employer-based system lead to low retention rates due to frequent change of employment or cost-driven change of the healthcare provider. The resulting competitive landscape calls for short-term differentiators with immediate impact rather than long-term competitiveness, in order to increase member retention through cost avoidance and satisfaction.
3. **Healthcare providers have significant data assets that lend themselves to longitudinal research**

Due to the previously described significant fluctuation in member audiences as well as lack of centralized data repositories (electronic medical records; EMR) for patients, there is a significant lack of data continuity which renders claims-data driven longitudinal studies impractical. Additionally, the regulatory limitations on correlating members’ claims data with lifestyle data also prevent contextual analysis of claims data with respect to health behaviors.

4. **Healthcare providers main focus is on sick members’ care**

The greatest profit of healthcare providers lays in the people that pay their premiums yet do not require medical treatment, i.e. the healthy people. Retaining, growing and using this audience as influencers of less healthy audiences has been a major focus in healthcare industry’s quest for cost avoidance. Unfortunately, the fact that these audiences don’t interact with the healthcare system also leads to a lack of data on them; understanding the behaviors of these so-called ‘invisibles’ is another interesting challenge for healthcare providers.

5. **Healthcare providers control members’ cost and benefits**

Healthcare providers determine the cost of benefits based on healthcare costs and risk assessments. It is, however the sponsors and members that decide which benefits to choose from and these decisions are more often than not solely based on cost considerations.

A remaining challenge for Serious Game development is related to the fact that purposeful play is something very personal and requires careful tailoring to individual needs, preferences and contexts. For it to have a measurable impact that translates well to real-world proficiency and behavioral change requires the experience to be very realistic. Game development over the years got away with fictional representations of a physical environment, approximations of physical behavior and crude as well as imprecise input devices. In contrast, many Serious Games applications might require a higher degree of visual, tactile, olfactory or other-sensory realism than commodity gaming hardware and software had to provide. Serious Games also might have to tie to existing real-world equipment in order to facilitate higher and quicker knowledge and experience transfer. At the same time, Serious Games have to still be able to compete with the appeal and experience of entertainment games which don’t have those additional constraints.

Finally, Serious Games have the requirement to capture and measure the various facets of individual game play that document a player’s progress towards the embedded purpose of the game. Availability of such data is not only crucial to integrate Serious Games seamlessly with other programs aimed at improving skills or self-efficacy. It is also a prerequisite towards improving the game itself and further document the business viability of Serious Games to various stakeholders. However, the fact that true Serious Games as defined above might not explicitly address these purposes but rather persuade players through the associated experience, functionality, or communication can make such data hard to capture. Such data is not directly tied to game design or game play but rather needs to be inferred from the player’s reaction.

All these factors increase the cost of developing Serious Games, on the one hand, and are creating the risk for Serious Games to remain an academic field of study struggling to prove ultimate viability and consequently handicapped by lengthy, tedious and very narrowly focused scientific research endeavors resulting in mere proofs of concept.
A Healthcare Industry Perspective

Taking above business considerations into account and with a focus on demystifying healthcare industry attitudes towards viable Serious Games research and development, the following approaches to applied research offerings to healthcare are suggested. Those are complemented by the more generalized scientific challenges for Serious Games subsequently outlined which are naturally focused on the feasibility of the provisioned solutions.

All of the following suggestions are aimed at providing an industry – in this case healthcare – with enough information to make educated decisions on the risks and opportunities of any particular offering. Based on these risk and opportunities businesses need to develop business cases that scale with respect to consumer as well as business impact. They also must not be exclusively focused on a long-term potential but have short-term and mid-term return-of-investment prospects that provide low-risk assessment opportunities along the way.

In general, one has to consider that health insurers deal with large audiences – millions of people – that need to be helped. In providing solutions, resources and investments need to be prioritized based on members impacted (for member retention), cost avoided or saved, and brand impact (to attract more members and increase the standing in the public eye). The arguments required to inform these prioritizations require solid scientific evidence as well as broad applicability.

1. **Bigger is indeed better!**

   More often than not, the scientific community is focusing on very small groups of subjects and their specific needs, on rare diseases, or on scientific tasks that can only be accomplished with a unique infrastructure. While this approach warrants tenure eligibility, it does not provide broad impact and is not attractive to businesses in healthcare, since it provides only a high-risk, low-opportunity business proposition. In choosing and conducting research experiments, an additional focus should be put on studies that – while small and focused in nature – lend themselves to generalization to wider audiences beyond the test subjects. Interestingly enough, often this broad impact is postulated in justifying the particular research endeavor in the first place. However, in only few instances – once a particular research funding has been received – are research findings then tied back to the broader impact initially claimed.

