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Chapter

Digital Games in Primary Education

Dionysios Manesis

Abstract

Digital educational games create a new perspective in learning culture, which go hand in hand with the interests of the pupils. Digital educational games are an innovation in primary education that can enhance children learning and acquiring skills. The integration of digital educational games in the school environment of primary education could effectively contribute to reforming the educational system. Early childhood education and primary education teachers can play a crucial role in supporting children's digital game-based learning (DGBL). Teachers' beliefs about using DGBL are important and often limit their efforts to integrate new technologies into the classroom. Positive views can help teachers embody DGBL in their teaching methods more easily. Thus, without the knowledge of teachers' views and intentions about using DGBL in primary education settings, any potential innovations in this area may lack utility. The scope of this chapter is to investigate the pedagogical dimension of digital educational games as far as the primary education concerns, examine the factors that influence the effectiveness of games in the learning procedure, give valuable information in the designers of digital educational games, and finally examine primary school teachers' beliefs about DGBL, as well as their confidence in integrating digital educational games in the classroom.

Keywords: digital educational games, digital game-based learning, primary education, pupil, primary education teacher

1. Introduction

Despite the fact that digital games consist, for the younger generation, a distinct form of informal information and communication technology (ICT) literacy practice [1], digital game-based learning (DGBL) has evolved into an integral and part of didactical use of ICT, especially in primary education [2]. Nowadays, digital games are a rapidly expanding field, mainly because they are considered as the most popular technology in children's entertainment. At the same time, digital games, when properly designed and utilized in a pedagogically appropriate manner, can be utilized as learning tools to improve the effectiveness of the learning process at all levels of education.

Literature on primary education and DGBL [3–17] has emphasized that digital educational games can enhance children's learning, social interactions, proper behaviors, problem-solving, higher order thinking, critical ability, memory, and eye-hand coordination skills. In addition, in primary education, digital educational games are seen as a dynamic tool for developing pupils' cognitive skills and enhancing their learning motivation. For example, when a pupil completes an activity

through an appropriately customized digital educational game, deals better with cognitive concepts, and is able to embrace the key points of a module more easily. Furthermore, pupils often take responsibility for their own learning style and consequently become more autonomous in their actions and decisions [18].

The overall aim of this chapter is to investigate the pedagogical aspects of digital educational games in the primary education. This chapter also aims at examining the factors that influence the effectiveness of games in the learning procedure, giving valuable information in the designers of educational policy as far as the DGBL concerns. Finally, the specific chapter examines primary school teachers' views about DGBL, as well as their confidence in using digital educational games into the classroom. Teachers' views are essential for DGBL integration in primary education settings, as positive views are crucial for influencing their decisions to use DGBL methods in their teaching. It is thus crucial to investigate primary school teachers' views and intentions about integrating and using digital educational games in their classroom. Their views and intentions may predict the integration of DGBL in primary education, while successful integration will also depend on other parameters such as appropriate skills and training. Such an investigation is also helpful for the design of primary school teacher training programs. The content of related modules could take into account teachers' views and intentions and address them accordingly.

2. Definition of digital games

There is a wide range of terms and definitions in literature related to digital games, mainly due to the existence of multiple digital media designed for gaming. As a consequence, the meaning of digital games has become synonymous to a wide range or terms, such as computer games, digital games, electronic games and video games. A brief definition of digital games entails their description as a wide variety of digital applications characterized by some common elements (e.g., the gaming environment, the strong participation of the gamer, the element of interactivity, and an increased use of multimedia) [19].

According to Prensky in [20] (pp. 118–119), a game can be defined as digital based on six characteristics leading to the gamer's involvement (when combined). These are the following characteristics:

- The rules of the game.
- The aims of the game.
- The result and its feedback.
- The element of conflict/competition/challenge/rivalry.
- The element of interaction.
- The representation of a story or plot.

