State-of-the-art in Business Games

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Abstract

The use of digital games and gamification has demonstrated potential to improve many aspects of how businesses provide training to staff, and communicate with consumers. However, there is still a need for better understanding of how the adoption of games and gasification would influence the process of decision-making in organisations across different industry. This article provides a structured review of existing literature on the use of games in the business environment, and seeks to consolidate findings to address research questions regarding their perception, proven efficacy, and identifies key areas for future work. The findings highlight that serious games can have positive and effective impacts in multiple areas of a business, including training, decision-support, and consumer outreach. They also emphasise the challenges and pitfalls of applying serious games and gamification principles within a business context, and discuss the implications of development and evaluation methodologies on the success of a game-based solution.

Keywords: *Serious Games, Game Based Learning, Business Games;*

1. Introduction

Modern businesses are frequently faced with challenges such as rapidly evolving marketplaces, shifting labour markets, and the need to reach consumers who are increasingly engaging with a wide range of digital media. Addressing these challenges requires a wide range of skills from both senior and front-line staff, in-turn requiring innovative and effective training tools such as serious games, gamification applications to aid staff at all levels of an organisation as they adapt in response to emerging challenges. Hence it is important to analyse the benefits and pitfalls of these technologies in order to demonstrate the impact that such technologies can have in an organization.

Underlying this review is an identified need to communicate the benefits of the use of serious games to address a wide range of perceptions of games and gaming across sectors, organisations, and individuals. Whilst academic evidence demonstrates the benefits of the use of games to address problems across a wide range of contexts, developers of serious games often face a challenge in presenting a compelling business case for their use, particularly as game elements may superficially appear unrelated to targeted objectives. This perception is rapidly changing, in part due to the success of a wide range of games deployed in business contexts, and also due to the emergence of development tools and game engines which increasingly allow immersive, engaging, and visual content to be created with significantly lower production costs.

Business games create opportunities for various organizational needs, such as: accelerating learning [1], driving workforce productivity [2], communicating with customers [3, 4] and collaborating with business partners [5].These gamescan accelerate learning by creating 'flow' conditions [6], and thus increasing the engagement and the immersion of the participant [7, 8].The key attributes of such games involve rules of motivation, known as Self-Determination Theory (SDT). SDT focuses on

three interrelated categories: mastery, relatedness and autonomy, which address the need to allow innate growth and wellbeing tendencies to flourish [3, 9].

Mastery concept in business games refers to the degree of actual interaction between the player and in the game [8]. The mastery of control over tasks allows optimal performance, where people are gravitating to tasks, time often passes quickly and self-consciousness dissolves [10]. People can develop skills through performing optimally challenging tasks [7].

Relatedness concept in business games refers to social connection and desire to interact with other people. It can also manifest itself as a desire for a higher purpose [3]. Business can create cohesion and mutual respect through sparking meaningful social interaction between members in the context of the competition. Relatedness creates opportunities for the company to remove negative elements such as anxiety and fatigue from traditional forms of work. Instead, it creates a fun, engaging and interactive experiences that allow people to focus more on internalizing knowledge and work productively [3].

Autonomy concept in business games refers to the innate need to feel in command of one's life and to be doing that which is meaningful [3]. Freedom to select what to do and how to perform aligns engagement with personal goals and offers an opportunity for interesting and stimulating work [7]. Business games create autonomy by design tasks that are optimally challenging and rewarding.

Business games bridge simulation with entertainment, and can be customized in for different learning styles. Managers can take pieces of the business game elements and embed them in their processes to suit their goals. Werbach and Hunter [3] suggest managers can and should tweak game elements to align their experiences with the firm's objectives.

On the flip side, business games developers face many challenges. Managers can be distracted by glossy promises of business games and miss deep challenges in game designs that can create value to the organization [11]. Promoting business games needs support from top executives and effective top-down communication process [2]. The name of the word 'game' may be biased in the corporate world. Managers may perceive games as frivolous activities [3]. Designing business games that are both fun and educational can be difficult. People are attracted to games for entertainment purposes, which require business games to be both educational and fun. Design of business games requires a combination of experience, the artist's touch, and the time and financial support to make progress [12].

