The use of computer games in classroom environment

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Abstract: As part of the educational use of ICT, digital games can be learning tools, motivators and generators of curiosity and as a result an effective means of optimising student learning and performance in daily educational practice. The positive relationship between learning and students’ engagement while using digital games has been confirmed by various independent studies over the years. Thus, the integration of digital games at different levels of education for teaching multiple learning objects comes as no surprise. Despite the many studies on the learning and motivational effects of digital games, teaching with digital games is not yet widespread in secondary education. Current research emphasises that most of these factors appear to stem from difficulties with the implementation of games in classroom settings. Problems with technology, the cost/expense of games/equipment, the lack of technical support are defined as some of the barriers to the addition of games and simulations in education.

Keywords: digital game; primary and secondary education; learning through play.


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1 Introduction

In recent years, there is a growing appreciation that the conventional approach to the process of teaching does not address the social, emotional, mental and motivational needs of the new generation [Tapscott, (2009), p.131]. Today’s students are no longer the people our educational system was designed to teach, argues Marc Prensky in his book
Since then, the term has become popular, especially in educational circles and is often used as a justification for making broad assumptions about the digital literacy of young people today [Becker, (2016), p.219; Palfrey and Gasser, 2013]. The term is used to describe the ‘net generation’ who spend most of their time on the internet, permanently ‘turned on’ (Prensky, 2001; Van Eck, 2006). They represent the “native speakers who have grown up in the digital era, have excellent knowledge of computer language, digital games and the internet” unlike digital immigrants such as their parents and older teachers [Prensky, (2005a), p.8]. On the contrary, digital technologies are often described as tools that will enhance collaboration and motivate learners to reengage with education (Papadakis, 2016) and enable them to develop the new multimodal literacy skills required for today’s knowledge economy (Lacasa, 2013). Lowering the barrier between education and real entertainment is an important challenge to better exploiting the potential of computers (Papadakis et al., 2016a, 2016b, 2016c; Kalogiannakis and Papadakis, 2017) and reaching a demographic that is traditionally averse to learning (Bellotti et al., 2009).

Digital games are an important part of most children’s leisure lives nowadays and are going to become the predominate form of popular culture interaction in our society (Gee, 2004; Kirriemuir and McFarlane, 2004). Studies show that even young children under the age of 8 years are frequent users of digital games and applications (Judge et al., 2015; Orfanakis and Papadakis, 2014; Papadakis et al., 2015, 2016). The popularity of the game in the dominant culture of the new generation has spurred the interest of the educational community, with several educators and researchers to seek different approaches, in using digital games in the classroom environment (Carvalho, 2016; Orfanakis and Papadakis, 2016b; Papadakis et al., 2016b). In 2009, US children between 8 and 18 years old played video games for an average of 1 hour and 13 minutes per day, according to a Kaiser Family Foundation study, which represents a substantial increase compared to 2004 (Meeri, 2017).

Digital games are gaining wide recognition as an effective way to create socially interactive and constructivist learning environments. Studies indicate that playing video games gives learners a ‘mental workout’ and the structure of activities embedded in computer games develops a number of cognitive skills (Giannakos, 2013). Additionally, many games use the same sorts of techniques we recognise as sound pedagogy, even if they were not designed that way deliberately. The dots connecting what is done in games and what is accepted as good instruction are increasingly connected [Becker, (2016), p.336]. This has been the case for both educational games and commercial games, which were built for entertainment but at times have been used as instructional tools in the classroom [Groff et al., (2015a), p.20].

Many educators see digital games as powerfully motivating digital environments (Papadakis et al., 2014) because of their potential to enhance student engagement and motivation in learning (Hsu et al., 2017) as well as an effective way to create socially interactive and constructivist learning environments (Chan et al., 2017). According to Gee (2007, p.216), “Video games engage players in powerful forms of learning, forms that we could spread in various guises, into schools, workplaces and communities where we wish to engage people with ‘education’”. There are at least three features of games that make them intrinsically educational: a motivational, a cognitive and a sociocultural perspective (Chan et al., 2017). During the completion of an activity through a custom-tailored digital game, students deal with concepts and more easily embrace the key points of the didactic module. Additionally, students take responsibility for their
learning and become more autonomous in their decision-making (Sumuer and Yakin, 2009). Hence, several researchers have tried to identify the obstacles for the slow adoption of games in education. For instance, personal experience with games and simulations affect the potential adoption of games and simulations by a teacher. Problems with technology, the cost/expense of games/equipment, the lack of technical support are defined some of the barriers to the addition of games and simulations in education (Justice and Ritzhaupt, 2015).

This paper is a review of the literature and is organised as follows. Section 2 introduces terminology used throughout this paper as well as a brief history of the educational use of digital games. Section 3 describes the advantages and the disadvantages of using educational games as well as the obstacles-barriers to the addition of games in education. In Section 4, different frameworks for introducing digital games in the classroom are presented. Finally, Section 5 presents the conclusions of this paper.