Digital games are based on predetermined rules and limitations which lead the player toward a clear goal also defined by a specific challenge. The features of such games interact constantly with the player, while providing feedback either through scoring or through changes made in the world of the game, thus allowing players constant watch over their progress and practice their skills through overcoming numerous obstacles during gaming [19, 21–23].

3. Definition of digital educational games

Digital educational games are software applications which combine both the characteristics of video games and those of computer-based games. They aim to design enticing learning experiences that successfully correspond to specific learning aims and results [24]. Digital educational games also take into account the desire and enthusiasm of students toward playing, while encouraging the development of logical thinking and the acquisition of knowledge, abilities, and skills. They can potentially stimulate the interest of the most demanding of students by assimilating them into the learning process through activities away from the traditional didactic methods adopted by most schools. In order to achieve this, digital educational games make use of multimedia and Internet technologies. At this point, the student has the ability to comprehend the demanding terms of a learning subject in his own learning pace through interactive and engaging applications and activities. Additionally, the possibility for socialization, cooperation, and creative expression is offered to learners of all grades through their interaction with digital environments and virtual worlds [25].

Digital educational games are considered to be attractive because of their entertaining features in combination with their pleasant environment, their esthetic quality (graphics, effects, music), the existence of a structured framework, their learning goals (also presented as problems demanding solution), and the existence of the gaming dimension (causing also the strong participation of the learner) [26]. As a learning approach, digital educational games are considered to be contemporary learning tools and modern mediums of learning by bringing education to a new dimension. When used appropriately in an organized learning framework (with specific learning objectives, appropriate developmental design, and evaluation), digital educational games can be classified as active learning environments [26].

4. Classification and characteristics of digital educational games

According to their educational use, digital educational games can be classified into three major categories: educational games, leisure games, and educational leisure games [27]. The main definition of educational games refers to games designed with specific educational aims in order to support the teaching and learning processes. This definition includes games belonging to the "serious games" category, to "edutainment," "game-based simulations," and "epistemic games." Leisure games are defined as games which do not promote learning as a clear and exclusive aim, although they also do not exclude their potential use when enforcing learning. This category consists of commercial games, also known as commercial off-the-shelf games (COTS games). Educational leisure games are those used in class or in laboratory to support and enforce teaching and learning despite the fact these are designed for commercial purposes (e.g., The Sims, RollerCoaster Tycoon series, Civilization, and Age of Empires). This category is also continuously being expanded since digital gaming market companies are aware of the possible future inclusion of digital games in education, in universities, and even in military training.

Digital educational games do not set enjoyment and fun as their primary objective, but their environment includes educational content in a challenging and enjoyable way which promotes active learning [22]. From a bird's-eye view, digital educational games must harmonize engagement, challenge, entertainment, and learning [28]. Digital educational games are based on four main elements which are

engagement, autonomy, mastery, and progression. Engagement is connecting the player with the educational content of the game. Digital educational games allow player to be more autonomous as far as the ability to make decisions and take appropriate action is concerned. Mastery is the degree of repeatability of players' specific actions in order to gain full control of the game. Progression refers to the reward to players for their success. In fact, progression is the main motivation for players to accomplish the game's goals while learning at the same time [29]. The evaluation of digital educational games can be conducted through several quality characteristics: game design, user interface, engagement, enjoyment, usability, playability, usefulness, cognitive behavior, pedagogical aspects, and learning outcomes [22].

5. The use of digital educational games in primary education

The didactic model of traditional teaching can be deemed as a noneffective method, which cannot also ensure great learning outcomes (at least as demanded by contemporary society). The current generation of pupils seems to lack motivation and satisfactory learning results as encountered in the existing traditional educational system [30]. Bodies from all educational levels need to redesign their schedules as well as their policies on the use and incorporation of DGBL corresponding thus to the current digital literacy level of learners. In addition, digital educational games are suitable for digital natives [31]. Indeed, this is one of the main reasons behind the increased levels of use of digital educational games in primary schools.