2. **Connecting the dots, part I**

   One challenge that industry has is screening the vast amount of isolated research in different research communities in order to construct a business argument for innovative solutions. Lack of internal research resources often limit research to be focused on market opportunities rather than applicability of accepted scientific research. It is here, where the scientific community, which nowadays conducts many research projects in a multidisciplinary context, can help. Tying isolated research findings together to create a broad-impact argument would be sufficient for industry to then determine the corresponding market opportunity. For instance, combining studies on muscle-mass increase in seniors through dance games, studies on slowing down cognitive decline through physical activity, and studies on reducing incidents of falling in seniors by increasing muscle mass, might well provide a compelling case to the healthcare industry if tied together to the argument that dance games for seniors in general increase muscle mass and thus reduce incidents of falling, while slowing down mental decline.
3. **Why build when you can buy?**

Far too often is much of Serious Games research effort spent on creating the game itself. This approach ignores several facts painfully apparent to industry: a) It takes a lot of experience and resources to create good games which creates an in itself expensive proposition. b) The likelihood that a game conceived by research can compete with the entertainment market is very small. c) The generally very short shelf-life of successful games titles does not justify large investments in applications aimed at long-term behavioral change. d) Consumers are first and foremost looking for the entertainment value of a game and then appreciate additional values. These facts favor a different approach to conducting Serious Games research focused on short- to mid-term impact, which admittedly is restricted by game companies’ proprietary software and hardware platforms: Whenever possible research should be built around existing successful games titles, peripherals, engines and audiences. Since those have existing well understood business models attached to them, understanding and promoting healthcare applications of games as additional sales channels for the entertainment industry rather than a new product line for healthcare providers – with much smaller target audiences – provides a more reasonable business proposition.

4. **Scalability through personalization**

Healthcare audiences are significantly more fragmented than entertainment audiences. While entertainment preferences vary mainly by age and gender, healthcare providers have to additionally consider the variety of different healthcare needs a person might have, the stage of a particular disease for disease management interventions, the socio-economic context for preventative propositions as well as many other factors. It is unrealistic to assume that reasonable business cases can be developed for applying games technology to any particular one of the resulting fragments. Consequently, the approach has to be to using common platforms that are customizable to a variety of healthcare needs and audiences, using different levels of difficulty, varying peripherals, and different rewards systems as a starting point. For instance, using a dance-mat game for preventative exergaming of the general population, adding, however, safety peripherals for social, cognitive and physical stimulation of mobile seniors, a higher contrast interface and senior-appropriate song choice, and adding for inclusion of wheel-chair bound audiences a hand-tapping peripheral, immediately scales up the opportunity space of the core health game proposition by several orders of magnitude.

5. **Connecting the dots, part II**

As the previous recommendations indicate, there is a significant recognized need for multi-disciplinary research collaboration towards studying and developing effective games applications to health and wellness. The same need, however, applies to the rest of the innovation value chain from science and research to product development and delivery. Unfortunately, on the industry side, such collaborations are not common. Instead, vendor and customer relationships dictate the cross-industry interaction which is usually based on mature products and services and related well-understood and proven business models. As experience has shown, it is extremely hard to identify the admittedly existing pockets of innovative thinking and corresponding risk-taking research champions that would add perspective, credibility, and viability in identifying research opportunities. Even if such potential partnerships are being identified by coincidence, more often than not, a true collaboration is hampered by industry regulations tailored to vendor management or dictated by competitive thinking such as intellectual property protection, non-
disclosure, and risk-averse master-services agreements. Science and research have the opportunity not only to identify the relevant industries for any particular Serious Games proposition and connect the corresponding thought leaders towards collaborative, mutually beneficial R&D undertakings, but also to provide the neutral ground for such collaborations to take place along the value chain. This would, however, require some additional understanding of and familiarization with this value chain in the first place.

Scientific and Research Considerations

Towards developing games into increasingly persuasive technologies that can be the catalyst for behavioral change, a variety of demands towards scientific research can be articulated, which seem crucial in order to advance the science in support of increasing health and wellness market momentum and discovering corresponding new application areas. The following list is certainly not exclusive and advancement in science and research in many other areas will be necessary to reach for the vision of life-accompanying Serious Game play for the benefit of individuals and their societal and environmental context.

Computer Graphics & Computer Vision

In order to provide truly compelling experiences, the need for increased realism and authenticity at reasonable cost requires new approaches that are able to rapidly capture and display existing environments and artifacts and integrate them with the game play. The field of Computational Photography (e.g., Tumblin and Raskar 2006) has recently matured to a discipline that promises to provide inclusive photorealistic experiences from real-world imagery, while Google’s Streetview has already begun to provide a glimpse at its commercial potential. At the same time camera technology has progressed to a point that the 3D reconstruction from cameras will soon become a commodity. Sony’s eyeToy and Microsoft’s Natal were just the beginning of exploring 3D camera recognition for interaction purposes but it can be expected that this progress will continue towards other areas of camera recognition applications. However, much research is needed on how such technology can be employed in mobile and outdoor environments, and can drive or integrate with games that run even on mobile and low-cost gaming devices.