2 An introduction to digital educational games

Since the advent of Spacewar in 1962, which is considered the first commercial digital game, digital games have been playing an important role within the world’s social, political and economic framework for more than 50 years (Newman, 2004). In the literature, one can find various definitions and terms referring to digital games. This diversity is due to the plethora of electronic devices on which a person can come across a digital game. Numerous researchers use the term video games when they intend to refer to all types of digital games, whereas other researchers use this term when they are referring exclusively to video console games. Thus, a wide range of definitions has been attributed to the concept of a game such as digital game, computer game, video game, electronic game, etc. Digital games are generally based on a digital model that allows for reproducing a reference situation, an ordinary and real situation. Digital games, as they consist of a mix of games and computers, combine attractive features such as graphics, physics and motion, to create virtual environments e.g., interactive simulations of the real world (Prensky, 2007). This situation might be, for example, a physics system (Angry Birds), a historical period (Civilisation), or the management of a city (Sim City) (Sanchez et al., 2016). Additionally, digital games include mobile applications for entertainment that are easily available today through various ubiquitous devices. According to Huizenga et al. (2017) each game has some basic components, which are shown in Figure 1.

Digital educational games are software applications which use both the characteristics of video games and computer games, to create attractive and motivational learning experiences to successfully bring specific educational objectives into educational practice. The games may either be designed to promote learning or the development of cognitive skills, or otherwise take the form of simulations allowing learners to practice their skills in a virtual environment (Erhel and Jamet, 2013). As a result, therefore, digital game based learning (DGBL) can be defined as the use of computer games (or digital games) to support or supplement learning within an educational context (Prensky, 2005b). There are a slew of video games, digital applications (‘apps’) and adaptive software platforms that can be used for instruction (Shapiro, 2014). These include entertainment games, or games designed for leisure that have been adapted into an educational setting, simulation games, which aim to simulate an aspect of reality and are
generally coupled with external learning material and learning games, which seek to provide the majority of the learning content within the game. The latter two types of game have both been designed with a particular learning outcome in mind (Grace, 2016).

Figure 1  Game basic components (see online version for colours)

Theories of DGBL suggest that digital games are not only persuasive in terms of real and virtual world parity; but also, a medium to foster complex values. Educational computer games could be an effective way of providing a more interesting learning environment for acquiring knowledge and can enhance students’ learning interest and motivation (Sung and Hwang, 2013). Game-based learning remarks on the potential value of learning through play in education and skills training (Paule-Ruiz et al., 2017). Digital games provide a forum in which learning arises as a result of tasks stimulated by the content of the games, knowledge is developed through the content of the game and skills are developed as a result of playing the game (McFarlane et al., 2002). As Grace (2016) states, a game is a closed system of meaning that is limited by time and space. There are agreed upon rules and constraints that are embedded in the game and these govern how the player/s are able to interact with the game. The interactions that the player has with the game are known as the game mechanics. Players will use these game mechanics in order to overcome challenges presented in the game while also being given feedback on their progress towards overcoming these challenges.

The characteristics which make digital games attractive are the existence of a structured framework, the pleasant environment, the great gameplay and the spectacular graphics, sound and music, the didactic goals which are presented as problems to be solved and finally a sense of playfulness which attracts the child’s attention (Prensky, 2007). Additionally, educational digital games utilise the Internet and multimedia technologies. Students have the ability to understand challenging concepts and acquire difficult skills with their own learning pace, through interactive and engaging activities. For the same reasons, Prensky (2007), states that educational digital games belong to the category of active educational environments.

Often those involved in the educational process, are just looking for games which have been created exclusively for educational purposes, ignoring that, within an appropriate context, even commercial games can be used for a variety of educational
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disciplines. According to Van Eck (2006), the research on using games for formal education focuses on three different approaches:

a) using commercial games as learning tools

b) integrating serious games, games for learning and multi-user virtual environments in the learning process

c) designing games with the students in which the practice of designing serves as a learning process.

A large number of commercial games are suitable for use in the classroom and there are various examples of commercial games which have been effectively used such as Civilization, Age of Empires, CSI, The Sims, Age of Mythology and SimCity (Van Eck, 2006). Other examples of similarly successful integration of commercial games in the formal learning environment and a variety of subjects are Pirates! for the revival of historical periods and SimEarth for simulation experiments in the subject of chemistry, Caesar and Colonization for reviving ancient and more recent civilisations, etc. Prensky (2005a) has compiled a list of 500 serious games which can be integrated in the curriculum.

As games have become more complex in terms of graphics, complexity, interaction and narrative, so have a variety of genres have come to dominate the market. There is, however, no standard categorisation of such games; different stakeholders in the games industry, e.g., game outlets, developers, academics, web review sites, use a taxonomy appropriate to their own audience (Kirriemuir and McFarlane, 2004). According to the Herz system (Herz, 1997 as cited by Kirriemuir and McFarlane, 2004) a game taxonomy is the following: action games (shooting games, ‘platform’ games, reaction-based games), adventure games, fighting games, puzzle games, simulations, sports games and strategy games. Another classification, among many, which is used by many researchers is the following (Laird and Lent, 2005 as cited by Lacasa, 2013):

• Adventure: the gamers must solve problems when they interact with other characters, progressing through different moments in the adventure.

• Strategy: humans confront problems that need solving, for example, distributing resources, organising production, defences and attacks.

• Sports: these games cover almost all sports imaginable.

• Action: they are the most popular and they assume that the human action controls a character in a virtual environment.

• Simulation: providing the player with control in a simulated world.

• Role play: a human can play with different types of characters, for example, a magician or other appealing types.

