Games are motivating, aren´t they? Disputing the arguments for digital game-based learning

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Abstract

The growing popularity of game-based learning reflects the burning desire for exploiting the involving and motivating characteristics of games for serious purposes. A wide range of arguments for using games for teaching and learning can be encountered in scientific papers, policy reports, game reviews and advertisements. With contagious enthusiasm, the proponents of game-based learning make their claims for using games to improve education. However, standing up for a good cause is easily replaced with the unconcerned promotion and spread of the word, which tends to make gaming an article of faith. This paper critically examines and re-establishes the argumentation used for game-based learning and identifies misconceptions that confuse the discussions. It reviews the following claims about game-based learning: 1) games foster motivation, 2) play is a natural mode of learning, 3) games induce cognitive flow, which is productive for learning, 4) games support learning-by-doing, 5) games allow for performance monitoring, 6) games offer freedom of movement and the associated problem ownership, 7) games support social learning, 8) games allow for safe experimentation, 9) games accommodate new generations of learners, who have grown up immersed in digital media, and 10) there are many successful games for learning. Assessing the validity of argumentation is considered essential for the credibility of game-based learning as a discipline.

Keywords*: Serious gaming, motivation, learning, cognitive flow, performance, NET generation*

1. Introduction

In recent years we have witnessed a growing interest in game-based learning. Driven by the ever-growing popularity of games for leisure and entertainment, a large number of research studies and reports on games for learning have become available. Many of these studies are motivated by the promise, if not conviction, that games can be purposeful tools for learning. Explicit reference to the "promise" or "potential" of games for learning is quite common, as to substantiate the relevance of the research. Although empirical evidence for the effectiveness of game-based learning is scarce [1], its proponents tend to present games as the panacea for solving many problems in schools and training, e.g. addressing media illiteracy [2][3], reducing student dropout [4][5], enhancing learning motivation [6][7], and the arrangement of flexible online practicals [8]. For this they refer to an abundance of arguments that explain the appropriateness of games for learning (e.g. fun, freedom of movement, role adoption, visual representations, safe experimentation). The 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. Obviously, researchers sometimes confuse their role as an academic with their role as a promotor. 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. This phenomenon is easily connected with Kuhn's theory of scientific development [9], which says that scientific research is nothing like the intellectual endeavour we know from the romantic image of the heroic, irreproachable and creative scientist aiming for absolute truth, but that it is generally dominated by social negotiation and conformism to prevailing dogmas. No game-based learning experts would ever negate their gaming mantra and state that games are useless. Just like surgeons tend to unconditionally “believe” in surgery and musicians truly “believe” in music, game-based learning experts “believe” in game-based learning and preach their application as it were a religious conviction. To outsiders, however, a lack of neutrality is suspect and may well be interpreted as a lack of credibility. Proposing games for education is likely to raise great scepticism among educators, because in their eyes games would affect common substance and thoroughness of educational culture and contaminate these with entertainment and superficiality. Whenever the sceptic teacher meets the cheering game expert, the dispute may polarise while no agreement is in sight, leaving everything unchanged. This is a regrettable situation for the gaming proponents as well as the schools and their pupils who are abstained from what could have been productive and challenging learning tools. As this paper aims to contribute to the wider uptake and success of game-based learning and by no means wishes to disqualify or hamper its application, it proposes a more realistic and credible argumentation that avoids the adverse effects of the one-sided promotion, while at the same time procuring larger and sustained impact. It is important that game proponents cautiously check the validity of their claims and stay away from window-dressing, wishful thinking and claims that may not be substantiated. It will strengthen their academic authority and help the adoption of games for learning. In this paper we will critically examine the argumentation of game-based learning and remove misconceptions that confuse the discussions.

2. Arguments for game-based learning

A wide range of arguments for using games for teaching and learning can be encountered in scientific papers, policy reports, game reviews and advertisements. The arguments do not just refer to the mere properties of games, but also cover the wider domain of game-based learning, which includes the context of use, the integration in the curriculum, gamification approaches, and the purposeful deployment of entertainment games (COTS – commercial off the shelf). We will investigate and elaborate a number of selected arguments that are often used in favour of games. The set of arguments presented below reflect the most common ones that can be found in the literature. It should be noted, however, that the arguments are neither exhaustive nor independent. These are grouped into three separate categories:

- Engagement:
  - The motivation argument: games are absorbing
  - The pre-dispositional argument: man is a player
  - The cognitive flow argument: being carried away by the game
- Learning:
  - The didactic argument: learning-by-doing
  - The performance argument: games offer continued self-monitoring
  - The freedom-of-movement argument: putting the learner in charge
  - The social argument: learning from peers
- Impact:
  - The safety argument: hazardless experimentation in a mimicked reality
  - The strategic argument: pleasing the NET generation
  - The case-evidence argument: success stories

The engagement category refers to the player’s mental nature. The learning category covers the mechanisms that support the processes of learning. The impact category includes arguments that explain the pragmatics of games. These arguments reflect general principles that are widely used, but in many cases they don’t tell the full story. They often include misconceptions or they neglect the practical conditions that would be required for being valid. Proponents of games should be self-critical and be fair about the conditions and constraints that apply for a game to be successful for learning.

3. Engagement

The engagement arguments refer to the attractive and absorbing qualities of games, which foster the continued involvement of learners.

3.1. The motivation argument: games are absorbing

The promise of games is all about engagement and motivation. Entertainment games are notorious for hooking and absorbing their players in such a way that they can hardly stop playing. All the same, instructional scientists consider motivation a main driver for effective learning [10-13]. Unfortunately, motivation of school children and students is generally known to be low. Education could only dream of the levels of engagement that games manage to evoke. This is where game-based learning comes into play. Many scientific studies and reports start from the premise that games are motivating and thus productive for learning. Games are valued for their motivational power, which is ascribed to their dynamic, responsive and visualised nature that goes along with novelty, variation and choice, effecting strong user involvement and providing penetrating learning experiences [14]. Players are challenged to actively engage in problem solving, exploration, goal formation, critical analysis, strategic thinking and enhanced creativity. Games have the potential to make learning fun [6][7]. The motivational power of games is readily explained with Keller's motivation theory [10], which approaches motivation as a mechanism for the realisation of conscious and purposeful engagement in an activity, and the self-determination theory of Ryan and Deci [12], which assumes the fulfilment of three intrinsic psychological needs: the need for competence, autonomy and social connectedness. Such conditions may seem to be easily fulfilled in a game, but of course in practice it is difficult. First, motivation in games is often driven by reward systems, which may include scores, property, permissions, reputation and more. Such rewards typically trigger and enhance extrinsic motivation (which is driven by pursued outcomes or external pressure) rather than intrinsic motivation (which is a personal trait of willingness, directly linked to the activity itself). Extrinsic reward systems, however, are associated with shallow learning rather than deep processing [15]. Games thus run the risk of being reduced to skinner boxes, which are "incentive dispensers that dole out rewards for attention" [16]. Second, extrinsic reward systems may undermine intrinsic motivation, because they are easily perceived as controllers of behaviours, shifting the locus of control from internal to external drivers. Third, extrinsic rewards may still be productive, provided that they help to amplify intrinsic motivation by making the activity more interesting [15]. In many educational games, however, extrinsic rewards systems are used that are not relevant for the learning contents and tasks. For instance, children's math exercises are often rewarded with a funny animated sequence along with some music, e.g. a cheerful rabbit dancing on the screen for a few seconds. This may be funny a few times, but after a while the children will realise that they are just being fooled to do these dull sums. If extrinsic rewards are used, they should be of relevance for the tasks at hand. Fourth, the motivational power of games is often treated as an axiom. But games do not have motivational power per se. Although to date many highly appreciated serious games have become available, the general assumption of their motivational powers doesn't necessarily apply to individual game instances. Game design as well as educational game design have to deal with large parameter spaces, which may hinder to harvest the motivational potential. The design is largely guided by a creative, intuitive process, which is not firmly grounded in any coherent theory of learning or appropriate research findings [17]. Consequently, the motivational power of a particular game is anything but straightforward and cannot be claimed on the basis of general arguments. Similar to film and TV programmes, which likewise raised high expectations for learning because of their dynamic visual nature, realism and motivational power, numerous examples of ineffective, poor quality and de-motivating instances have become available. Claiming that games are motivational per se is unjust, if not absurd.