Using a methodology outlined in Section 2, this article reviews the evidence base regarding the benefits of serious games when applied in business settings. Section 3 reports on the findings of the review, categorising the results to clearly define the concept of a serious game in a business context (Section 3.1), reflects on evidence regarding their benefits and drawbacks (Sections 3.2), and puts forward methods for their design and evaluation (Sections 3.3). In concluding (Section 4), the overall findings of the review are considered with respect to their implications for businesses seeking to take advantage of serious games and gamification principles.

2. Research Programme

This Section outlines the approach taken to consolidate the available literature on the use of games in business contexts. In itself, this is a broad area, and therefore Section 2.1 refines the scope of the review, presenting the key research questions used to underpin the review. The search strategy detailed in Sections 2.2-3 was then applied to identify papers relevant to these key research questions.

2.1. Aim, scope and research questions

The aim of the research presented in this paper has been to identify, interpret and summarise the literature currently available on serious games, relating it to the needs of decision-makers and identifying how best to support them in evaluating whether a game or gamification-based approach is relevant to a specific challenge. In scoping this study, the focus has been on articles that are central and relevant to serious games within manufacturing and business contexts.

In terms of research questions, we approached this study by posing the following questions:

- What are the leading examples of serious games for business context (refer to Section 3.1)?
- What are the benefits, limitation, inhibitors and enablers of serious games (refer to Section 3.2/3.3)

- What design methodologies can be applied in order to develop a successful serious game (refer Section 3.4)?

The purpose of these questions was to guide the search, with the authors being mindful that existing literature may be insufficient to allow these to lead to conclusive findings; however, identifying the shortfalls in the current evidence base allows for some important areas for future work to be identified in Section 4, addressing question (3).

2.2. Search strategy

The search strategy was developed by first identifying the relevant data sources, time frame and key words. Initially a very broad selection of databases were identified, to cover a diverse range of publication formats including journal articles, conference proceedings, theses, books, and articles from trade journals. These databases included IEEE Explore, ACM, and Inspec, Science Direct database along with the more traditional library cataloguing systems providing access to a variety of journals/conferences. The search strategy initially identified key words that could be associated with Gamification. Examples of these include: serious games, gamification, business games, and game based learning. Initially this study focused on literature published between 2001 and 2013, with their citations being cross-checked to ensure any earlier publications were also captured. The principal research databases were then searched using a range of combinations of these key words. The lists of hits for each search string were firstly edited to remove any duplicate records that appeared, the titles were checked to ensure relevance to the review, and then the abstracts of all other articles and papers were reviewed before selecting publications for a full review. For completeness, an Internet search was also conducted using a similar process to that used with the library databases. The results of of these searches were combined to provide results as outlined in the following section.

2.3. Results and analysis

Initially the search terms identified some 200 articles, reports and theses. These were then carefully filtered to establish 60 documents that were directly relevant to our research enquiry.
The analysis itself was aided by applying mind-mapping techniques to capture and cluster the main themes and contributions. These were then presented at an industrial seminar, which helped the researchers to test the clarity and completeness of their findings. These are now discussed in detail.

3. Generation of key findings

The first research question, "What are the leading examples of serious games ", is primarily addressed in Section 3.1, in which several definitions of serious games are put forwards. Subsequent sections then tackle the question of "(What are the benefits, limitation, inhibitors and enablers of serious games" and "What design methodologies can be applied in order to develop a successful serious game?". Identifying the gaps and shortfalls in this evidence base then allows for consideration of key areas for future work in Section 4.

3.1. Applications and penetration of serious games to business decisions

Before considering how games are perceived, it is essential to clarify their definition in the context of this article. "Serious Games" represent a dramatic convergence of games and e-learning technologies in order to provide a rich, immersive virtual learning environments. By combining sophisticated theories of education with cutting-edge technology, serious games have tackled a wide range of challenges ranging from corporate training and education through to emergency medical response. The broadest definition of a serious game, therefore, is perhaps best defined as a game played for a purpose other than entertainment. Zyda [13] provides a broad-stroke definition of a serious game as "a mental contest, played with a computer in accordance with specific rules that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives'. Serious Games are games designed with the purpose not just to entertain, but to also solve a problem. Bogost [14] in his book "Serious Games" defines them as

games that "have an explicit and carefully through-out educational purpose and are not interned to be played primarily for amusement". In comparison to Gamification, that uses some design elements from games, Serious Games involve any application of the wider ecology of games [15].. For purposes of simplicity in this article, the term Gamification will be used to describe both Gamification and Serious Games.