Educational games offer a new perspective toward the culture of learning, which conforms to the habits and interests of learners. According to a relevant report by the Federation of American Scientists, the integration and use of digital educational games in the school environment could effectively contribute to the reformation of the educational system [32]. When adding the element of entertainment in the learning process, education becomes not only more interesting and pleasant but also more effective [33]. As a result, digital educational games can successfully promote pupil participation, cooperation, and the development of problem-solving strategies [34]. Digital educational games can also place the learner-player into a situation described best by the term "flow" which is characterized by an increased attention span where all demanding tasks seem to be simple and fun. Learners are encouraged to learn by playing digital educational games, since such games offer an alternative learning environment which is both fun and effective.

All appropriate digital educational games can be very useful and effective educational tools, providing an alternative way of presenting educational content [35]. The educational organization known as *Common Sense Media* supports the belief that appropriately designed educational games do not distract pupils. On the contrary, they can be used as support channels for all practices and types of learning and teaching. Additionally, digital educational games can motivate students independent of gender, age, or level of education, while offering an appropriate environment to different learning groups, for achieving common learning goals through cooperation. Educational games may also support teachers in their attempt to teach different types of pupils [36, 37].

As Klopfer et al. described in [38], digital educational games are usually defined as rich and exciting learning environments because they allow players to access environments otherwise impossible (e.g., players can go back to the story, manage entire civilizations, or handle the intricate operation of a big city). Digital educational games that include virtual worlds and simulations can also be transformed into necessary educational tools, mainly due to promoting and upgrading

participatory interactive and entertaining activities [39]. All appropriately designed games are able to support learners in developing such abilities and skills that will be proven valuable to the real world and which cannot be effectively taught through traditional teaching [40]. This fact could be applied to primary school students. Such an example could be "The Sims" game addressing students of all ages, while assisting in the simulation of social situations through a variety of unpredictable situations (e.g., the role of economic goods and the relations between family members). Another example could be the game titled "Minecraft" whose sales exceed those of 20 million copies.

Primary education is considered to be the most appropriate of all levels of education for the integration of digital educational games to occur. This happens due to the fact that primary schools can adequately respond to new and complex development-related challenges. In primary education, there is need for profound change, while the use of DGBL can be easily implemented through expanding and supporting the existing traditional teaching methods. The following components support the assumption of an efficient integration of digital educational games in primary education through:

- A framework for the introduction of ICT in primary education teaching and learning called "Cross-Thematic Curriculum Framework for ICT." This framework mentions ICT as an essential part of education and a powerful tool for both pupils and teachers. It is also important for children to always come in systematic contact with technology for their all-rounded development.

- The flexibility of the curriculum.

- The combination of digital educational games with the curriculum in an easy and immediate manner.

- The prospects for the evolution of digital educational games based on the relatively positive views of the majority of primary school teachers (especially of the young ones).

- The pupils' psychological and emotional development through the use of digital educational games.

Furthermore, DGBL can enhance the study program of primary education as far as the ways of promoting learning are concerned. The educational system can make use of the energy and passion displayed by pupils on digital educational games in order to use these for improving its learning processes, based on the acquisition of meaningful abilities and skills. The incorporation of new technologies in the game is indeed essential to the learning process in all stages of development.

According to Shaffer in [40], there are certain principles which explain the way of learning through the use of digital educational games:

- All previously acquired knowledge by the learner is in position to both assist and hinder learning. Undoubtedly, all pre-existing knowledge upon a subject is favorable. If someone's knowledge is flawed, this will become obvious only through a test when sticking to the traditional learning method. In the case of learning through digital educational games, the same person will be able to trace his problematic point easily and fast, since one wrong move leads to consequences. By doing this, the user will be able to correct himself and move forward.