3.2. The pre-dispositional argument: man is a player

The basic idea of this argument is that games are "fun". We like games because humans are assumed to have a natural pre-disposition toward play. While most people think negatively about school and studying, games are supposed to alleviate the burden by making learning more playful. To express the purposeful application of games, Abt [18] introduced the term "serious game" as to contrast it with leisure games. The term "serious game", however, is inherently confusing. It is an oxymoron, which is a figure of speech combining two concepts that are contradictory (e.g. "the only choice", "old news", "virtual reality"). The seriousness of education conflicts with the pleasure of play. While education is readily associated with an obligation - even forced by law - , homework, examinations, a necessity of life, and a prerequisite for having a job, a salary and a career, games are associated with play, joy, leisure and having fun. In his seminal book “Homo Ludens” Huizinga [19] describes play as a leisure activity, non-obligatory and fully free of any material goal or interest – no profit can be gained from it. Play is also freedom, which makes it very different from education with its mandatory classes and schedules. Essentially, we are able to force children to go to school or to do their homework, but - in contrast - it is impossible to force them to play. If we would force them, they would reluctantly represent play by correctly conforming to the game’s rules and taking their turns, but they will not experience play. According to Huizinga playing a game is anything but serious: play is easily hampered by making it purposeful. However, there is something to be said against this. Although play is thus not to be understood as a teleological means to an end, play is not without effect. Whether pursued or not, play involves experiences that influence the players’ mental states at affective and cognitive levels. As Huizinga states, play is a natural way of learning. Likewise Blanchard and Cheska [20] suggest that play reflects a universal mode of learning. Young lions and dogs spontaneously growl, threaten, lark about and creep up on each other, as to prepare for adulthood. Children will pick up any stick, stone or piece of plastic to start playing around and unintendedly they develop their skills. Play positively influences important psychological, sociological, and intellectual developments of children [21][22]. Also adults learn by playing. Cultural activities such as sports, film, theatre and music all include elements of play, that is, using a temporary set of agreed rules and a shared agreement that it is not “real” life. Play takes place in what Huizinga defines as the magic circle: a playground, which is a temporary world detached from real life, and which allows for fantasy and pretending, while special rules apply. Likewise, learning new things at school complies with pretending: learning takes place in a shielded, safe environment, where special rules apply and modelled exercises prepare for the real thing. Therefore, fun and seriousness need not necessarily be in conflict. As Papert [23] noted, fun doesn’t mean “easy”. The best fun is “hard fun”. People like to be challenged by difficult tasks and they are eager to see how they can stretch their abilities. After all, the conflict between play and learning is not prohibitive.

3.3. The cognitive flow argument: being carried away by the game

According to Gee [24] the secret of a videogame as a teaching aid is not the high quality, immersive 3-D graphics, but it is in the underlying architecture, which balances the challenges offered to the player with the players’ abilities seeking at every point to be hard enough to be just doable. This is called game balancing: adapting task complexity to the player’s abilities. In psychological terms this mechanism is easily linked with Vygotski’s [22] zone of proximal development and Csikszentmihalyi’s theory of cognitive flow [25]: challenging people slightly beyond the boundaries of their abilities, while avoiding both frustration (when tasks are too complex) and boredom (when tasks are too easy). Under the right balance players may be pulled into 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. Such state of intensive mental activity is highly favourable for sustained learning. If such states were achieved in schools, the students would not want to leave the school by the end of the day, but continue their work. They would not even hear the school bell ring. Here, game-based learning fits in to sketch the ideal future of schools, with unstoppable students, addicted to learning, that have to be chased away by the end of the day. Although educational game balancing is anything but straightforward and it would require continuous in-game monitoring of the player’s learning progress, it can in principle be based on approaches to adaptive learning systems, which include dynamic learner models along with knowledge representations and reasoning approaches [26]. Technical barriers are limited, because today, in the ever-growing landscape of the internet and social media, user modelling and profiling have become key services for any online business, e.g. Google, Facebook. However, the call for cognitive flow and the associated promotion of games for achieving this, neglects two major issues. First, reliable instruments for the continuous monitoring of cognitive flow are lacking. Cognitive flow is commonly registered via post-practice self-reporting instruments [27]. However, the resulting indicators are no more than subjective impressions that reflect averages over large periods of time. Nevertheless, advances in real-time physiological and behavioural tracking may solve this problem in the near future. Second, the notion of cognitive flow, which is actually a blinkered focus on task achievement, conflicts with the requirements of self-evaluation, reconsideration and reflection. Such activities at a metacognitive level are essential for the players' self-awareness and insights in their task execution and the self-judgements about the effectiveness of applied strategies. The learning-by-doing nature of gaming and the high cognitive loads associated with the strong engagement are likely to procure superficial, rote learning and to hamper deep processing. Quite some studies on reflection and metacognition have indicated that stepping back for a while and reconsidering and evaluating the things done so far are a powerful way to enhance one´s insights and understandings [28]. The frequent interplay between the level of learning and the level of meta-learning is an important mechanism for becoming a self-conscious, autonomous, responsible and self-directed learner [29]. Cognitive flow severely conflicts with developing metacognitive skills and thus hampers learning. Players should be allowed or even urged to step back every now and then from their monomaniacal game challenges, interrupt their state of cognitive flow and become active at a metacognitive level. It would raise the effectiveness of game-based learning.