Game-based learning can be done through either the adoption of existing recreational games in the commercial market for educational use, or the development of educational games with constructivist learning paradigms in mind (Kirriemuir and McFarlane, 2004). The games, in general, can be classified into three broad categories according to their educational scope: leisure games, educational leisure games and educational games (see Figure 2) (Ulicsak and Williamson, 2010).
Educational games are those characterised as having been designed with clear learning objectives and are intended to facilitate the teaching-learning process. This definition therefore includes edutainment games, serious games, game-based simulations as well as epistemic games. Leisure games are games that have not been designed with a clear learning objective in mind, without, however, excluding the fact that they can be used to enhance learning. This category includes commercial off-the-shelf games (COTS). These games are produced firstly for commercial purposes and sold largely through commercial retail outlets. Some COTS games have been used quite successfully in learning situations, such as Minecraft [Becker, (2016), p.38]. Educational leisure games are games such as The Sims, the Roller Coaster Tycoon series, Civilization and Age of Empires, which have been used in classrooms to enhance learning, although originally designed for commercial purposes. Figure 3 shows snapshots of two successful commercial games, Age of Mythology and SimCity. As stated by De Jans et al. (2017), a new wave of massively prominent casual video games that interest a wide of audience has emerged,
having over 200 million players around the globe. These mini-games are brief games that are easy to learn and clearly differ from regular videogames which demand some time for the rules and setups to be mastered.

2.1 A brief history of the educational use of digital games

The concept of using digital games to support learning activities is not novel as there have been studies found dating back more than 40 years (Grace, 2016). As Zhen (2017) states educational gaming has changed a lot over the past 40 years. From the 8-bit survival game Oregon Trail to the voxel-based building game Minecraft, educational gaming continues to follow the trends of technology and innovation by trying to create the perfect blend of learning and fun. Since the 1960s, the effectiveness and benefits of technology-enhanced learning have been examined and reported to enhance the interest and motivation of learners of all ages in various fields (Sung et al., 2017).

Already in 1970, at the dawn of the modern computer game era, studies were conducted on the effect of using computer games to enhance learning [Van Eck, 2006 as cited in Hansen and Storjord, (2016), p.29]. As Becker (2016) states, this was the era that produced such noteworthy titles as Oregon Trail (1985) and Where in the World is Carmen Sandiego? (1985). Perhaps the most well-known educational game, Oregon Trail, developed by MECC, was released in 1971. Although not available at home until the first mass-produced personal computers, Oregon Trail could be found in some form at virtually every school from the 1970s until today and it put educational gaming on the map. The goal of this game is to teach American geography and history by having the player guide a family on their way across the country during the 1800s (Zhen, 2017).

In the 1980s, there was great enthusiasm for harnessing the design knowledge embedded in video games to improve instruction (Squire, 2003). At first the adoption was slow, but growing steadily (Groff et al., 2016). The self-proclaimed ‘edutainment era’ (Van Eck, 2006), which began in the mid-80s and lasted until the mid-90s was the time of the introduction of digital games in the educational process. Initially, the use of digital games was considered by many educators as a panacea. As Squire (2003) states, since the widespread popularity of PacMan in the early 1980s, some educators have wondered if “the magic of Pac-Man cannot be bottled and unleashed in the classroom to enhance student involvement, enjoyment and commitment” [Bowman, (1982), p.14]. As a result, anyone involved in the educational process could ‘insert’ a game in their teaching practice and believed that their lesson would become more fun and more efficient, spurring students’ interest. Needless to say, this did not happen, which caused this approach to fall out of favour causing various negative comments regarding its educational efficiency. Finally, in the late 90s, several factors led to shrinkage and, finally, to the integration of the digital games market in only a few key players. A development, which, in turn, prevented the rapid adaptation of game industry requirements, to the requirements of the school curriculum (Shuler, 2012).

Ben Sawyer coined the term serious games, marking the beginning of the second age of computer games in schools with the first being the edutainment era of the 80s and 90s [Becker, (2016), p.338]. The game learning-based method has been particularly active in recent years (Richards et al., 2013), as a result of the integration of the various forms of information and communications technology (ICT) and the widespread use of smartphones and other handheld electronic devices (Zaranis et al., 2013).
3 The benefits and obstacles of introducing digital games in the educational process

3.1 The benefits of introducing digital games in the educational process

Education in the 21st century needs to be concerned with making learning activities similarly engaging and passionate – school is a place where learners want to go to in order to explore their passions rather than out of duty or compulsion (Lacasa, 2013). In the current traditional education, the learners can be positioned as passive receivers and are expected to memorise content without getting much context (Hansen and Storjord, 2016). On the other hand, ‘digital natives’, ‘digital literacy’, ‘digital divide’, ‘digital media’ – these and other such mantras such as ‘21st century learning’ – are phrases that continue to be used to characterise both students today as well as the necessary scope of the educational system (Lacasa, 2013).

The majority of school students face school as a boring break from their engagement in various forms of ICT. It seems that the current generation of students is not motivated, nor has sufficient learning outcomes in existing traditional education system (Gee, 2007). The instructional model based on the traditional teaching format is an inefficient method and cannot ensure the high-quality learning outcomes that modern, post-industrial society requires. Traditional instruction is an emotional, social and cognitive experience in which teachers use their knowledge, voice and movement to address the learners with questions and stories (Giannakos, 2013). Many modern educators and researchers advocate for a shift from the traditional standard practice, which is still dominantly practiced in most schools today, to the critical reflective practice (Chan et al., 2017). Schools of all types and on all levels should redesign their curriculum as well as their policies regarding the use and integration of ICT, to best meet the levels of computer literacy of current students and staff (Squire, 2003). Several studies comparing games to more common teaching methods point to the fact that games can provide an enhanced experience (Carvalho, 2016). Digital games are an engaging medium for learning, since games can stimulate cognitive processes such as reading explicit and implicit information, deductive and inductive reasoning, problem-solving and making inferences from information displayed across a number of screens (Bellotti et al., 2009).

