The devil's advocate: identifying persistent problems in serious game design

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Abstract

After a long period of steady growth, games for learning and training (serious games) have become well accepted as productive teaching tools. This article argues, however, that a number of persistent weaknesses in current serious game design practice pose a barrier to harnessing the games´ full educational potential. For serious game designers it is quite a challenge to maintain a subtle and critical balance between gaming elements and didactic elements. Quite commonly counterproductive game preferences are being used that favour player experiences above learning efficacy, thereby neglecting established knowledge from instructional design, student guidance and assessment of learning outcomes. By taking up the role of the devil's advocate, this article takes a critical look at current serious game design routines. The issues that are discussed include experiential learning, cognitive flow, motivation, scores and realism in serious games, among other things. Each topic is elaborated with reference to established educational research and is concluded and summarised with a claim. The main purpose of this article is to contribute to the overall quality of serious game design by identifying and opposing unfavourable design routines.

Keywords: *serious games, experiential learning, cognitive flow, motivation, score, performance*

1 Introduction

The first usage of computer games in education dates back to more than half a century ago. Today, such "serious games" [1] have been widely accepted as effective educational tools. Many schools and training institutes have included games in their educational programmes. Worldwide, the serious game industry has become a multi-billion dollar business showing persistently double-digit growth rates. Games are valued for their motivational power, viz. the ability of hooking and absorbing players in such a way that learning becomes fun [2]-[5]. This engaging potential is ascribed to the dynamic, responsive and visualised nature of games, which goes with penetrating learning experiences, interaction, novelty, variation and choice, altogether effecting strong user involvement [3]. In serious games, players are challenged to actively engage in problem solving, exploration, goal formation, critical analysis, strategic thinking and enhanced creativity. The rich potential of games has led to wide variety of serious applications, not limited to the domain education. Among other fields, games and gamified approaches have also been purposefully applied in the domains of health (e.g. diagnosis, treatment, wellness, obesity, sex issues, pandemics), culture (museums, cultural heritage, arts, history), training (employability, vocational and military training) and business (team building, marketing, assessment, corporate training, advertising, customer relationships, creativity) and for addressing a variety of socio-political issues (social inclusion, integration of migrants, political communication, the environment, climate change, discrimination, crisis management, scenario planning, aging, research and many other areas) [6].There is a great variety of objectives pursued, including sensitising people, raising awareness, influencing, reinforcement, behavioural change, acceptance, information transfer, and surveys. However, the scope of present study is expressly limited to games for education and training, that is, games for achieving learning objectives.

In the course of time quite some studies have demonstrated the productive effect of serious games for learning and training in a wide variety of disciplines, ranging from arithmetic, spelling and history to management, media literacy and social skills studies [7], [8]. Still, the rise of serious games has been slow, despite the contagious enthusiasm of their proponents. Since the early days in the 1970's, proponents have tirelessly pointed out the advantages, but teachers remained sceptical for various reasons. First, games were readily associated with leisure and fun, which were supposed to conflict with the guiding principles of schools, teaching and diplomas. Second, serious games have been often presented as an electronic replacement of teachers, if not as a catalyst for a disruptive change of the existing school system [9]. Third, games are inherently complex constructs requiring third parties for their development and sufficient technical staff and infrastructure for their application at schools.

Over the years, a lot of scepticism among teachers has faded, because of an increasing number of successful serious games examples that have become available. Also, technical advances have lowered the barriers for using serious games in schools, e.g. online services, browser games, mobile games, even simple tools for teachers and students to create their own games. Still, as opposed to the entertainment game industry, which is carried by multiple global players, the serious game industry displays many features of an emerging, immature branch of business: many small companies with weak interconnectedness, absence of harmonising standards, limited division of labour and insufficient evidence of the products' efficacies [6], [10]. Moreover, serious games are often considered a simple derivative of entertainment games, based on the same game design skills and game development skills [11]. However, this is only partly true, because designing games for learning rather than entertainment requires additional expertise about instructional design, student guidance and assessment of learning outcomes. Since the inclusion of this type of expertise has been scarce for a long period of time, serious game design has been dominated by game mechanics rather than didactics, that is, emphasising player experiences over learning efficacy. Various authors [6]-[9] have pointed at persistent weaknesses in serious game design, in particular the unclear didactical foundations and the lack of empirical effect studies, but a comprehensive overview of didactic pitfalls underpinned by the established outcomes of research into learning and instruction has not been available. As a consequence, a number of didactical weaknesses have crept into the practices of serious game design. In this article we identify and discuss a number of principal design weaknesses and misconceptions that can be frequently observed in serious games for learning. The overall methodology is based on the consensus about the evidence collected from research into learning and instruction over the past decades. Topics include experiential learning, cognitive flow, scores and realism in serious games, among other things. The purpose of this analysis is to contribute to the overall quality of serious game design by identifying and opposing unfavourable design routines.