4. Learning

The learning arguments refer to the mechanisms and processes that make up the player´s learning experiences and accommodate the attainment of learning outcomes.

4.1. The didactic argument: learning-by-doing

Among many didactic arguments a major argument is that games support learning-by-doing [30-32]. Learning-by-doing means learning from the experiences that "…result directly from one's own actions, as contrasted with learning from watching others perform, reading others' instructions or descriptions, or listening to others' instructions or lectures" [33]. Learning-by-doing is an overarching concept including discovery, exercise, inquiry, problem solving, and authentic contextual knowledge, which activate learners and help them to acquire the tacit knowledge [34] that is intrinsically bound to the actions performed. Learning-by-doing goes with an active role, problem ownership and sufficient moving space: players in a game are in charge of addressing the challenge posed and learn from the responses they obtain from the game world. However, the learning-by-doing argument does not always hold. First, just doing things and having the associated experiences are not a sufficient condition for learning, because doing a task may be just too difficult (e.g. doing brain surgery), the learning may require background knowledge or practical skills (e.g. knowledge of medicine and surgical instruments) and just doing things does not necessarily lead to deep cognitive processing and the associated insights and understandings. Second, studies into computer-assisted instruction and simulations have shown that learners often adopt trial-and-error strategies that involve a lot of doing, but lack any thoughtful analysis of experiences [35]. Undirected trial and error behaviours are easily induced by game interactions that put little cognitive load on the users, such as interaction by direct manipulation with graphical objects [36]. The dynamic nature of games inherently promotes players to act before thinking. In addition, many games include deliberate mechanisms for inducing stress, such as time lock, time pressure or time-dependent scores, which are likely to promote hurried, shallow or incomplete processing. Scholars such as Schön [28] and Kolb [37] realised that just having the learning experience is not a sufficient condition for learning, but should be complemented with a thoughtful reflection about the game's contents, the player's activities, the associated learning achievements. Games should exploit the potential of learning-by-doing by including instructional measures that help to make the activities meaningful and that support deep processing, reflection and the consolidation of experiences.

4.2. The performance argument: Games offer continued self-monitoring

In digital games any keystroke or mouse event can be captured and processed for diagnosing player performances. The recent revival of educational data-mining and learning analytics perfectly fits in the trend of collecting, storing and analysing ever more user data for the benefit of both education providers and learners [38-40]. This is even extended by new developments in affective computing, based on advanced sensor technologies and image processing algorithms, which allow for extending learner models with emotional state data and body movement data. This all fits in with the so-called "quantified-self movement", which is a movement of users and tool makers who share an interest in self-knowledge through sensors for self-tracking (see Quantifiedself.com, since 2007). Nevertheless, the claim of performance tracking in games is highly deceptive and does not necessarily provide insight in the player’s learning achievements, because learning and performance are conflicting concepts that often require opposite attitudes. Various authors [42][43] explain the difference between a performance orientation and a learning orientation. Game play tends to focus on performance, which is linked with an attitude of achieving milestones and scores (in many cases under time constraints), swift completion of tasks, avoiding errors, and the use of proven methods for reducing risks. A performance orientation draws players toward activities that they are good at already. All these features are not necessarily beneficial for learning. As opposed to performance, learning requires spending sufficient time for in-depth understanding, and having sufficient opportunities for reflection, revision, self-evaluation, and even the preparedness to make mistakes. Most game reward systems, however, discourage making mistakes because of the penalty points involved. Hence, the process of gaming may readily counteract the process of learning. Having completed a serious game successfully with a high score doesn´t necessarily imply successful learning. This discrepancy between learning and performance will be larger as games offer more freedom of movement to the learners. For example, in well-structured drill-and-practice games such as math games or spelling games, the learning gains are likely to coincide with performance gains (cf. Figure 1, curve 1).