Research recognises that gaming can be an effective tool for motivating and enhancing student interest in learning and a valid instructional platform for cognitive stimulation (Willis et al., 2017). Game-based learning has the potential to put information inside the world and give it more contexts (Hansen and Storjord, 2016). This can happen in a safe environment that Gee (2007) calls the ‘sandbox principle’. Educational games create a new culture of learning which is in line with the habits and interests of students. Evidence suggests that games can be used to scaffold learning, a process involving the provision of temporary support to assist individuals in learning, which is gradually reduced as the student improves (Dunwell et al., 2017). Additionally, games-based learning can also provide a better challenge level when it manages to operate at the edge of the learner competence, while traditional learning usually stays at the lowest common denominator and may not be challenging enough for some (Hansen and Storjord, 2016). As Meeri (2016) states video games involve mostly active forms of learning through practicing and doing, rather than by passively watching and listening.

The report of the Federation of American Scientists mentions that the integration of digital games in schools could contribute positively to the reform of the education system
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(Kebritchia et al., 2010). Adding fun to the learning process makes learning not only more pleasant and attractive, but also more accessible (Prensky, 2002). Hence, digital games can promote the active involvement of students, as well as reasoning and problem solving strategies (Gros, 2007). Digital games can enable players to achieve a ‘flow state’, a situation described in the literature by an intense concentration of attention, so as to make hard and often boring school work look simple and often entertaining (Kirriemuir and McFarlane, 2004). Csikszentmihalyi (1990) describes flow as a state of optimal experience, whereby a person is so engaged in activity that self-consciousness disappears, time becomes distorted and people engage in complex, goal directed activity not for external rewards, but simply for the exhilaration of doing (Squire, 2003).

Since 1981, Malone claimed that video games have the potential to enhance learning and both learner and tutor satisfaction with learning through challenge, curiosity, fantasy and control (Malone, 1981). If properly designed, digital games can be very effective as educational tools, providing an alternative way of presenting educational content (Protopsaltis et al., 2011). Digital educational games using the overwhelming enthusiasm and desire of students to play (Kirriemuir and McFarlane, 2004), encourage the development of logical and critical thinking as well as a greater acquisition of knowledge and skills. Stimulating the interest of even the most demanding students, they fully integrate them into the learning process, through learning activities diametrically opposed to the traditional teaching methods adopted by most schools today (Dunwell et al., 2017).

The non-profit educational organisation common sense media notes that it is generally recognised that properly designed educational games can be a suitable approach to modify some of the barriers of knowledge-based teaching approaches used in schools, enabling a shift to student centred learning (Rideout and Saphir, 2013). Additionally, they can stimulate students in ways that abolish the effects of age or level of learning and can provide the right environment for different groups of students to work together to achieve common learning goals. Good educational games can also help teachers to enact the curricula in ways that will help students develop deep understanding of and connections among concepts (Allen et al., 2013).

Educational digital games are rich and stimulating learning environments, because they allow the conduct of virtual experiments that would be impossible to conduct in a real setting, such understanding the complexity of a city, looking back in history, etc. (Klopfer et al., 2009a). Digital games which include simulations, virtual environments, social and cooperative play have the potential to turn into a key educational tool because they focus on interactive and participatory educational activities (Gee, 2007). As Thomas (2009) states the approach described above is applicable even in younger age groups. One such example is the title ‘The Sims’, which is aimed at children of almost all ages and helps them, through unforeseen circumstances, to simulate social situations as accurately as possible, such as the relationships between family members, the role of economic goods, etc. Another successful example is the title ‘Minecraft’ with worldwide sales exceeding 20 million copies. Minecraft is a virtual world where players can build their own environments using Lego-like blocks that can be coloured to look like almost anything (Becker, 2016).

Michael Gallagher, president and CEO of the Entertainment Software Association (ESA), the trade association of the video game industry in the USA, states that digital games can revolutionise education in terms of enhancing student learning. The education system can harness the passion and energy of students for digital games to transform the
face of education for the 21st century, to expand critical thinking skills, to foster student-student teaching and learning and may reinforce evidence-based learning (Institute of Play, 2012). Integrating technology with the game has been proven to be effective for the learning process in all development stages (Schaumberg et al., 2012). According to Garris et al. (2002) games are related to the learning process, as shown in Figure 4.

**Figure 4** Educational game cycle (see online version for colours)

Game-based learning in the classroom can encourage students to understand subject matter in context, as part of a system. In contrast to memorisation, drilling and quizzing, which is often criticised because the focus is on isolated facts, games force players to interact with problems in ways that take relationships into account (Shapiro, 2014). Digital games can not only be used as learning tools, but also as motivators or generators of interest. For instance, the game ‘Age of Mythology’ features a huge number of references to ancient mythology (Greek, Roman, Egyptian). It is not uncommon that a game makes players curious about references and their sources so they look them up and voluntarily start reading books or watching documentaries on these topics (Breuer and Bente, 2010). Most recently, with the rapid proliferation of smart mobile technology, several researchers highlight the advantages of using mobile games, focusing mainly on increasing motivation and their numerous positive effects on cognitive, emotional and social aspects of students (Papadakis and Kalogiannakis, 2017; Papadakis et al., 2016a, 2016b, 2016c).

