

Editorial

Game-Based Learning, Gamification in Education and Serious Games

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Video games have become one of the predominant forms of entertainment in our society, but they have also impacted many other of its social and cultural aspects. The new forms of interaction and communication in online multiplayer games, the millions of viewers of professional e-sports competitions, the huge following of gaming streamers through channels such as Twitch, and the communities of players that are formed around a specific title are just some examples of the impact of games in everyday life today.

However, games are just one aspect of the ludification of culture [1]. Approaches to this field can be situated into the “Game” or the “Play” categories. Although these words are generally presented as entwined in the discourse on video games, they are two distinct subjects. “Game” comes from the Latin word “Ludus”, meaning both learning and entertainment. Games are thus associated with problem-solving activities that are fun, and are endogenous systems that are structured by game mechanics (or game rules). On the other side, “Play” comes from the Latin word “Paidia”, meaning (childish) amusement, and relates to creativity, freedom to improvise, and in general occurs in open systems. Immersion is a phenomenon experienced by an individual when they are in a state of deep mental involvement [2]. This phenomenon can improve the learning process, and games are able to provide this by involving the player in a narrative, or by challenging the player [2]. These intrinsic properties of games can be enhanced by the multisensory stimulation provided through immersive technology, such as the HDMs (Head-Mounted Displays) used in virtual reality.

Serious games try more and more to explore the impact of games and the inherent motivation and immersion of players to help them accomplish other objectives, be they related to education, marketing, social awareness, health and care, etc. Education is an area with more (successful) examples of the utilization of serious games (therefore leading to the game-based learning term, which focuses on the development of games that are designed with specific learning objectives in mind). Educational contexts can also benefit from the use of game mechanics and principles through gamification processes to reinforce the motivation of learners.

The aim of this Special Issue is to present and discuss new advances in games to show how they could enhance the effectiveness and outreach of education, advertising, social awareness, health, policies, etc. We focus on the “Ludus” side, more related to structured learning activities, not only with a focus on game-based learning and serious games, but also on the use of game elements and game design techniques to gamify the learning process [1].

The published contributions really demonstrate the wide scope of application of game-based approaches in terms of purposes, target groups, technologies and domains. However, one aspect they have in common is that they provide evidence of how effective serious games, game-based learning and gamification can be.

Zafeiropoulou et al. [3] present the design and development of an Augmented Reality (AR) gamified application for the implementation of physics experiments in a fifth-grade



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class of a Greek primary school. A treasure hunt game was implemented, which allowed students to interact with a digital world and to manipulate virtual objects with the use of an AR device. The evaluation of the system's usability by both students and teachers indicates that the application has the potential to be an easy-to-use educational tool for improving not only the teaching of physics experiments in primary school, but also the learning process, by positively affecting the students' motivation and engagement.

Cheng and Chen [4] present Swift Playgrounds, an innovative app for the iPad and Mac that makes learning interactive and fun. Their study was carried out by letting elementary school teachers and students participate in Swift Playgrounds computational thinking courses. By trying this app, teachers of different disciplines attempted to realize more learning situations. Students learned how to cope with functions and loop skills by playing with "Byte", which is a character in Swift Playgrounds. The authors had three main purposes for the study: first, designing a computational thinking course, "Hello! Byte", in Swift Playgrounds; second, assigning elementary school teachers to assess the qualitative analysis of tasks in Swift Playgrounds; and third, assigning elementary school students to complete the tasks and assign a difficulty index in Swift Playgrounds after using the app. The results show that most teachers considered this approach to be able to improve logical thinking and inferential capability after assessing, and most students considered functions and loops to be quite difficult after using the app. According to the students' indices, about 86 percent of students thought that adding commands is easy, and about 37 percent of students considered the functions to be easy.

Leonardou et al. [5] present the main findings of an online study on primary school teachers' attitudes toward digital game-based learning (DGBL), given the central role teachers play in the learning process. Furthermore, this research investigates teachers' opinions about the functionalities provided by one exemplary case, the Multiplication Game (MG), and the integrated teacher dashboard. The MG is an assessment and skills improvement tool that integrates an adaptation mechanism that identifies student weaknesses on multiplication tables and, in its latest version, also supports a strong social parameter. Students can be informed about their own progress as well as the progress of their peers in an effort to examine if social interaction or competition can increase players' motivation, which is a subject that raised some concerns in the teaching community. The article indicated the potential usefulness of MG and the benefits it can offer as a learning tool to improve pupils' multiplication skills and help teachers identify individual pupils' skills and difficulties and adapt their teaching accordingly.