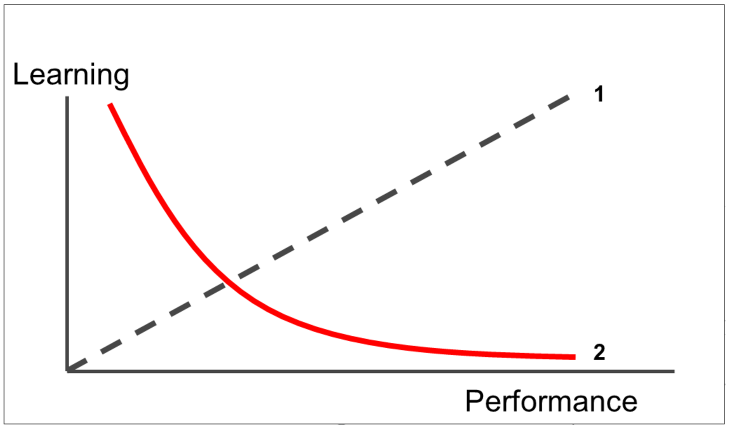

Figure 1. Exemplary relationships between learning and performance (1: linear, 2: non-linear)

However, in games that offer more freedom of movement and autonomy (e.g. based on contextualized problem solving, adventure games, inquiry-based learning, competence learning, and self-directed learning) the quality of learning is likely to diverge from the quality of performance. Generally the connection between learning and performance in a game will be nothing like the intuitive linear relationship (cf. curve 1) that is often silently assumed. In the extreme case, it would show some inverse relationship (Figure 1, curve 2). Hence, it is highly unlikely that a player’s performance metrics are representative indicators for the player’s learning achievements. Game-design guidelines derived from the above would be to link score with learning achievements rather than with performances. In addition, allow for making mistakes, reward error correction and include room for reflection. In view of the contradictions between performance and learning, one may also want to separate the two in a game, for instance by having a unconditioned trial session dedicated to the learning process, followed by a proof for demonstrating performance.

4.3. The freedom-of-movement argument: putting the learner in charge

Games are highly interactive, dynamic systems that put the player at the centre of the action. Being put in charge for winning strategies, taking decisions and solving problems is a major motivator. The associated problem ownership and responsibilities require the game to avoid fixated, linear pathways, but to provide sufficient freedom of movement, which allows for a variety of strategies and approaches. From the perspective of learning, however, such freedom of movement can be problematic. First, freedom of movement conflicts with the need for effective scaffolding, which may include clear learning tasks, step-by-step approaches, explanations and many more structured elements.

Educational game designers are averse from interrupting game play with such scaffolding or instructional sessions, because these would break down the gaming experience and the flow that goes with it. By postulating the learning-by-doing mantra the danger of such interruptions is averted: essentially, freedom of movement is no longer viewed as a problem, but as a starting point. By that, educational gaming is in good company, because it shares this starting point with a wide range of established pedagogical approaches such as constructivism, discovery learning, problem-based learning, experiential learning and inquiry-based learning, all of which adhere a philosophy of minimal guidance. According to constructivist premises learners should be challenged by authentic and ambiguous problem settings that allow them to deal with different sources of information and to construct their own solutions [8]. Such contexts require substantial freedom of movement, indeed. In the last decades, however, various review studies have demonstrated and re-established the impotence of the minimal guidance approaches [44-46]. The majority of experimental studies disqualify the effectiveness and efficacy of instruction with minimal guidance, while guided instruction is found to produce better learning achievements, deeper learning and better transfer to other contexts. Various studies show that low-aptitude students are particularly at risk of negative learning outcomes, e.g. misconceptions or disorganised knowledge, under minimal guidance conditions [47]. Ironically, for low-achievers games are often depicted as a better mode of instruction than classroom lectures or textbooks [48]. Game-based learning simply cannot do without instructional interventions. Second, in games with many degrees of freedom the arrangement of instructional guidance is inherently problematic. Salen and Zimmerman [49] explain that for most games it is difficult to foresee or control the player´s game experiences, because of the large number of game states and the even larger number of trajectories that a player could travel through this state space. Even simple game rules may lead to emergence of unforeseen game states [50][51], as can be observed in games such as chess, go and football. This means that it is difficult to anticipate the diversity of game conditions that players are subjected to. Hence, a game is not necessarily a well-controlled environment and different players will have different experiences. From a pedagogical point of view this uncertainty is highly unfavourable, because teachers are supposed to arrange and preserve the optimal conditions for their pupils´ learning. Because every individual game run is different, it is also difficult to establish the game's effectiveness for learning. It is just not feasible to test for all possible trajectories through the game. Neither would it be adequate to test the appropriateness of a game's "average pathway", because the "average player" is non-existent. Now that teachers cannot accurately predict what will happen in the game, education starts to resemble a casino. The impracticability of preparing appropriate guidance for all cases devalues the credibility of game-based learning. The only remedy would be to reduce the player´s freedom of movement and include instructional components to prevent that players would spend too much time to game activities that aren't productive for the player´s learning. In the ultimate case, however, educational games degrade to well-structured, quiz-like tutorials that fail to capitalise the rich potential of gaming for learning. For being effective means of learning, games should appropriately balance the freedom of movement with supportive instructional events, thus balancing self-directedness and guidance.