- The learners' motives direct, define, and support their steps toward learning. Learners are usually motivated by scores and the progress of games. For example, they play persistently until they reach a safe score in the game. Through this process, they learn how to act in the environment of the game, how to experiment, and how to think and learn about the completion of a task. In this way, they develop a productive and consistent way of thinking.

- Learners need to acquire abilities and skills for perfecting and applying all knowledge acquired. Usually, the design of a game is focused on rules and learning parameters without dwelling on their possible application. In contrast, all well-designed games are adjusted to each player and his learning pace. The learner keeps his basic knowledge as a starting point, but he cannot move forward without completing all levels. So, the game represents a realistic, interactive, and active learning environment that is focused on thinking, learning, and applying the appropriate knowledge at the appropriate time.

- Target-based practice is connected to feedback and to the enhancement of quality learning. Traditional learning does not provide any success-motivated feedback and does not offer pupils the possibility of constantly placing their thoughts and abilities in a realistic environment. In digital educational games, players are motivated by the aims of the game, while learning through errors and their consequences. Indeed, feedback motivates players to keep trying until they reach the goals of the game, providing them also with all necessary information to succeed.

Users consider games a relaxing and natural activity which leads them to also view computers as gaming tools. At the same time, users expect recognition of their efforts by the game either through feedback or by being encouraged to proceed to more difficult procedures [41]. Through this process, the "I act to learn" model is being developed as opposed to the "I learn before I act" one. Learners also develop their fantasy through the environment of the game, while creating all appropriate conditions to approach new technologies in a friendly way [40].

When considering the use of digital educational games as pedagogical tools, teachers can play an important role by ensuring that their pupils re-evaluate all problems appropriately during the learning activity of the game. Digital educational games can also provide the learner with satisfactory interaction and can offer multiple chances for learning by doing.

Teachers today have to ensure that learners have the appropriate reflexes to gaining knowledge through playing digital educational games. DGBL is considered to be the fundamental component of teaching, although they do not have to play a central role to be deemed as necessary to learners. For example, (see [31]) pupils may be taught a foreign language by the traditional teaching method while in class and practice the language at home using the equivalent digital game. Digital educational games may also have additional value as supplementary teaching/learning material and as source teaching/learning material at the same time.

As new multipurpose mediums that activate pupils' interest and learning, digital educational games offer new perspectives that need to be treated maturely by teachers interested to renew their means of teaching. But it is impossible for digital educational games to be treated as educational materials without fulfilling specific requirements to support in-class learning. Those requirements are a combination of the digital educational games' content and the basic principles of class management, which are fundamental for the development of digital educational games.

Most researches based on the use of DGBL in primary education focus on the investigation of how digital educational games and gamification (the strategic use of games' elements to reach a goal) can be used to motivate students, to improve their skills, and to maximize their knowledge in different disciplines [3, 42–44].

6. Effectiveness of digital educational games as learning tools

A part of the research conducted is based on digital educational games and their ability to pique the interest of students. This investigation indicates that most digital educational games display some common characteristics such as the sense of control, curiosity, and the cases of intrinsic and extrinsic fantasy [26]. Based on such results, some teachers seem to support the use of digital educational games as part of didactic activities. Digital educational games are those types of games which encourage the development of logical thinking and the acquisition of knowledge and skills in a pleasant manner. Their background is connected to pieces of knowledge that users need to apply in order to achieve all goals proposed. The additional value brought to the educational aspect of digital educational games is based on the motives introduced to learners supporting the gain of knowledge while having fun. At the same time, the use of multimedia and all interesting stories can become "partners" of the user during the game leading to the achievement of all learning goals [26, 41].