Today the use of game elements, design and mechanics is incorporated in many aspects of our lives such as education, work, entertainment, communication and exercise. Many researchers have studied the benefits of participating in games in peoples' lives. For example, Jane McGonical [16] mentions numerous aspects that can be promoted through games. Some examples are: motivation, competitiveness, collaboration, creativity, enjoyment, engagement, satisfaction and innovation. Many researchers (i.e. [17-20]) support her claims and provide evidence that games have the capability of satisfying a range of needs found in [21] hierarchy of needs (e.g., creativity, problem solving, morality, spontaneity, self-esteem, confidence, achievement, respect of others, respect by others, friendship, family).

Whilst these definitions provide some insight into how serious games are perceived across sectors, agreeing a definition is only a first step towards understanding the general perception of serious games. This can vary substantially between individuals and organizations: whilst evidence detailed in this article shows games can be a useful productivity tool, it is equally true that some employers have concerns regarding the intrusion of entertainment games into the workplace through both desktop PCs and mobile devices, distracting employees and reducing productivity. Serious games, however, have the potential to satisfy both stakeholders: the employer sees productivity gains through employees who are highly engaged with interactive and entertaining tools or training media, and the employees themselves gain both the pedagogical benefits of more interactive training, and the motivational benefits of engaging gameplay - making work "fun" need not mean sacrificing productivity; in fact, it can enhance it.

Hence, after realising the benefits that can be achieved through the adoption of games and gamification techniques, studying the impact of games in the workplace gained increasing attention from the research community. Reeves and Read [22] claim that games can enhance the overall productivity of employees by boosting collaboration, engagement, creativity, analytical thinking, quick decision making and many other success factors. Researchers [19, 23] have also provided guidelines and developed frameworks for successful and meaningful gamification of real life activities. Numerous businesses have employed gamification as a means to achieve their goals, whether these are enhancing the user experience [24], boosting motivation [25] or promoting engagement [26].

As with any emerging medium, serious games initially represented a high-cost solution, requiring both investments in high-quality artwork, as well significant low-level programming expertise to translate a game design to a finished product. However, as a recent review of game engines for serious purposes demonstrated [27], the creation of tools and environments to support game development have increasingly allowed these costs to be reduced, as has an expanding market for pre-developed game content such as 3D objects, images, and functions. The technological advancements of the last two decades have not only allowed for the creation of sophisticated virtual worlds, but also substantially reduced the costs incurred by their development and deployment. As Internet access became prevalent amongst households in the developed world, it granted access to these virtual worlds to more than two billion visitors. Ryan, Rugby and Przybylski [28] characterise these virtual worlds as immersive, engaging and with increased complexity, and believe that they can be the enablers of numerous social behaviors, activities and goals. Bogost [29] believes that the interactive video games can set the stage for meaningful expression and persuasion, and are often considered an engaging and immersive solution.

Effectiveness studies which focus on measuring the impact of serious games on metrics such as engagement, motivation, and reflection – rather than comparing them to existing teaching methods - are particularly relevant, such as the evaluation of Triage Trainer conducted by de Freitas and Jarvis [30]. This evaluation presented a increasing in learning transfer when comparing serious games with a tabletop game as part of learning. Studies such of that of Mansoor and El-Said [31] have shown that serious games are capable of offering a level of social interaction similar to face-to-face contact, but without the physical restrictions and costs normally imposed by real-world reconstructions of training scenarios.

Rather than promoting serious games as a replacement or alternative to traditional learning methods, it is far more accurate and beneficial to stress their potential as a powerful complement to existing learning approaches. This is evident as the principal approach in references throughout this section: seldom is a game intended to fully replace an existing training programme. However, it is equally

true (for example in the case of Triage Trainer), that the use of a serious game can replace elements of existing courses effectively, being blended into other materials. Hence, whilst return on investment (ROI) might be seen from the greater impact of a training intervention with game-based components, rather than its reduced costs, a developed game can offer cost-reduction benefits due to the ease with which it can be distributed, and its capacity for replacing costly simulative or trainer-led components of a course. Serious games allow learning practitioners to offer previously difficult to deliver levels of interactivity, dynamism, and feedback to large groups of learners. By successfully addressing the challenge of creating games that are simultaneously compelling and educational, serious games developers are capable of motivating and challenging learners as they explore situations that are impractical or impossible to replicate using existing teaching methods.