4.4. The social argument: learning from peers

To a large extent gaming is considered a social activity. This seems to match very well with social learning theory [52][53], which assumes that all learning is a social process: people learn by observing other people's behaviours, attitudes and achievements and by cognitively encoding and adopting these behaviours. Social learning is strongly based on the notions of modelling and imitation: by observing peers we learn how to behave. The learning from peers is also theoretically covered by constructivist theories from Piaget and Vygotsky, because of their focus on making meaning through social interactions [54][55]. During the last decades a wide variety of approaches to collaborative learning have been studied, most of these focussing on small group collaborative learning in face-to-face sessions. Severe barriers for group learning have been identified, which include group tension and conflicts [56], individual differences between group members both in prior knowledge, ambitions, speed of learning and work load, social loafing [57], which refers to the reduction of individual effort when participating in a group, and the free rider effect, which is taking the credits without making efforts. As compared with face-to-face groups, computer-based collaborative learning, e.g. multi-user gaming, reduces the opportunities for direct observation and interaction. Group coherence and trust may be limited, when participants have never met face-to-face. Also lurking is easier because of the limited direct observation. Yet, multi-user games for learning are widespread. Fellow players may act as a role model, discusser or critic. Epistemic games are designed to allow learners to develop domain-specific expertise and the social habits and vocabulary that prevail in a particular domain [58][59]. However, harvesting the social benefits of games for learning is not self-evident. Many games just offer a single player challenge. In multi-player games competition between players rather than collaboration tends to be a dominant mechanism. This means that open conversations are likely to be absent and that information is kept secret rather than being shared and discussed. Competition is known for effecting enhanced motivation, but it does not contribute directly to the learning. Multi-user gaming requires appropriate pedagogical measures and cautious avoidance of the adverse effects of competition and other non-collaborative modes [60]. Sometimes competition between teams rather than individuals is offered, which allows for intra-team collaboration against shared opponents. Romero et al. [61] propose to take into account the truncated nature of online communication and suggest that learners in online multi-user games would need dedicated wizards and tools for supporting group awareness, and learning. Various authors [62][63] found that using awareness tools had a significant effect on improving task performance. Overall, the social learning argument is weak. Most games for learning do not necessarily foster social learning. Indirect interactions and lack of contextual clues, as well as the competition between players, which requires secrecy rather than knowledge exchange, are severe obstacles for learning. This is why debriefing sessions – stepping out of the competition - are considered essential for game-based group learning [70] [71].

5. Impact

The impact arguments refer to the (supposed) consequences that the game would have on the curriculum, the education providers or the target groups of learners.

5.1. The safety argument: hazardless experimentation in a mimicked reality

In many cases a game or simulation environment allows for learning to deal with real world tasks, e.g. firefighting, managing a company, ship navigation, or crisis management. Players are challenged to develop relevant knowledge representations and the associated reasoning and problem solving strategies and benefit from transferring these to real world situations [64][8]. Such virtual exercises go with many advantages. For instance, once the upfront investments are made, operational costs are limited and would allow for large scale exploitation. Also, operations under hazardous conditions can be practiced in a safe environment without the risk of damage or casualties. Didactic advantages are in the opportunity of providing repetitive and adaptive training, learning from failure, and the possibility of presenting both realistic and imaginary content, which all contribute to the efficacy of learning. The basic premise underlying these productive effects, however, is that the knowledge and skills learned from the mimicked reality are easily transferred to the real world. Such transfer is defined as the degree to which knowledge, skills and attitudes that are acquired by playing a game can be used effectively in real, operational, professional situations [65]. However, research on the transfer of gaming experiences to the real world shows ambiguous results [66-68]. The situated context and the practical operations that make up a game tend to direct the learner's focus to concrete, local problems in the game, which may counteract pursued generalisation and abstraction. By playing a game learners will improve their performances in the particular game, but will not necessarily be able to demonstrate good performances in other contexts. With respect to simulators Korteling et al. [65] explain the importance of fidelity of the synthesised world, which is the degree of similarity between the simulator and the real world. Higher degrees of fidelity lead to better transfer. Even more important is the validity of the simulator, that is, the functional representation of the world, e.g. in a flight simulator, should be correct. For the case of serious games Westera et al. [8] explain that realism and authenticity are better replaced with credibility. Ke [69] concluded that instructional support is required for transferring the lessons learned in games to other contexts. Various authors [70][71] emphasise the importance of a debriefing activity after the completion of the game for consolidating the learning outcomes and enhancing transfer.