Arner, McCarthy and McNamara [6] present StairStepper, an adaptive literacy skill training game within an Interactive Strategy Training for Active Reading and Thinking (iSTART) intelligent tutoring system. StairStepper models text passages and multiple-choice questions of high-stakes assessments, iteratively supporting skill acquisition through self-explanation prompts and scaffolding, adaptive feedback based on performance, and self-explanations. The results of an experimental study employing a delayed-treatment control design to evaluate users' perceptions of the StairStepper game and its influence on reading comprehension scores indicate that participants enjoyed the visual aspects of the game environment, wanted to perform well, and considered the game feedback helpful. The results also indicate that the StairStepper game may fill the gap in instruction by providing enjoyable practice of essential reading comprehension skills and test preparation, potentially increasing students' practice persistence while decreasing teachers' workloads.

Santos et al. [7] presented the League of Emotions Learners (LoEL) game app, designed to develop the emotional competence and intelligence of young people. The authors stress the importance of being able to understand, express, and communicate emotions, a competence widely recognized as fundamental. This is particularly important for the younger generation entering the professional market as, in this context, emotions are managed and communicated in ways that are different from what they are used to and that can easily lead to misunderstandings. The game app was designed following an analysis on how young people deal with, understand, and interpret emotions, particularly in the

context of a professional career, where the ability to enter a dialogue with different people and how to get around problems in a healthy and resilient way is essential. The results obtained in the initial validation show a very positive understanding of the impact of this app on youth.

Maskeliūnas et al. [8] describe an interactive serious programming game for teaching JavaScript programming in an introductory course at university. The game is based on visualizations of different types of algorithms, which are interpreted in the context of city life. This game encourages interactivity and pursues a deeper learning of programming concepts. The positive results of the evaluation of the game using pre-test and post-test knowledge assessment are presented.

Riera et al. [9] present a work that uses a Virtual Reality (VR)-enhanced gamified application designed to increase the awareness of safety measures, one of the most important being the correct usage of the seat belt, a device that is known to save thousands of lives every year. For this goal, a motorized rollover system was developed that, synchronized with a VR application shown in a head-mounted display for each user inside a real car, simulates the rolling of the car with up to four passengers inside. This way, users feel the sensations of a real overturn and therefore they realize the consequences of not wearing a seat belt. The system was tested by more than 500 users, for a month, in the context of a road safety exhibition in Dammam, Saudi Arabia. The results show that awareness regarding the use of seat belts increased very significantly after using the presented edutainment tool.

Heldal et al. [10] investigated the feasibility of utilizing serious games (SGs) and eye-tracking technologies (ETs) for training the eyes of children with oculomotor dysfunction (OMD), a condition resulting from problematic coordination between their left and right eye muscles. Via the activities they created, a trainee can, with their eye gaze, follow objects that are moving, change their directions and speed, or pop up on the screen. The results map the current physical training goals to activities for SGs using the input from ETs, and illustrate this correspondence for designing and developing six games. The games' feasibility evaluation was conducted via semi-structured interviews and evaluations of user experiences; the findings demonstrate the potential of using SGs and ETs to train OMD and point to future needs for improvements.

Tuah, Yoag and Ahmedy [11] report on the development of a gamified application with several tasks aimed at managing diabetes mellitus as these are regarded as useful for patients in facilitating daily self-care management and the personalization of health monitoring. The developed application was tested through system testing and usability testing using the Software Usability Scale (SUS). The result showed that the gamified application is easy and practical to use for an individual with or without diabetes. All the provided functions worked as designed and planned, and the participants accepted their usability.

Sipiyaruk et al. [12] present an integrative review that explores the literature on serious games in dental education to construct a conceptual framework. Their investigation demonstrated an increase in the use of serious games since 2018 and the key strengths of the findings include positive educational outcomes, enhanced engagement and motivation, and the advantage of stealth assessment.

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