How, then, to best communicate these benefits to decision-makers across the business sector? Whilst academic evidence is one part of this puzzle, academic publication alone seldom fulfils all requirements: risk can be difficult to assess, and many evaluations show success in a context-limited sense, with difficulty identifying the underlying drivers and themes which can guarantee success or failure for an individual project. As with any innovative solution, demonstration of value and appraisal of success hinges on the ability to prove ROI, which in turn incurs a need for research or clear metrics for impact, which may be difficult to ascertain when looking at long-term impact on behavior.

Because of their ability to motivate, engage and influence behaviors, serious games are being used in the corporate sector for training, recruitment and marketing and sales , via targeting planning, problem solving and hypothesis verification. However in order to improve the uptake and the evaluation of serious game, it is necessary for the designers to support higher order thinking (i.e strategic thinking, analysis and interpretation of events, preparation of research questions) and creativity simulation. This can be achieved through the advances in Artificial Intelligence (AI), in particular concerning the simulation of (single) human behavior are needed, in order to allow creation of living worlds, populated with realistic or at least credible non-player characters (NPCs) (these NPCs are especially necessary for complex environments, in particular related to human sciences and the impact of technologies- refer to section 3.4) [78].

 In the next paragraphs the authors are going to present games that were funded by large commercial organizations for corporate training.

Large organizations such as IBM, Cisco and Deloitte are investing resources in using games to train their workforces in areas ranging from compliance training to leadership trainings. These organizations recognize due to the exposure of their workforce to new ICT technologies, new employers are not motivated by the traditional forms of training, resulting into poor trained workforce. Organizations are finding that the application of a game-based learning approach to corporate training is helping them increase employee engagement and drive performance over and above that previously delivered by traditional training approaches.

Serious games provide employees with a compelling context-relevant storyline, achievable goals, constant feedback on their progress and rewards such as achievement badges and public recognition. They also provide employees with opportunities to fail learn from their mistakes and try again in safe environments. Typical examples games used for corporate training are:

IBM's CityOne [32] is a Serious Game for Environment Protection. It is a free to play game which also follows the city simulation model. It aims to help players discover how to make cities and industries smarter by solving real-world business, environmental, and logistical problems. For example there is a business scenario in which a city is running dangerously low on its water supply due to excessive leakage. The game contains various missions/quests which are closely related with energy, water banking and retail industries. As a marketing tool, the game enables companies like IBM to market its products and services in a way that engages existing customers and potential customers more deeply, making the company's value proposition clearer and more compelling.

Figure 1: IBM CityOne

Siemens uses Plantville [33], a serious game, as an online marketing tool to showcase its products and services. It also uses the game as online recruitment tool and as part of employee training. Plantville gives players the opportunity and challenge of running a virtual factory, complete with evaluation of key performance indicators, allocation of scarce capital funds, and the ability to improve process efficiency with the purchase and installation of Siemens equipment. Factory managers in Plantville are required to hire and deploy workers, balance worker safety and satisfaction against production delivery schedules and continuously adapt strategies to changing external conditions.

Figure 2: Siemens SG using a modified version of Plantville

This exploration of the Serious Games leads us to summarise:

Finding 1: Serious games are being used for training, recruitment and marketing in many areas such as healthcare, manufacturing and the public sector. Serious games provide opportunity for learning and training, allowing the employees of the company to be rewarded and challenged.

3.2. Enablers and inhibitors of serious games

Whilst the previous section clearly demonstrates the benefits of effective serious games, several key enabling and inhibiting factors have also been shown to affect their uptake. A foremost inhibitor, given the relative infancy of the field when compared to other training media, is a paucity of empirical research relatable to specific business challenges. This in turn can make it challenging to construct a clear business case for a serious game, when compared to a more formal training approach which can build upon a larger corpus of research.