Summarising, there is an increasing body of evidence for the contribution of digital games in developing students’ skills and abilities (Groff et al., 2010). A critical review of learning opportunities based on games, conducted by TEEM, an organisation that evaluates educational software, identified several skills which were developed through a number of properly designed studies (McFarlane et al., 2002). These skills are directly related to the development of students’ strategic thinking, problem-solving skills, research-design skills, communication skills and an increase in their self-regulation competence as well as communication skills, creativity skills, IT skills, etc. Similar results were reported by several other researchers (Klopfer et al., 2009b, 2009c; Groff et
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al., 2010; McFarlane et al., 2002). Kirriemuir and McFarlane (2004) state that teachers recognise that playing games can support valuable skill development, such as: planning, communication, negotiating skills, group decision-making, data-handling. Students have an active role in their learning by using games. They can repeat activities several times, they can progress at their own pace and failure is an opportunity for learning and for trying again, not something to be concerned about (Cruz et al., 2016). Summing up, the arguments for the use of digital games in education are that they (Ke, 2008):

- encourage active participation of students
- encourage active learning
- can be effective tools to enhance the learning process particularly in complex or obscure topics
- promote cooperation among students.

Therefore, educational games can help students to (Prensky, 2007):

- use action (and therefore experience) instead of interpretation-explanation
- create personal motivation for learning
- ‘accept’ multiple learning styles and skills
- reinforce their skills through an interactive decision-making environment.

3.2 Skepticism – barriers about the use of digital games in the educational process

As Giannakos (2013) points out the introduction of games in teaching is often complex and learners do not always use them as expected and/or learners do not have the expected performance when they are using them. Despite the many studies of the learning and motivational effects of digital games, teaching with digital games is not yet widespread in secondary education (Huizenga et al., 2017). Games still carry a stigma for some educators and the idea of “games in the classroom” is frowned upon in some schools (Groff et al., 2015a). Additionally, the results of studies comparing serious game environments (SGEs) with conventional media are still highly contradictory. Those results do not allow us to conclude that educational games and simulations have a positive effect on learning and motivation. Some authors believe that these contradictions stem from that fact that the effects of digital games based learning can be modulated by a range of different factors (Erhel and Jamet, 2013).

In schools, barriers to adoption include not only negative perceptions towards the educational value of games but also the difficulty of providing good enough games to keep students interested (Carvalho, 2016). An analysis of the digital games market shows that successful games offer complex experiences for players, feature beautifully rendered characters and landscapes and show ever more realistic animations, but have very little, if any, educational purpose and value (Bellotti et al., 2009). On the other hand, most edutainment has failed to realise expectations (Kirriemuir and McFarlane, 2004). For some learning game designers, the emphasis of the design and primary driver is the game’s playful mechanics and design; whereas for others, the primary focus is on assessment and data collection. However, too often these approaches fall short in the
other areas. Balanced design argues for the coordination and alignment of these three areas – game design, content and assessment – for a more powerful learning experience and a more robust learning tool (Groff et al., 2015b) (see Figure 5).

**Figure 5** Effective game design for a powerful learning experience (see online version for colours)

Some researchers are skeptical of the use of the game as an educational tool. The reason is that technology alone cannot guarantee effective learning, as a suitable educational design based on fundamental principles of learning is necessary. Digital games are rarely considered a valuable asset and teachers hold the belief that they are not likely to fit easily into existing teaching routines (De Grove et al., 2012). One of the most frequently encountered obstacles is that it is difficult for teachers to quickly identify how a particular game is relevant to some component of the statutory curriculum, as well as the accuracy and appropriateness of the content within the game (Groff et al., 2015a). For example, Van Eck (2006) states that one of the biggest misconceptions among educators is that if a game is missing content or has inaccurate content, it cannot be used responsibly for DGBL. Negative teacher perceptions can be an important barrier to technology integration in general and to using digital games for learning in particular (Huizenga et al., 2017). Teacher perceptions are important because teachers play a crucial role in selecting, implementing and evaluating educational games for their students (Huizenga et al., 2017). However, educators can use these teachable moments to create cognitive disequilibrium (through instructional strategies and activities) by presenting or designing activities by which students discover information that conflicts with the game and the student’s knowledge (Van Eck, 2006).

The challenges in embedding serious games into formal education lie in their ability to demonstrate the complexity and interconnectedness of issues. These challenges can be approached through the use of three frameworks, namely the identification of learning goals, identification of teaching enhancement and game assessment. In the area of pedagogy, the learner needs to be active while playing rather than be cognitively overloaded (Papanastasiou et al., 2017). The greatest obstacle to integrating the use of
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Games into the curriculum is the mismatch between the skills and knowledge developed in games and those recognised explicitly within the school system. It seems that the final obstacle to the use of games in schools is a mismatch between game content and curriculum content and the lack of opportunity to gain recognition for skill development. This problem is present in primary schools, but significantly more acute in secondary (McFarlane et al., 2002).