On the other hand, there are many factors which can influence the effectiveness of digital educational games. These factors are related to the user's personal traits, his preferences, and personality, since not everyone has the same style and attitude while interacting with digital educational games or during problem-solving. For that matter, designers of digital educational games make use of various teaching methods and strategies for developing their digital game environment. One of the most important processes for the creation of acceptable and motivating activities is the technique of placing the user's abilities and the challenges encountered within acceptable limits. By doing this, the user will not be left with feelings of boredom, lack of fun, worry, or stress. When the challenge is above the user's abilities, it usually brings up feelings of anguish and disappointment, while a challenge below the user's abilities will probably bring a sense of monotony [45].

It must be mentioned that there are several uncertainties, concerning the learning effectiveness of digital educational games. For example, there is gap of consensus concerning the factors that may have an impact on DGBL effectiveness. As a result, more sophisticated assessment models are needed, which will take into account more direct or indirect factors and interactions [46].

During the past years, the spread of digital educational games has instigated further research on their potential as learning tools (especially when addressing younger audiences). The game's environment is considered as impressive and typically captures the attention of users, while the quality of graphics and its realism increases the player's involvement and identification with the game's characters. The user's active role, the challenge presented, his curiosity, the fantasy, and the conflicts are all factors that make players get acquainted with the way the plot of the game is structured and also allow them to engage in the game. The experience of the game is the cause of the player's intrinsic motivation to remember, understand, and apply in accordance with the version of the game's taxonomy of educational objectives [47].

In addition to this, digital educational games allow for an overall presentation of a subject and promote the active role of the user who takes initiatives. They also support stand-alone activities where the activity itself becomes the motive of

involvement while the game and the adjustment of its functions occur according to the preferences and level of the user [30]. At the same time, digital educational games can contribute to the achievement of specific learning goals, such as promotion of knowledge, cognitive development, social interaction, and the shaping of attitudes [10]. Digital educational games are effective when increasing the students' skills, in cases such as socialization, cooperation, problem-solving (use of memory and mathematical skills), and the visuomotor coordination [3, 9, 48, 49]. Digital educational games may also provide models of appropriate learning practices [13].

The structure of digital educational games which usually attracts players involves the immediate reaction from the game's environment to each action of the player, its dynamic images, the interaction, the existence of a specific goal, the set of rules, the challenge, and the elements of fantasy and curiosity [29]. Prensky in [26] presents an extensive research on the field of DGBL and the qualities corresponding to different types of learning. All interactive learning techniques applied to digital educational games (e.g., practice and feedback, learning by doing, goal-oriented learning, discovery learning, role-playing, and constructivist learning) render them applicable to a wide range of learning types. All of the features mentioned earlier puff the potential of integrating DGBL into existing educational platforms.

7. The role of the teacher

Despite the fact digital educational games demonstrate great potential of evolving and becoming integrated in primary teaching and learning, their application demands attention in order to exclude all possible weak points from their proper function. The use of digital educational games in a class of primary school demands the teacher's attention on the content, structure, and design parameters. At this point, the teacher plays an important role in order to ensure the quality of learning and the participation of learners. Apart from it being essential, the teacher's role entails also creativity since he is expected to include game-based learning in his teaching techniques. This occurs due to the fact that all primary school curricula do not contain detailed instructions for the appropriate use of digital educational games [2]. So, the teacher is called to integrate games appropriately in his teaching methods, while combining games with a discussion process and extra activities, without the use of the computer since the game by itself might cause confusion to its users [40]. DGBL should also be combined with other educational medium in order to ensure the generalization of knowledge and its application in other fields [34].

When using digital educational games in primary education, the role of the teacher is shared by both computer and learners while each supports a different function [30]:

Computer as teacher	Learners as teachers
It creates a learning environment based on the game's rules of conduct	Learners correct their own mistakes
It changes and adapts according to the level of the user	They advise their classmates on how to achieve goals
It is available at any time and for as much time as needed by the learner	They cooperate with their classmates to find solutions to problems
It may contain appropriate instructions or it can assist in the process of problem-solving	They gain knowledge and dominance over the subject they learn about