2 The didactical application of games

Serious games are often promoted as the innovative alternative to traditional classroom instruction, which heavily relies on teacher-led information transfer. The motivational capacities of serious games are often applauded and promoted with the promise that games are fun, while school is boring. Therefore, most serious games are devoid of traditional instructional approaches [12]. Instead, they either use a drill and practice approach or an experiential learning approach. Table 1 summarises the key characteristics of the respective didactical approaches.

Table 1. Basic didactical approaches and their application ranges.

Approach	Based on	Goals	Use in games
Direct instruction	Information transfer	Knowing what, Understanding	Rarely
Drill and practice	Cramming	Reproduction, Automation	Often
Experiential learning	Experiencing	Knowing how, Contextual understanding	Quite often

Drill and practice is based on the behaviourist notions of repetition and reinforcement to condition learners (or animals) to routine tasks (or to teach animals simple tricks) [13]. It is a shallow, rote learning approach, which supports the successful reproduction of knowledge (e.g. learning things by heart) and the automation of basic, operational skills. Gameplay for drill and practice is characterised by mechanical repetition, which may be suited for certain content, ages or contexts. In this area, games can be particularly useful to incite learners to continue practicing boring tasks, e.g. for exercising in basic numbers, arithmetic, vocabulary, spelling, or geography. But it fails to provide deeper insights and understanding.

In contrast according to Dewey [14], experiential learning refers to deeper modes of learning by active exploration and engagement in a meaningful context. Dewey claimed that learning should be connected with some real world context in order to allow the learner to relate symbolic content (e.g. concepts and principles) to real-world referents. Serious games most dominantly rest on experiential learning approaches [2], [11], [12], [15-20]. They are pre-eminently used for providing rich, meaningful contexts (such as business simulation games) that place the player in a key role to pursue favourable outcomes. Therefore our main focus will be on games for experiential learning.

3 Misconceptions and flaws

3.1 A general promotional overshoot

Serious game proponents substantiate their case with a number of claims about the beneficial characteristics that games offer for learning. Table 2 summarises a number of claims that are frequently made [21].

Table 2. Exemplary claims about serious games.

Concept	Claim
Playfulness	Games make learning fun
Challenge	Games are exciting
Motivation	Games are motivating
Flow	Games induce cognitive flow
Meaning	Games provide a meaningful context
Activation	Games are activating (learning by doing)
Experience	Games provide penetrating learning experiences

Claims like the ones in Table 2 aren't tenable. This becomes obvious when one would replace the word "game" with some other communication tool, for instance "film", "books" or "TV". The claim that films are motivating, can be easily refuted: it all depends on the scenario, the direction, the actors, the sceneries, etcetera. And of course, the same holds for the claims about games. The problem here is that the claims confuse the general potential of games with the qualities of a specific game implementation. It is fully understandable that serious game companies extensively advocate the advantages that their products and services, as these are their bread and butter. But it is remarkable that almost any scientific study about serious games starts off with a song of praise as to motivate the relevance of the study. The unconcealed enthusiasm of these scholars is contagious, but it may readily conflict with academic standards of objectivity and critical analysis when it comes to making claims. Apparently, researchers sometimes confuse their role as an academic with their role as an advocate. Being an expert in a field is not without self-interest and it effects a degree of self-dependence, which inevitably fuels the fanatic and uncritical promotion of one's own specialism. The conclusion to be drawn here is the following one:

- Categorical claims about games for learning are not necessarily valid for game instances.