Gee (2005) points out to those involved in the educational process that is not enough the use of digital games in education, but it would be most effective when used in conjunction with effective learning tools, environments and systems. The same researcher states that a game is not evaluated as educational because it has modern three-dimensional graphics, but the extent to which the games features are exploited, both inside and outside the classroom. The overriding objective in a typical playful learning activity is a successful combination of education and entertainment, something that is not always feasible. Although there are typically elements that are repeated in successful games, their simple integration does not guarantee a good outcome, especially when it comes to educational games (Prensky, 2005b). Also as Becker (2016, p.337) state, we cannot assume everyone will like a lesson just because the teacher is using a game. Some students do not play many games and a few do not play them at all. Some may even resent the fact that teachers are using their favourite out-of-school activity in school. Becker suggests that the teacher must be prepared to tell students why they are doing it and what they should get out of it (Becker, 2016).

Even though some games can foster positive educational outcomes for a variety of learners in specific subjects, this conclusion cannot be generalised to all games in all learning areas for all learners (Kordaki and Gousiou, 2017). Simply introducing a game in the classroom, without a preconfigured teaching context, will be more negative than positive (Squire, 2003), as not all games are appropriate nor addressed to each student. For example, students’ attention may be disrupted by introducing a game in the classroom and thus the desired objectives will not be achieved. Additionally, a game has to not only be age-appropriate, but also time-appropriate. Students may ultimately fail to extract the required knowledge of a game, especially when it is not based on a well-designed interface or when there inapplicable learning objectives incorporated in its structure. Other researchers who are associated with game design, are worried that the creation of games in which the main objective is to ‘facilitate’ the learning process will eventually converge on losing the playful, yet attractive nature, so it is no longer attractive to students (Smith and Mann, 2002).

Although Cordova and Lepper (1993) note that digital games enhance learning by increasing student pleasure, they sound the alarm that these kinds of activities may distract students’ attention from the learning content, undermining the learning process and students’ achievement. The obstacles which contribute to the negative view on the use of games include poor or low quality graphics, the lack of time in the curriculum, the inadequate representations of the learning objectives when games are used in the educational process and a general mistrust of the term ‘game’ and its use in the classroom as an educational tool (Rice, 2007a). Corresponding research findings suggest to researchers and practitioners (Garris et al., 2002, Van Eck, 2006, Gee, 2007) that in order for a game to be effective in the educational procedure it must meet some basic features such as a functional interface, proper use of graphics and multimedia features, the proper integration of learning activities in the game plot, well designed characters etc.
Despite the potential of games as tools for teaching and learning, teachers, as indicated by Klopfer et al. (2009a, 2009b, 2009c), could possibly face barriers to adopting games in class. For instance, they might have little experience of integrating games into the classroom and they might have problems engaging students due to insufficient understanding of the variety of games available as well as the lack of data and assessment feedback from games (Groff et al., 2015a; Hsu et al., 2017). Several other types of barriers teachers face when they use games to teach include: expertise (they need training), systemic (it is difficult to integrate game playing in the rigid curriculum), financial (the cost of games) and technical (lack of dedicated equipment in school) as well as a lack of documentation and training support, technical support and research and development support (Van Eck, 2006). Consequently, the choice of digital games can be limited (De Grove et al., 2012). As Rice (2007b) states, teachers are limited when they use video games because they do not have the technology to support video games within the classroom. The same researcher notes that many of today’s advanced games require newer technology to operate than what the older operating systems within the classroom can tolerate. The use of mobile devices by students will address some of these barriers as they can use them anytime and anywhere, playing the game inside and outside the classroom (Cruz et al., 2016).

To sum up, as with any new instructional tool, there are barriers to digital game use in the classroom. Some are physical barriers, some are cultural and some are perceptual (Groff et al., 2015b) as shown in Figure 6.

**Figure 6**  Barriers to digital game use in the classroom (see online version for colours)

Source: Adapted from Groff et al. (2015b)
4 Games implementation strategies in the formal educational context

Using digital technologies is a creative experience in which learners actively engage with solving problems in authentic environments that underline their productive skills rather than merely passively consuming knowledge (Lacasa, 2013). Digital games are based on the principle that playing is learning in a challenging environment where students can make mistakes and experiment through a process of trial and error (Papanastasiou et al., 2017). As Gee (2004, p.23) states: “When we think of games, we think of fun. When we think of learning we think of work. Games show us this is wrong. They trigger deep learning that is itself part and parcel of the fun”. Games can make learning more engaging and satisfying, offering at the same time, the possibility to expose learners to experiences that would be impossible, unsafe or at least impractical to reproduce in the real world (Carvalho, 2016).

Many researchers and educators have indicated that teachers play the dominant role in the use of games in a formal educational context (Hsu et al., 2017). Alexander et al. (2010) state that teachers can implement video games into classroom instruction as follows:

1. digital games possess educational value and by having players interact with them they are engaged in significant learning
2. digital games do not possess initial educational value, but content can be interwoven through instruction
3. video games are used as a simulation and have a direct tie to the curriculum.

Figure 7 Teachers roles in a game-based learning scenarios (see online version for colours)

Source: Adapted from Becker (2016)
Accordingly, Becker (2016, p.221) states that there is a list of nine roles that teachers can take on in game-based learning scenarios. These roles are not mutually exclusive. It is common for a teacher to take on multiple roles at once as well as slip back and forth between roles (see Figure 7).