Computer as teacher	Learners as teachers
It gives immediate feedback through the results of the learner's actions	
It incorporates learners into a competitive environment while motivating them to become involved	

8. Barriers in the use of DGBL in education

Despite all possible gains deriving from digital educational games, there are many barriers to their inclusion in primary education. Some teachers believe that new technologies are not capable of guaranteeing effective learning on their own, while there is still need for adequate educational designing based on the fundamental principles of learning. As consequence, there is a percentage of teachers remaining skeptical on the use of digital educational games as teaching and learning tools. When introducing a game in class without having a specific educational framework beforehand, it may lead to negative results rather than positive ones, since not all games are appropriate or designed for all types of learners [31]. Because of this, the attention of learners might be diverted from the class, resulting to the failure of the desired learning goals. Then, learners might be unable to get knowledge out of the game, especially when the game is based on a wrongly designed environment of contact or when it is structured on elusive learning goals. Other researchers participating in the creation and designing of games are worried that games based on facilitating learning might result in losing their appeal to learners [37].

The simple use of DGBL in education seems to be insufficient as there is much more need for their correct use, combined with effective systems of learning. For example, games are not deemed as appropriate in education on the basis of their 3D graphics but on their application inside and outside of the primary education classroom. The main goal of a typical DGBL activity is to result in a combination of knowledge and entertainment. This is not always feasible, though, as there are certain elements reproduced in successful games whose incorporation does not necessarily guarantee a great educational outcome [2, 48].

Literature refers to two types of barriers encountered by teachers that might place limitations to the successful application of digital educational games in teaching. Firstly, there are external barriers like the lack of time, lack of education, limited funding, and limited access. It is rather difficult for teachers to incorporate digital educational games during a single teaching hour, especially when there is lack of time, support, and access to media. Teachers also lack further training on how to use digital educational games effectively in class. For that matter, the lack of time, lack of motives, and lack of support discourage teachers from becoming involved with DGBL [2].

Secondly, there are internal barriers for the exclusion of computer games from classroom, such as teacher's personal beliefs (e.g., his negative attitudes toward digital educational games), his lack of interest, and his lack of confidence in using digital educational games as didactic tools [2]. This hesitation based on the appropriateness of digital educational games according to age and content might be subdued by the possibility of selecting age-appropriate computer games from the age rating system of Pan European Game Information (PEGI). The PEGI system takes into consideration the appropriateness of a game according to age—not according to level of difficulty or the user's abilities. This system includes age rating labels and other types of labels based on content, which can ultimately guide parents and teachers when choosing the age-appropriate digital game [49].

9. Conclusion

With the increased popularity of ICT, the use of digital educational games to support learning has recently gained new meaning [48]. The incorporation of digital educational games in primary education in order to teach multiple terms is indeed necessary, as even those involved in the process recognize the importance of the digital educational games as assistive learning tools. The majority of research conducted on the basis of the use of digital educational games confirms the positive relation between learning and engaging pupils with digital educational games, while motivating them to acquire or check their knowledge in a pleasant and creative manner. Although there are many difficulties in the integration of digital educational games in the class, the use of digital educational games, as a breakthrough teaching and learning tool, has great growth prospects.

The ministry of education, the designers of educational policies and curricula, the administration of primary education, and teachers on their own have to support the integration and use of digital educational games in teaching and learning processes. The training of teachers on the value of digital educational games is also of great importance. Teachers' confidence in digital educational games can be enhanced by attending properly designed training programs that will provide teachers with the appropriate skills in order to evaluate and implement appropriate DGBL in primary education. In parallel, there is need for technical, financial, and administrative support.

The conduct of further research is necessary for exploring all factors and parameters in the use and integration of digital educational games in primary education. There are also suggestions for designing and creating appropriate digital educational games, using contemporary scenarios, and being compatible with the expected learning outcomes. This will eventually allow the active participation of all users-learners and the creation of digital learning communities, which will render learning a more pleasant and engaging process.

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