However, as a recent business training review suggested, when seeking to address such goals as behavioral or cultural change within an organization, distributing resources across multiple interventions is likely to yield more success than a single intervention approach [34]. In such a context, a game-based learning approach holds clear potential as an innovative approach to tackling

a problem, able to communicate concepts in novel ways whilst holding a unique form of appeal for target audiences. As games have frequently been show to work effectively as part of blended learning approaches [35], their potential for integration alongside other forms of learning material has enabled their use as a supplement and enhancement [36] , rather than replacement, for existing training programmes. The ability to support and scaffold game-based learning with external materials also enables more flexible game designs, which can focus on delivery of the content and concepts best suited to game-based learning, rather than attempting to convert an entire training programme to a game-based form. This allows games to focus on higher levels of Bloom's taxonomy [37] , allowing players to apply knowledge and experientially learn, rather than attempt to communicate factual information in isolation.

Traditionally, game-development has been associated with high costs, relative to a more formal method of instruction. Consequently, a previous enabler has been the organizational size: many implementations to-date have been by larger corporations such as IBM [32], with SMEs restricted from adoption by the high cost-per-capita of game-based learning solutions. Emergent game-development environments are increasingly challenging this presumption, allowing game developers to rapidly and efficiently build serious games [27]. Hence whilst cost could be seen as an inhibitor, the emergence of technologies to streamline the development of games and rapidly create structured, immersive game based content has proven a strong enabler. In particular, as game "engines" handle low-level tasks such as 2- or 3-D rendering, asset management, and common game behaviors and design paradigms, the role of the developer has transitioned from that of a low-level technical developer to high-level concept designer and implementer.

Existing cultures and perspectives on gameplay are a final consideration as both enabling and inhibiting factors. Whilst a recent ISFE report showed over half of European respondents to consider themselves "gamers", the stereotype of the gamer as a young male persists in some sectors [38]. Whilst a wide range of both serious and entertainment games successfully targeting other groups have challenged this assumption, the acceptance of individuals at all levels of an organization's hierarchy of the benefits and potential of game based learning is a key enabling factor. A study of the serious game "Ward off Infection", for example, showed that for hospital wards where senior management struggled to perceive the benefit of the game, this was transferred to front-line staff who subsequently failed to engage [39]. Buy-in at all levels of an organization can be difficult to foster, particularly if senior management are not well-represented in stakeholder groups during the design phase of a game. However, a positive attitude at all levels of an organization has strong benefits in supporting the uptake of any new technology through the generation of perceived usefulness [40], including serious games.

Finding 2: Serious games benefit business decision making by engaging and motivating their workforce, improving training outcomes and influence the behavior of their existing and new potential customers, however the effectiveness of the serious games could be influenced by a number of risk factors such as the rate of change of ICT Technologies and the ongoing efforts in order to support the infrastructure, losing the balance between pedagogy and gaming, the change in nature of gamers.

Finding 3: The growth in serious games is being enabled by the is a paucity of empirical research relatable to specific business challenges, the growth of the gaming industry, the new generation of games , and by contrast is being inhibited by existing cultures and perspectives on gameplay, unwillingness by the senior manager to adopt the gaming culture.

3.3.   *Design processes supporting the development of serious*

In this section, we review frameworks and methodologies for the development of serious games, and consider how this relates to a business environment. On a technical level, a digital game is not dissimilar to any other large software development project, and therefore recognized models such as Boehm's spiral [41] are readily applicable. One perspective describes a serious game as an iterative, user-centric agile development project [42]; iteration is expressed as central in a range of methodologies for serious game development [43, 44]. However, in its loosest form, iteration can be suggested as a solution to a wide range of issues; the problem is translating the iterative cycle into one sufficiently pragmatic for game development within resource constraints. In doing so a range of unanswered questions emerge: if investing resources into multiple iterations results in a lower-

fidelity game, does it remain the optimum route in the face of research suggesting such fidelity is so valuable [27]? If we do iterate, how do we ensure each prototype is sufficiently well researched to ensure valuable feedback into the next cycle? Here games again present some unique considerations in terms of both the challenges and potential they afford when used as research instruments [45].