Apparently, learning from games does not automatically lead to productive transfer to other contexts. In the worst case, learners have performed well in the game and learned a lot, but are not capable of applying the acquired knowledge and skills in real world practice. For supporting the transfer of learning serious games should offer both a diversity of contexts and a diversity of contents, and include activities that allow for abstraction and generalisation, reflection upon action and reflection within action [28]. The acquired knowledge should be made robust against different conditions and circumstances to allow productive transfer to a wider range of contexts.

5.2. The strategic argument: pleasing the NET generation

It has been argued that a new generation of learners is entering education, who have grown up immersed in new communication technologies, including smartphones, social media and video games. This new generation of learners has been characterised as the “NET generation” [72], “Millennials” [73] or “Digital natives” [3] as to indicate that it has fully integrated the use of modern ICTs in its daily activities. It is asserted that these digital natives behave and learn differently compared with previous generations and that education has to fundamentally change its approaches to accommodate the interests and styles of operation of this new generation [3]. Digital natives have been suggested to be active, if not impatient learners, proficient in multitasking, and fluent at communication technologies [74]. Even their brains have been said to be different. Cognitive neuro-research has shown that the brain continually reorganises itself in response to diverse stimuli, a process known as brain plasticity [75]. Small and Vorgan [76] claim that youth are impairing their high-level cognitive and social abilities, which are located in the frontal lobes of the brain, by the continual interaction with digital media, because these mainly stimulate the temporal lobes of the brain without strengthening connections in the frontal lobes. Among scholars, however, there is controversy about the structural adverse effects of pervasive digital media usage by youth [77][78]. Nevertheless, schools and training institutes wonder how they should adapt their strategies for addressing the demands and requirements of this new generation of learners. Many believe that including video games in the curriculum would offer a unique opportunity to engage learners in learning environments that reflect contemporary media usage [2]. In recent years, however the image of young people as a new human species alien to previous generations eroded. Claims that the new generation demonstrate new, different learning styles, based on technology skills, exploration and multitasking, are highly questionable. Although young people extensively use communication technologies, a large proportion of young people do not match the digital native stereotype of being highly skilled in communication technologies. Their knowledge and skills about these technologies are both shallow and diverse. Decades of research into learning styles have demonstrated that people may have different preferences and approaches to learning, but these are neither static nor are they generalisable to the level of the whole population. Individuals frequently adapt their approaches to the task requirements and the context of operation, while at population level substantial variability is present [74]. Also, there is an overwhelming body of research demonstrating that multi-tasking (which is likely to be just frequent switching between tasks) leads to cognitive overload, loss of concentration and reduced performance because of competing stimuli [79]. Proponents of a game-based learning strategy should realise that the strategic argument of accommodating the NET generation fails simple because the NET generation does not exist [80]. Even if young learners might be pleased with serious games in their classes, it is questionable if these games would meet the learners´ expectations, since high-end commercial entertainment games function as their reference benchmark. Opting for a game-based teaching strategy would allow schools to demonstrate a future-oriented vision and profile that certainly yields promotional value and reflects innovation awareness. However, the main argument of accommodating the NET generation fails.

5.3. The case-evidence argument: success stories

Reference to a serious game that turned out to be successful for teaching or training is a popular argument in favour of games: students liked the game! Obviously, positive evaluations contribute to the body of evidence in favour of serious games, so it is good that these are available. However, the evidence is not always decisive. First, successes in the past are no guarantee for future successes, because there is no grounded recipe for designing a successful solution with mechanical precision [17].