3.2 A naïve interpretation of experiential learning

The dynamic, interactive, responsive and visualised nature of games makes them very well suited for rich, meaningful learning environments that offer sufficient variation and choice to induce powerful learning experiences [3]. Game studios refer most dominantly to experiential learning as their guiding learning theory [11]. However, most game designers tend to mistake experiential learning for free exploration, that is, offering students maximum freedom of movement and minimal tutorial interference. Unfortunately, this focus on exploration is a quite naïve interpretation of the experiential learning paradigm, as it leads to trial and error, disorientation, and limited conceptualisation, which are all detrimental to effective learning [22]. In hundreds of research studies over the last 50 years, evidence for the effectiveness of such minimal guidance approaches is almost non-existent: guidance- and instruction-based approaches consistently produce superior learning outcomes [23], [24]. When students engage in a business game we cannot expect them to be able to appropriately manage a multinational industry, without sufficient guidance and instruction. One might object that this way they will experience and discover the complexities by themselves, but eventually they will end up in a thoughtless trial and error strategy, without relevant learning gains. Tragically, research shows that exactly less able students favour those minimal guidance approaches, even though their learning is highly ineffective: they like the game, but hardly learn from it [24]-[26].

Given the overwhelming evidence against minimal guidance approaches, serious games should best include instructional episodes that allow for the structural linking of game experiences with underlying concepts, rules and principles, so that a meaningful body of knowledge is acquired. Serious game designers should be prepared to put aside their aversion to traditional schoolish elements and include these in their games. The conclusion:

- Experiential learning in serious games requires the inclusion of guidance and instruction.

3.3 The drawback of cognitive flow

One of the most popular arguments to use games for learning is the ability of games to induce cognitive flow, which is a mental state characterised by extreme involvement, concentration, engrossment, restricted awareness, altered sense of time, insensitiveness to hunger and insensitiveness to fatigue [27]. Such state of intensive mental activity is considered highly favourable for deep and sustained learning. As diverse game elements are particularly suited for prolonging the learners' state of flow, games have the capacity to engage them for longer periods of time. Cognitive flow in games isn´t very different from game addiction, be it that flow is a unique, favourable version of addiction that comes close the ideal educational situation of having students that can hardly be stopped. However, there are two principal arguments that contradict the positive effects of cognitive flow on learning. First, the notion of cognitive flow, which is actually a blinkered focus on task achievement, severely conflicts with the requirements of self-evaluation, reconsideration and reflection on one's learning. Just having the learning experience is not a sufficient condition for learning, but should be complemented with a thoughtful reflection on one's own learning processes [28], [29]. Such metacognitive competences are considered essential in today's knowledge society, where people need to continually update their knowledge levels amidst an abundancy of information sources. Therefore, serious games should expressly not aim to prolong the state of cognitive flow, but instead should deliberately put the game on hold from time to time, in order to allow the students to review their actions, strategies and progress. Second, for measuring cognitive flow only post-practice self-reporting questionnaires are used [30]. The resulting indicators are extremely inaccurate and unreliable as they reflect overall posterior subjective impressions and don't record changes over time. Paradoxically, flow cannot be measured during gameplay as this would require to interrupt and pause the game time after time, which would by itself immediately break the flow. Unreservedly, we conclude:

- Cognitive flow reduces the quality of learning.

3.4 The deceptive idea of playful learning

While most people think negatively about school and studies, games are supposed to alleviate the burden by making learning more playful, suggesting that relevant knowledge and skills can be acquired almost without effort. The problem is, however, that playing a predefined serious game has very little in common with the notion of playfulness. Huizinga [31] describes play as a leisure activity, non-obligatory and fully free of any material goal or interest – no profit can be gained from it. Games, in contrast, are generally characterised by rules of play, performance, completion and scores. Serious games, in addition, are meant to pursue the external goals of mastery. According to Huizinga [31] play is anything but serious: play is easily hampered by making it purposeful or mandatory. Therefore, the association of serious games with playfulness is unjust. Although education could certainly be made less tedious, the process of studying remains inherently difficult, requiring hard work and dedication. Yet, studying can even be fun, be it the "hard fun" as noted by Papert [32]: fun doesn't mean "easy". Running a marathon can be fun, but it is hard fun rather than playfulness. People like to be challenged by difficult tasks and they are eager to see how they can stretch their abilities. This is what happens in serious games: generally it goes with hard work rather than playfulness. We conclude:

- Learning from serious games is unjustly associated with playfulness.