Also noted in literature is the need for development effort to be genuinely collaborative in nature [46, 47], a consequence of the need to balance carefully the needs of engagement with the needs of instructional design [48]. The various stakeholders in a serious game development project are seldom co-located, a major factor in effective collaborative design [47]. Furthermore, the various perspectives of these stakeholders must be considered through objective research rather than subjective input, else a game can risk duplicating existing problems [49]. Similarly, a risk may exist of games being designed to meet stakeholder expectations, taking a simulative route due to the ease in aligning the look-and-feel of the game with that of more conventional educational material. Simulation is partly paradigmatically opposed to gaming: simulations strive for reality, whereas games will readily sacrifice it if it becomes a barrier to user experience. Evidence comparing high-fidelity simulations to lower-fidelity games has demonstrated results in favor of the more engaging experience. Social games present a particular challenge from this perspective, as the game may function more as a tool for populating and sustaining a social network, rather than an instructional medium. As such, an entertainment game could serve as an effective "serious" tool, with its key defining characteristic being its owner, rather than its content.

Reports from pragmatic development contexts reinforce these concerns [50]. In addition to over-prescription of iteration and reluctance to embrace fully a game-based medium, Werneck and Cheng report other issues to include negotiation within the project, level of scrutiny imposed to more novel approaches, revisioning and postponement, and misinformation on resources. These alone each represent significant barrier in attempting to enact a collaborative development project, even more so when cast in the light of negative perceptions of gaming still noted in some sections of the organizational hierarchy by this study. It is important to consider this study in terms of the single case it reports on, but other studies have similarly reported difficulties in serious game development to arise from the complex multi-organizational structure at the core of many projects [51], as well as the constraints of technology, domain knowledge, user research, and game design. This is reiterated from an alternative perspective in the four-dimensional framework [52], which posits learners, their context, the representational medium, and pedagogic method to be key, though offers little guidance beyond highlighting these initial considerations due to the lack of an evidence base on which to construct such guidelines.

Pervasive and mobile computing offers some potential to move beyond these confines and create new models and mediums for learning transfer. Physical activity is an obvious area for this application which has been explored through a number of systems with positive outcomes [53]. Sensor networks and virtual worlds have also been explored towards more general learning objectives with promising early findings [54]. Frameworks in support of the development and deployment of games in pervasive and mobile contexts are emerging, and though again lacking in conclusive demonstrations of efficacy, provide some relevant considerations. In an attempt to prescribe a framework for persuasive gaming, Oja and Riekki focus primarily on the case of ubiquitous games, noting the importance of access to data and considering both bespoke games and gamification [55]. Omitted, however, are the underlying ethical questions raised when seeking to adjust behavior, and particularly how this access to data can be achieved consensually without compromising the efficacy of the intervention: if we inform users of the purpose of the activity to inform consent, we might similarly compromise its efficacy as a means of "stealthy" learning transfer [56].

Finding 4: Effective serious game development requires involvement from stakeholders throughout the development process. Therefore, care should be taken to support stakeholder involvement regardless of development context, supporting where possible co-location and open channels of communication between all parties.

3.4. *Technologies supporting the development of Serious Games*

The technical state-of-the-art in serious games mirrors that of leisure games [57], however the technical requirements of serious games are frequently more diverse and wide ranging than their entertainment counterparts. Serious game developers frequently resort to bespoke and proprietary development due to their unique requirements, such as [58] and [59], and difficulties exist for game

engine developers in accurately understanding and supporting the needs of instructional design. The popularity of video games, especially among younger demographics, results in them frequently being perceived as an ideal medium for instructional programmes aimed at hard-to-reach audiences [37]. However, preliminary studies have also shown this demographic responds poorly to low-fidelity games [60], and as a result there has been a trend towards the development of more complex serious games that are informed by both pedagogic and game-play elements.

Although many serious games have limited visual interactivity, immersion and fidelity, there is an increasing motivation to create serious games that intend to support situative (social and peer-driven) and experiential pedagogies; partially because behaviourist approaches have been shown to be limited (e.g. people learn to play the game, not address learning requirements), whilst cognitive approaches struggle to impart deeper learning in the areas of affect and motivation [61]. Furthermore, recent work by Mautone [62] demonstrated enhanced learning when introducing game elements to a standard flight simulator. Consequently, re-evaluation of simulator approaches to incorporate game and game-like elements places an increasing demand for serious game developers to deliver high-fidelity solutions. Given this motivation to create immersive, high fidelity serious games, an obvious development choice is to utilise game engines, which provide 'out of the box' support for state-of-the-art desktop GPU rendering and physics.