When a teacher is to use an educational game in his/her teaching, the decision is not easy, as there is a wide variety of different kinds and types (Groff et al., 2016). For the reasons above, Squire (2008) created taxonomy of digital games based on two axes: timetable and implementation. The reason he chose to use these two classification axes is because the choices of educators are guided or restricted by the available time as well as the type of teaching method or pedagogical method they implement. At this point, it should be noted that the time the researcher counts in his classification, refers to the time, that is required for someone dealing with the game for recreational purposes, generally and not necessarily to the time required for use in the classroom (see Table 1).

<table>
<thead>
<tr>
<th>Game genre</th>
<th>Time to completion</th>
<th>Timescale</th>
<th>Open-endedness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Targeted games</td>
<td>1–4 hours</td>
<td>Weeks</td>
<td>Low</td>
</tr>
<tr>
<td>Linear games</td>
<td>20–40 hours</td>
<td>Month</td>
<td>Low</td>
</tr>
<tr>
<td>Open-ended games</td>
<td>100–200 hours</td>
<td>2–24 months</td>
<td>High</td>
</tr>
<tr>
<td>Persistent words</td>
<td>500+ hours</td>
<td>6–48 months</td>
<td>High</td>
</tr>
</tbody>
</table>

Source: Adapted from Squire (2008)

Targeted games have been designed with a specific theme or concept, such as adding fractions or photosynthesis. These types of games are easier to integrate into the classroom, because they can act complementary to the curriculum and can be implemented within the traditional school curriculum. Linear games can be either short or long term and generally include a story path through the game. An example of such an approach is the game ‘Lure of the Labyrinth’. It is a game that rewards the student for learning algebraic concepts and is addressed to students of secondary education. It includes a large collection of mathematical puzzles, embedded in a compelling narrative, in which students work to find their lost pet and save the world from monsters. Open-ended games provide tools and a platform to build objects and/or scenarios and generally offer a rich learning context through which specific learning objectives can be achieved. For example, ‘Civilization’ is a strategy game that takes place on a flat map of a computer-constructed world. The player develops several skills and learning objectives such as the cultivation of critical and moral thinking through the development of empires and civilisations (Fitzgerald and Groff, 2011). Finally, virtual worlds, such as those which occur in massively multiplayer online role-playing game, e.g., the ‘World of Warcraft’ (WoW), are often difficult to be integrated into the classroom because of their complexity. Several studies have found that games of this type provide rich learning environments. Positive claims have been made about the educational potential and learning opportunities provided by commercial games, such as increased motivation, raised interest in specific subjects, multiple representations, an open-ended approach to information, students in control of their own learning processes and peer collaboration (Bourgonjon et al., 2013). Correspondingly, Groff et al (2016) created a simple model of games categorisation based on the aforementioned work, as shown in Table 2.
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Table 2  Digital game categorisation

<table>
<thead>
<tr>
<th>Examples</th>
<th>Commercial</th>
<th>Educational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short form</td>
<td>Angry birds</td>
<td>Lure of the Labyrinth</td>
</tr>
<tr>
<td>Long form</td>
<td>World of Warcraft</td>
<td>Minecraft</td>
</tr>
</tbody>
</table>

*Source: Adapted from Groff et al. (2016)*

Short form games include games that have been categorised as targeted games and some linear games, such as ‘Angry Birds’ or ‘Mario Kart’. ‘Angry Birds’ can be used to explore the physics behind trajectories. This game involves “firing” an angry bird at a structure in order to knock it down and get at the green pigs hiding inside (Becker, 2016). This category of games can be more easily integrated into the classroom environment in relation to long form games. Additionally, they show a sharp increase in their number due to the rapid development of smart mobile devices and their accompanying mobile applications (Richards et al., 2013). Long form games extend beyond the regular teaching period. They require extensive planning and preparation by the teacher, an optimal alignment with respect to the curriculum. However, they can be used in the ‘flipped classroom’ model, in which learning takes place outside of the classroom, but also could serve as a framework for further ‘exploration’ in the classroom (Richards et al., 2013). A further advantage of the use of games of this type is that they develop new approaches to teaching 21st-century skills such as problem-solving, decision-making, appropriate use of ICT resources, action planning, etc. (Klopfer et al., 2009).

With regard to the suitability of each digital game for age and content, a teacher can be helped greatly in his/her choice by using the Pan European game information system, (PEGI) (Felicia, 2009). The PEGI system takes into account the suitability of a game for a certain age and not the difficulty level or skills required for a game (Felicia, 2009). This system includes age rating labels and content classification labels, that may help guide parents and teachers in the selection of age appropriate digital games for children (see Figure 8).

**Figure 8** Age-rating and content classification labels (see online version for colours)

![Age-rating and content classification labels](http://www.pegi.info)

*Source: Adapted from http://www.pegi.info*

Also, given the popularity and the frequent efficiency of commercial games compared to educational games, it is useful for the teacher to know the key differences between the
two types of games, because they highlight the dynamic influence of genres and environments on school-related processes (Gee, 2003). Commercial games are rarely linked with the curriculum and they cannot be used without ‘interpretation’ or ‘translation’ to provide a student-scoring mechanism. Unlike in the case of serious games, i.e., games that are designed specifically for educational use, the integration of games in the core curriculum is feasible, which seems to be important in facilitating both a formative and summative assessment of students’ learning. Educational digital games or serious games are powerful, innovative learning tools whose foremost goal is to integrate education rather than provide entertainment (Kordaki and Gousiou, 2017). The term “serious game” is often used to refer specifically to the class of digital games intentionally created for teaching certain skills, knowledge, competence, or promoting a specific attitude towards a topic, as an instructional tool in itself, or as part of a larger curriculum of activities [Carvalho, (2016), p.24].