Human-Computer Interaction

Toward providing interactive experiences as well as new capabilities to the end-users, an increased focus has to be put on the human-computer interaction aspects of Serious Games. Today’s market penetration of commodity gaming platforms which exhibit much higher graphics and processing performance than their expensive special purpose predecessors makes scientific research in multimodal input and multisensory feedback again an academically worthy endeavor with significant commercialization potential. Controller-free input such as demonstrated by Sony’s eyeToy, Microsoft’s Natal, gesture recognition such as underlying the Wii input technology, and face and voice recognition such as also promised in Natal need to be combined with outcomes of the research fields of Affective Computing and Intelligent Interaction (e.g., Paiva et al. 2007) capturing emotions, attitudes and unconscious behaviors by means of computer vision as well as different biometric and physiological sensors.

Similarly, multisensory feedback is needed for the player to receive realistic system response that corresponds with the game application as well as the underlying game purpose of a Serious Game in order to have the potential to invoke success in skills
augmentation or behavioral change. While aural feedback has reached especially through the introduction of spatial audio an acceptable level of maturity, other senses have continued to suffer from neglect. Tactile feedback so far is only available as rudimentary vibration of game controllers, haptic devices are only available for industrial or highly specialized applications (e.g., Bayonat et al. 2006), olfactory displays are still very much limited to academic Virtual Reality applications (e.g., Yanagida 2004), and so are other types of sensory renderings such as heat, wind, and humidity. Revisiting the research in those technologies in the context of Serious Games applications as well as developing a methodology on how to synchronize the various modalities appropriately in the context of game play and interaction seems to be an equally necessary and exciting challenge; not to mention the challenge of taking those modalities then to the low-cost and mobile applications space.

Modeling, Simulation, and Artificial Intelligence
In order to have an impact, Serious Games must be more concerned than traditional games with creating an accurate model of the player. For healthcare applications focused on behavioral change and motivation, such model is crucial. This is in order to better tailor the game experience to the player’s needs and preferences, including potential NPCs to accurately communicate with and hopefully persuade the player. Such player-adaptive experiences require a level of artificial intelligence to appropriately respond, anticipate and direct the human user’s actions that is not yet available in current systems. If, however, an additional goal of modeling the players is to reflect themselves in the game (such as in first-person genres and RPG’s) then we additionally need much more accurate simulations of human’s in the game. This statement does not only refer to the visual appearance, physical behavior or physiological composition of humans as being the focus of much computer graphics and medical simulations research these days. It moreover includes the aspect of personalities, social behaviors, emotions, attitudes and complex interactions of body, mind and spirit (cf. e.g., van Lent and Swartout 2007) which – in nature – have in return an influence on the visual and physiological representations of individuals. Only if such complex models of overall human existence can be established, can we target effectively the aforementioned societal problems through Serious Games such as health including obesity and depression.

Evaluation & Assessment
The increased demand for measurable impact in Serious Games in combination with an infinite number of applications and associated individualized goals and purposes make traditional effectiveness studies highly impractical beyond pioneering proofs of concept. In addition, the increasing ubiquity of game play makes it highly impracticable to conduct field studies for all possible game play contexts. Possibly the integration of emerging small, inexpensive and even disposable biometric sensors could provide the means for remote monitoring in context as well as in-situ adaptation of game play to player performance and behavior. In addition, advanced sensor technology to capture the corresponding context and circumstances as well as the networking and communication infrastructures to support such adaptive ubiquitous Serious Game play provide further challenges for science and engineering worth addressing.

Conclusions
The emergence of social gaming and the corresponding increasing number of casual gamers entering the market for gaming purposes beyond mere entertainment is
providing new opportunities to Serious Game development. By addressing global and societal relevant problems like education, health, employment and politics, the field of Serious Games will not only be able to overcome its cost and market size challenges but provide attractive market potential for the traditional game industry which is at the mercy of fluctuations in the economic wellbeing of its player constituents. Health and wellness seems to be a promising and underexplored application field. Understanding the value systems of the involved producing as well as delivering industries – from game development to healthcare providers, healthcare payors and disease management organizations, is crucial towards feasible as well as viable solutions. Along the way are a variety of scientific and research challenges that need to be addressed, yet by themselves can already contribute to solving those societal problems through economic and educational stimulation. One prerequisite is, however, a new type of transdisciplinary partnership between academic disciplines and application industries leading to a whole new intellectual and practitioner workforce as well as market-stimulating products and services in Serious Games.

References