One of the most important elements of the creation of serious games is the visual representation of these environments [63]. Although serious games have design goals that are different from those of pure entertainment video games, they can still make use of the wide variety of graphical features and effects that have been developed in recent years [64].

The creation of a serious game is a complex engineering project that requires skill and dedication. The development of a serious game engine is a complicated process that requires time, resources and teamwork. As serious games become more complex, so do the engineering challenges that arise during development of the game. Hence the selection of an ideal engine for this development is crucial. In order to simplify the game engine selection Petridis et.al have designed a framework which allows the developers of the serious game to select the most appropriate engine, based on the technical requirements and the instructional design of the serious games. Based on the framework the game engines are categorized according to their visual/audio fidelity, functionality, networking capabilities, composability and accessibility. Examples of such game engines that are currently used in r corporate training are Unity and Sealund's Just PlayIt .

Table 1: Framework for comparing engines in SG

Audiovisual Fidelity	Rendering
	Animation
	Sound
Functional Fidelity	Scripting
	Supported AI Techniques
	Physics
Composability	Import/ Export Content
	Developer Toolkits
Accessibility	Learning Curve
	Documentation and Support
	Licensing
	Cost
Networking	Client Server/ Peer–to- peer
Heterogeneity	Multiplatform Support

Finding 5: The technologies supporting the development of serious games has been advanced by the rapid evolution of technology in gaming and ICT industry in the areas of visual fidelity, artificial intelligent, haptic devices and sensors, networking, CPU advancements, etc, though future work should address the many issues surrounding the equation of the learning requirements to the technical features.

3.5. Evaluation Methodologies of Serious Games

There are a few established generic evaluation approaches which can be used to evaluate serious games, however there are dependent between the sector for which the game is designed and the nature of the evaluation design. This presents something of a dilemma when attempting to provide a comprehensive review of evaluation methods: approaches such as randomised control trials [65, 66], focus groups [67], interviews, narrative inquiries, and quantitative analyses of game engine data [68] have all been conducted. As an emerging form of training medium, a strong argument exists that serious games should be evaluated exactly as any other educational medium, and affording them specific consideration with respect to their evaluation detracts from the comparability of any results. Therefore the methodological toolkit of a serious game evaluator needs to be a broad one: often the sector dictates the most appropriate methodology, rather than the use of a serious game itself.

Serious games present an advantage in that the game engine, could be analysed in order to understand the player behavior and through relating this to real-world behavior [68] . Due to the difficulty in assessing factors such as motivation and behavior directly, emphasis has frequently been given to establishing proxy measures of efficacy, such as how realistic a simulation is through analysis of technological aspects of the human-computer interaction [69]. However, Norling notes that believability is often not a paramount concern, and that excessive focus on this criterion can be to the detriment of games' ultimate goals [70]. Thus transposing evaluation simulation methods to serious games is inadequate because the focus of the evaluation should be more focused on the educational content.

It has been shown that serious games must be able to exhibit effective learning transfer, whilst also engaging the user [71, 72]. Several studies have focused on the assessing the gameplay experience in isolation [73]. If a game cannot engage learners, then sourcing an adequate sample of experienced players with whom to assess learning outcomes becomes an impossible task [74]. We therefore go on to describe evaluation techniques with respect to these two key areas of engagement and learning transfer. Engagement has been measured in the medical area for applications such as stroke rehabilitation [24]. Burke et al.[24] identified game design principles for upper limb stroke rehabilitation and present several developed games using video-capture technology. In this case, the evaluation approach adopted a randomized control trial, which monitored usage between healthy subjects and stroke victims, showing positive early results. Heuristic approaches to evaluation also offer some potential [75]. Pinelle et al. by analysing reviews of 108 games identified 12 common classes of usability problems, which lead them to the development of a set of ten usability heuristic based on the problem categories [76].

Several frameworks have been developed such as TILT and Flashlight to evaluate the integration of technology in teaching. However these frameworks evaluate the integration of the technology in teaching rather than learning.

 Such a perspective can be difficult to apply for serious games, particularly those distributed online or in an e-learning context where the presence of the tutor cannot be relied upon. Few frameworks specifically delineate methods for game-based learning, understandable, since any such evaluation benefits from its ability to be compared methodologically and in terms of results to other learning solutions. Qualitative work has been used extensively to assess serious games, though it is easy to argue its selection is often grounded more in pragmatism than suitability. Certainly qualitative work can be essential in providing insight into learner response and understanding, and when conducted rigorously can form a core basis on which to build structural models for quantitative assessment. However, qualitative findings alone, particularly with a limited sample size, are often one of the central criticisms of inadequate serious game evaluations.