It is difficult to determine the effectiveness of a game beforehand, because of the large parameter spaces in the design and the large variabilities of both user characteristics and contextual conditions that the design should meet. Similar to newly launched TV-shows, movies or music albums, a new game may easily flop, despite the evidence of previous successes. One only gets to know afterwards. Second, the evidence reported in the literature does not tell the whole story, because scientific journals prefer reporting positive outcomes rather than negative outcomes. Consequently, the journals display a highly biased series of success stories, while they neglect at the same a time an unknown volume of refutations. Although publication bias has been widely recognised as a fundamental problem of the scientific community and many scholars have called for the publication and preservation of null results, most studies that lack positive outcomes simply go out of sight [81][82]. Hence, the body of evidence is utterly one-sided. Third, the quality of the evidence may be questioned. According to Linehan and colleagues [83] there is little empirical work published that evaluates the educational effectiveness of serious games in a rigorous manner. Many research papers about serious gaming focus on local practices, which is pragmatic rather than theory-driven. The general pattern of such research involves the design and development of a particular game for a specific purpose, including user needs and requirements analyses, testing and running the game in a pilot and, possibly, assessing the users' appreciations and gains in performances. Generally, the heart-warming outcome is that the game produced pursued learning gains and that the users appreciated the game. Such papers makes high demands to the integrity of the researchers, who may have made many efforts at developing the game, collecting and processing the data, and writing the scientific paper, and who would be badly injured if all these efforts would not lead to a scientific publication. In all cases it comes close to researchers marking their own paper, if not selling their topic. In addition, confounding distortions may be caused by the Hawthorne effect (too close relationships between researchers and test persons [84]) and the Novelty effect (test persons pay increased attention to media that are novel to them, which unwantedly leads to increased efforts and increased learning gains [85][86]). In an extensive literature study, Connolly et al. [1] have identified a growing body of empirical evidence for the effectiveness of games-based learning, but call for more randomised controlled trials (involving comparisons between an experimental group and a control group) for increased scientific robustness. In the past, however, various scholars have disqualified randomised controlled trials. Shaver [87] states that controlled experiments and the notion of statistical significance are useless since in practice many input variables remain uncontrolled: in any practical educational setting the causes and effects cannot be identified unambiguously because of confounding variables. In recent years, this lasting dispute about randomised controlled trials has flamed up, involving severe criticisms on the statistical methods and parameters used for defining what effects are to be considered "significant" [88-90]. Johnson [89] suggests that the common significance threshold of 5% is far too high and should be lowered down to 0.1 %. This would disqualify the majority of social science research as to produce nothing but noise, which would effect a total breakdown. Notwithstanding these sobering observations, the continued collection of evidence, that is, any data that substantiate the successes and failures of serious games, remains crucial for building an empirical knowledge base and consolidating best practices, extracting guidelines and eventually developing predictive theories. The tragic fate of new instructional media is that all stakeholders call for scientific evidence of the new claims that are made. Not being able to fully answer this question is acceptable though, so long as schools and teachers are allowed to arrange their lessons without ever being bothered about the scientific validity of their teaching.

6. Conclusion

In this paper we have analysed a range of arguments that are commonly used for substantiating game-based learning. We have demonstrated the weaknesses of general claims with respect to engagement, learning and impact, respectively. Proponents' enthusiasm and interests may easily filter through the arguments and affect the independence and validity of claims. The over-simplification, generalisation and neglect of nuances and subtleties are deceptive and may easily arouse unrealistic expectations. In the short, conversation partners, that is, teachers, decision makers, customers, may be persuaded to engage in game-based learning, but in the long run it may do more harm than good by affecting the credibility of the domain. We should recognise that the discipline of game-based learning is still in its infancy. As a scientific discipline it is actually lagging behind an ever-growing and flourishing game-based learning practice that manages to successfully deliver a wide variety of creative game instances that are highly appreciated by their users. Such pattern of a successful practice that is driven by technology rather than scientific rigour could be observed before in other domains, e.g. the steam engine, which worked well before we had developed thermodynamics, or the aeroplane, which successfully took to the air well before we had aerodynamics to describe and understand what happened. Anyway, we need to strengthen the scientific base of game-based learning and systematically enlarge the body of evidence that explains what factors and conditions produces most favourable outcomes. We should thereby not just be fixated on the pros of game-based-learning, but also be open to the cons, and the conditions when not to use games for learning. Nevertheless, game proponents contribute to a good cause, because it supports educational innovation with emerging technologies. At the same time they should help strengthen the scientific dimension by making claims that are based on evidence rather than potentialities, beliefs or preferences.

7. References

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