At this point, it is considered useful to explain how serious games differ from other concepts like edutainment or entertainment education. As Breuer and Bente, (2010) state edutainment became a buzzword in the production and evaluation of educational media during the 1990s. Although some researchers use serious games and edutainment as synonyms, most game designers and researchers agree that serious games go beyond edutainment. Game-based learning and gamification are not the same. Edutainment games are a subset of serious games. Digital game-based learning is learning that happens with the help of digital games. A serious game is a digital game designed for purposes other than or in addition to pure entertainment (Becker, 2016). Edutainment games are those games within the serious games family which are mainly developed for use in K–12 education, have a focus on the conveyance of curricular textbook knowledge and rather pursue additive combinations of entertainment and education in a motivator or reinforcement paradigm (see Figure 9).

Figure 9  The relation between games and educational concepts (see online version for colours)
Entertainment education refers to any attempt to make learning (more) enjoyable, no matter if media-based, mediated or within a classroom setting. Digital game-based learning is the section of serious games, which incorporates education/learning as the main or sole purpose. These games are usually educational in subject matter, engaging and motivating the students to learn (Breuer and Bente, 2010). Gamification, while related, is the use of game design elements (as opposed to entire games) in a non-game context (Becker, 2016). The classic edutainment video games that experienced their advent in the 1990s are one segment of digital game-based learning (Breuer and Bente, 2010).

The most successful commercial games for educational use are those referred to as the ‘big G’ games (Gee, 2012). These are games which include not only the game itself, but also the social interaction that develops around it. Typically, games of this type comprise a plurality of features which Gee (2003) has incorporated in a list of 36 principles known to contribute to the creative use of games. As Becker (2016) states, Gee principles have become well known for connecting notions of what is considered good practice in situated learning to what is experienced while playing (good) games. Some of these features are the promotion of collegiality, the development of critical thinking ability across different fields, etc. In general, there are very few examples of commercial games, which can be effectively used in school conditions. The most representative example is the commercial game ‘Civilization III’ as shown by a study conducted among students in Boston. Similarly, positive results were shown by the results of Simon Egenfeldt-Nielsen’s study with the game ‘Europa Universalis II’ as part of his doctoral thesis in 2005 (Groff et al., 2016). In summary, these studies showed that commercial games can promote thinking and problem solving skills, however, always within an appropriate teaching context and the corresponding necessary teacher preparation. Corresponding findings have been seen with the use of games such as ‘The Sims’, ‘CSI’ and ‘FIFA World Cup Soccer’.

On the other hand, are the ‘small G’ games, which according to Gee (2012), include only the gameplay of the game and probably do not include the majority of the 36 principles which are used by the same researcher in order to evaluate a game, most notably the lack of social interaction. What is clear, though, focusing on a game alone is not enough to create the best learning environment, but there is a need to develop shared meanings through social engagements and interactions among students (Gee, 2012).

**5 Conclusions**

Whether in the form of smartphones, laptops, or tablets, digital technologies may be increasingly ubiquitous in a person’s social life but marginal in their daily educational experience once they enter a classroom (Lacasa, 2013). In many cases, digital games have proven to be powerful education tools not inherently, by their design, but mainly through their effective classroom implementation (Groff et al., 2010). Besides, the vast majority of the research literature related to the use of digital games in education confirms the positive relationship between active learning and student outcomes. Gaming presents an opportunity to engage adolescents through a medium which is increasingly prevalent as a leisure activity (Dunwell et al., 2017). As far as is known, ‘fun’ and ‘learning’ are not mutually exclusive terms, while, on the contrary, learning can be fun.
and effective too. Thus, it is not a surprise that games are growing in popularity at all levels of education, to include simulations, virtual environments, social and cooperative play and alternative reality games. As Van Eck (2006) states, the combined weight of three factors has resulted in widespread public interest in games as learning tools: the ongoing research conducted by digital games based learning proponents, the ‘net generation’ who has become disengaged from traditional instruction and the third factor is the increased popularity of games.

Considering the fact that various studies show that digital games are an effective and useful tool for learning, often gives the false impression that the integration of each and every game is beneficial to the educational process (Becker and Gopin, 2016; Van Eck, 2006). Clearly, the above approach does not apply. In fact, it is important to note that if a game is intended to be introduced in formal education, the environment and the activities that will facilitate the integration of the game are the key to realising the full potential of its use. The size of the game, which is translated as the amount of time and effort devoted by the teacher to adapt the gameplay according to classroom requirements and the expected duration of the game are also important when considering several constraints when analysing game integration in the school environment. Finally, the appropriateness of each game, like any other educational technology, depends not only on the value of the digital game itself, but also on the requirements, characteristics and limitations of the learning environment, as well as the teachers and students who will ultimately use it. A central component of the movement to help game-based learning be a central tool in today’s classroom is to provide educators with the knowledge, resources and support necessary to overcome these barriers (Groff et al., 2015a).

Much has been written during the first decade of the new millennium about the potential of digital technologies to radically transform education and learning. Education in the digital age is precisely concerned with harnessing and activating the potential of the learner’s voice and video games offer a means of doing so (Lacasa, 2013).

References


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