Finding 6: Evaluation methods need to be broadened in order to elicit deep understandings of game efficiency and their impact on learning. Although until now it is evidence that quantitative / statistical methods are often being used in evaluating a serious game, we argue that more qualitative

evaluations would be necessary in order to discern qualitative differences in conceiving and approaching a serious game.

Finding 7: We perceive that the consistent use of such methodologies will help game and learning designers as well as game researchers to understand better what players do in games and thereby becoming better at designing adaptive games and effective game frameworks that transform learning experiences.

4. Discussion

Learning through play is not a new concept. Educational computer games (i.e serious games), underpinned by pedagogical goals and the appropriate use of game mechanics have potential for learning through the intrinsic ability to engage, motivate and could influence the behaviors of the users. Games through storytelling, quests, rewards and competitions can create an environment in which learning could take place. Large organization such as IBM, Microsoft, Dell, Cisco,etc are using serious games to train their workforce from compliance training to leadership training.

Well-designed serious games can make learning fun, challenging and rewarding. Serious games designers are faced with the challenge of designing a game which is fun, tided up with pedagogical elements[13]. The methodology, then, must safeguard against both these failure conditions: on the one hand, it must ensure the game retains the engaging characteristics that make game-based learning an optimal selection for the learning context; on the other, it must ensure that effective pedagogy is implemented in a synergistic fashion with gameplay elements. Thus the importance for a more formal design methodologies for serious games is well documented [77]. A central challenge in creating a prescriptive approach is being able to sufficiently evidence context-independency of development models, since a proven approach for one serious game may not be applicable to another, given the broad range of topic areas and learner demographics games. Existing e-learning development methodologies have met limited success when transposed to serious gaming, as they emphasise instructional content with little affordance for the unique way in which games attract and retain learners.

In order to create a successful serious game we need to ensure involvement from stakeholders throughout the development process. Therefore, care should be taken to support stakeholder involvement regardless of development context, supporting where possible co-location and open channels of communication between all parties.

Ultimately, the design and implementation of effective serious games must be grounded in pedagogy, as well as technology, and therefore future work should address the many issues surrounding the equation of learning requirements to these identified technical features. Towards this end, future studies will focus upon the analysis of the impact of the various engines and their functionalities on targeted learner groups.

Evaluation methods need to be broadened in order to elicit deep understandings of game efficiency and their impact on learning. Although until now it is evidence that quantitative / statistical methods are often being used in evaluating a serious game, we argue that more qualitative evaluations would be necessary in order to discern qualitative differences in conceiving and approaching a serious game. Playing a serious game predominantly generated a subjective experience, which is based on individual beliefs, conceptions, and actions that are being evoked in a different manner encompassing novel game plays and game mechanics. There is a need to collect, capture and analyse these conceptual artifacts in relation to the affordances of games in order to better map the efficacy of game elements to individual experiences. This may be achieved through applying methodologies that have already been used and proved their rigour in educational research such as phenomenography, grounded theory and action research among others. We perceive that the consistent use of such methodologies will help game and learning designers as well as game researchers to understand better what players do in games and thereby becoming better at designing adaptive games and effective game frameworks that transform learning experiences. In congruence with this, game frameworks that align game play/mechanics with teaching methods, learning styles, feedback and assessment processes would facilitate the process of developing and evaluating complex learning features in games that would literally add the proliferated educational value in a serious game.

5. Conclusions

This article has presented a structured review of the literature on the use of serious games in a business context. Whilst these benefits in turn have contributed to increased uptake of game-based approaches, serious game developers need to be aware of the need for solutions to provide demonstrable return on investment and solutions to business needs.

 The increasing evidence base is already challenging perceptions that work cannot be "fun", and the use of games and gamification principles has demonstrable potential to improve the efficacy of training programmes, increase productivity, and even reach out to a global community of volunteers willing to contribute their time to gamified problem-solving.

The next step will include the implementation of a framework for the creation and evaluation of serious game for business context and especially in the servitization area.

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