3.5 The one-sided orientation of games on performance

As do leisure games, most serious games focus on performance. There are rules of play that require an attitude of achieving milestones and scores under strict conditions (e.g. time constraints), swift completion of tasks, avoiding errors and reducing risks. Various authors [33], [34] have explained how such conditions contrast with optimal requirements for learning. As opposed to performing, learning effectively requires instructional episodes, spending sufficient time for in-depth understanding, and having sufficient opportunities for reflection, revision, self-evaluation, and even the preparedness to make mistakes. Being urged to performance may be attractive, challenging and exciting as such, but inevitably goes with haste, stress, panic, anxiety or lack of consolidation, which at best leads to shallow processing and superficial learning. Learning from serious games could become more effective when game designers were prepared to deviate from the straitjacket of performance and allow instructional episodes and pauses, and avoid game elements that induce stress. Having completed a serious game successfully with a high score doesn´t necessarily imply successful learning. The conclusion here reads:

- The focus on performance in serious games affects the quality of learning.

3.6 The use of inappropriate score systems

Most serious games use score systems. These score systems have both an informative purpose by displaying how well a player is progressing during the game and a motivational purpose by highlighting the player's successes. However, most serious games use simple, ad hoc score systems that do not represent established skills or competence frameworks and that are devoid of the attainments from test theory and assessment research. Hence, their validity, accuracy, neutrality and representativeness is questionable. Also, the scores tend to be performance oriented, that is, they reflect achievements and outcomes rather than the underlying learning processes. The performance orientation urges players to demonstrate high ability and to avoid errors, which prompt them to select tasks that they are good at already. In such contexts failure becomes a threat to success and thereby it undermines the player´s self-esteem, self-confidence, and motivation, which in turn may lead to negative, self-defence reactions [35], such as discounting [36], task avoidance, feigning boredom and task-irrelevant actions to bolster self-image [37], and learned helplessness [38]. Because errors and failure are productive sources of learning [35], [39], the score mechanisms should not discourage these by imposed penalties, but instead should stimulate errors and appreciate error correction. Overall, serious games should stimulate a learning attitude rather than a performance attitude by lowering the price of failure [4], by avoiding time-constraints and other stress factors, and by allowing players to spend sufficient time and effort to try and retry, to reflect on their achievements and to decide upon their own strategies. Hence, we conclude:

- Prevailing score systems in serious games hamper the learning.

3.7 Overrated motivation power

Motivation is widely considered a main determinant of effective learning [40], [41]. It is associated with the energy, intention, direction, and persistence that bring individuals into action. Games are highly valued for their motivational potential. This is generally ascribed to the dynamic, responsive and visualised nature of games and the adaptive mechanics that balance the challenges offered to the player with the players' abilities "seeking at every point to be hard enough to be just doable" [4]. A variety of theoretical models of motivation have been proposed (e.g. [40]-[42]), all including the distinction between intrinsic motivation and extrinsic motivation. Intrinsic motivation is one's personal drive and tendency to engage in an activity because of the activity itself, to seek out novelty and challenges, to extend and exercise one's capacities, to explore, and to learn [41]. Extrinsic motivation, in contrast, refers to performing an activity driven by external factors, e.g. by external pressure or pursued outcomes such as rewards, prestige, diplomas or salary [21]. Extrinsic motives are known to be often less productive than intrinsic motives: extrinsic motives are readily associated with shallow learning [43]. An overwhelming number of studies have demonstrated that intrinsic motivation as compared with extrinsic motivation leads to more interest, excitement, and confidence, which in turn contributes to enhanced learning. Unfortunately, games are dominated by triggers for extrinsic motivation. First, these triggers include the wealth of primary sensory stimuli of dynamic images and sounds, which continually captures and redirects the player's attention [3]. Second, game design heavily relies on reward mechanisms, which include the use of scores, powers, permissions, privileges, bonuses, levels, leader boards, achievements, reputation, credit points and certificates. Third, external pressure through imposed tasks, directions, surveillance or deadlines also fosters extrinsic motivation. Regardless of the players' enthusiasm, games that rely on extrinsic motivators run the risk of being reduced to skinner boxes, which are "incentive dispensers that dole out rewards for attention" [44]. These boxes support a truncated, low-level mode of learning most suited for teaching tricks to animals. Serious games should shift the focus to intrinsic motivation by focusing on the actions rather than the outcomes, by allowing for the player´s freedom of movement, self-selected goals, problem ownership, responsibility, control, and the satisfaction that goes with the mastery of the action: "I can do it". We conclude:

- Serious games rely too much on extrinsic motivation, which effects shallow learning.

3.8 The superfluous strive for realism

While high-end leisure games set the standard for realistic 3D graphics, educational games are typically "low budget, low tech". Many serious game creators strain every nerve to come close to this high level of realism, which in the end only partially comes through. However, for various reasons the strive for realism in serious games is needless, a sheer waste of money, time and effort. First, media equation theory [45] says that the human brain cannot distinguish between human communication and communication with artificial agents, e.g. comic characters. Hence, simple line drawings would do the same job as photo-realistic 3D graphics. Second, cognitive load theory urges us to reduce the amount of simultaneous stimuli because of the limited capacity of our brain´s working memory. Hence, simplified representations of objects, characters or situations leaves more room for learning [46]. Third, the willing suspension of disbelief refers to our ability to fully accept non-realistic situations as being credible. For instance, in the Pacman game players take fright when they are chased by little ghosts even when the ghosts are no more than a jagged bunch of pixels. Certainly players are aware of that, but they are ready to sustain their disbelief. Finally, when it comes to photo-realistic virtual characters, the uncanny valley effect dramatically disturbs the acceptance and communication: the uncertainty about whether or not a character is real produces anxiety and aversion. Virtual characters should be credible, but certainly not all too realistic. Our conclusion:

- The strive for photo-realistic game scenes, objects and characters in serious games is superfluous.

3.9 Inferior validation approaches

Scientific validation of novel learning tools such as games is essential. Empirical evidence is required to establish or refute their effectiveness and stay away from subjective preferences. Unfortunately, most serious game studies fail to use a thorough experimental set-up that allows to compare the effects with those of a control group [16]. Even so, most studies don't use tests to measure the learning outcomes, but simply ask students what they think. The collected subjective responses are inherently suspect, because various biases may truncate the outcomes. First, the researchers are often the originator of the game, which may induce confirmation bias: intensely hoping for a positive result. Second, participants that take part in the testing of a serious game are likely to unwittingly adopt the expectation that the game is special and positive (Hawthorne effect). Third, researchers mostly recruit their own students as test persons, which introduces additional dependencies. Fourth, the testing of innovative tools may suffer from the novelty effect: test persons pay increased attention to tools that are novel to them, which unwantedly leads to increased efforts and increased learning gains [47], [48]. Unfortunately, these gains tend to diminish after a few weeks or months, when students become familiar with the new medium. Finally, various statistical weaknesses are manifest: too few participants, erroneous data processing and misinterpretation of outcomes [49]. Even worse, the classical statistical methods that are commonly used in the social sciences are under attack, now that more reliable Bayesian sampling methods have become available [50]. The conclusion here is:

- The shallow validation approaches of serious games provide too little evidential value.

4 Conclusion

Despite its long tradition, serious gaming is still an emerging field that is largely driven by supporters and believers, which inevitably directs the focus to benefits rather than drawbacks. Generally, being an expert in a field is not without self-interest and it effects a degree of self-dependence that inevitably fuels the unreserved promotion of one's own specialism. As a result, self-correction of accepted approaches and routines is weak. In this paper we have identified and critically assessed a number of structural weaving faults that have crept into the fabric of the educational game design practice. It has been our contribution to raising awareness and stimulating the debate in order to amplify the overall quality of serious games.

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