International Journal of Learning, Teaching and Educational Research
Vol. 21, No. 5, pp. 367-400, May 2022
https://doi.org/10.26803/ijlter.21.5.19
Received Sep 1, 2021; Revised Jan 9, 2022; Accepted May 29, 2022

Application of Gamification Tools for Identification of Neurocognitive and Social Function in Distance Learning Education

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Abstract. The present study investigates the role of synchronous and asynchronous education techniques in the context of digital and game-based learning materials through a collaborative study, conducted during the Covid-19 pandemic (October 2020 – June 2021), in an online e-learning environment. The study involved 35 last-year elementary school children, in Western Greece, with learning and behavioral issues. The children were given games with both practical and academic modules throughout their online schooling. For example, a math game was played over WebEx using Kahoot; a game for European institutions was created using the learningapps.org software; and online games from the European Union's "Learning Corner" as well as the game "Defeat the Virus" were used for the Social and Political Education topic. The findings are based on data collected through synchronous and asynchronous e-learning frameworks (WebEx, e-Class), and were linked to both cognitive learning aspects and school children active participation in online education using a standardized psychometric scale called "Psychosocial Adaptation of Primary School Children." The findings suggest that gamification might be a beneficial tool for improving children' cognitive performance in elementary school and generating a meaningful learning experience. The educational intervention aided young people in the development of assertiveness/leadership skills; interpersonal communication skills; social competence; and self-perception. The benefits of the online educational process include the enhancement of students' neurocognitive processes, particularly their executive functions, as well as their social competencies and interpersonal relationships.

Keywords: gamification; neurocognitive parameters; social function; distance learning; school children

1. Introduction

Learning is a complex and necessary basic characteristic of evolved species. It is a cognitive process that leads to a reasonably steady alteration in the activities of the being. This shift is brought about by future neural system alterations that occur because of experience accumulation, i.e., repetition and mental processing of events. Game provides numerous chances for social and personal development. It encourages newborns and toddlers to collaborate and socialize by putting their physical and mental talents to the test. Games fosters social awareness and consciousness and provides an opportunity to address issues such as justice and equality. Additionally, a young child may gain confidence, the capacity for observation, assistance, and assessment, as well as initiative. Further, a young child develops organizational abilities and the capacity for both victory and defeat. It encourages imagination and creativity, as well as flexibility to a range of situations and active participation-based learning. Play is a permanent value of infancy in all cultures, a means of normal psychosomatic and spiritual development, and a prelude to later life. The process of learning may be explored in a neurophysiological level, within the context of the brain's cognitive functions. As a result, learning is conditional on the state of the nervous system. The nervous system of an intelligent living being offers the biological substrate for the development of internal states (mental structures) that serve as the foundation for the being's future conduct.

The human nervous system is composed of numerous distinct components. The central nervous system, for example, is comprised of the brain and spinal cord. Generally (and in our approach to this journal article), we are interested in kinds of learning that include the intellect's brain operations. However, learning in its broadest sense is connected to the nervous system. The psychological dimension examined through the administration of a psychometric tool is the method through which learning as a psychological phenomenon is studied, i.e., at the level of psychological mechanisms and functions, rather than at the neurophysiological level of events. Learning is considered a complicated phenomenon that influences the human being's total psychological dimension. It is the result of the cooperative action of several psychological processes (e.g., attention, processing information in working memory, coding knowledge and information, recalling them from long-term memory, etc.). Cognitive psychology is a significant subfield of psychology that focuses on the study of mental events associated with learning.

Playing is a pleasurable activity. That is why a growing number of modern experts are exploring the educational consequences of its use. Nobody doubts video games' educational benefits. They are drawing-educators, academics, and game creators from all over the world *(Clark, Tanner-Smith & Killingworth, 2016)*. Due to their fascination with and comfort with technology, today's kids choose an integrated learning experience through an electronic game. This is because electronic games are designed with the "play and learn" philosophy in mind, which adds to their educational value *(Demetriadis, Tsiatsos & Karakostas, 2012)*. Additionally, they are founded on modern theories of learning and models of creative learning, including "discovery learning," "experiential learning," "group learning," "learning-by-doing," and the "Theory of active learning." Electronic

games, for example, can contribute to the development of cognitive processes and abilities *(Antonopoulou et al., 2020; Manin, George, & Prevot, 2006)*: reflex development—visual-motor synchronization, parallel information processing, concentration, observations, problem-solving ability, contact, imagination, and activity.

The learning game (or educational/learning game) is an organized activity in the form of a game that strives to mix fun and learning while also achieving specified learning objectives. The term "digital learning games" refers to a type of digital game that is specially developed to serve certain educational objectives (*Michael & Chen, 2006*). Two critical variables contribute to the success of a digital learning game (*Hamalainen, 2011*):

- The game's scenario: The game is centered on a basic scenario that incorporates the student-player and serves as the psychological backdrop for the gaming experience (interest, involvement, competition, etc.).
- The educational technique: The game's instructional technique. It is essentially the mechanism that activates the cognitive processes of the student-cognitive actor to process knowledge relevant to reaching the learning objectives.

It's worth noting that participating in digital learning games introduces players (school children) to and educates them about modern digital tools, assists them in developing cognitive and social skills, and prepares them to make the best use of them throughout their first and second academic years of education. Digital learning games provide students with the necessary skills to begin acquainting themselves with digital technologies that will be used in the future and that they might potentially use in an academic setting of digital leadership. It's worth noting, as recent research (*Antonopoulou et al., 2019; 2020*) indicates, that the greater one's knowledge and specialization in digital tools (social media), the more capable one is of exercising effective digital leadership in a variety of environments, including educational organizations (*Antonopoulou et al., 2021a*), business organizations, and so on, throughout adult life. In summary, it is widely accepted that the young generation must be educated in current digital settings and acquire digital skills to function optimally on the social and professional network in the upcoming years.

Game-Based learning (GBL), has as its overarching objective the creation of educational settings that combine learning with the fun and joy provided by a well-designed game. This is accomplished using a variety of cutting-edge technologies, including mobile devices, Web 2.0 applications, 3D virtual worlds, instructional robots, and physical user interfaces. The benefits of this approach are projected to stem mostly from greater motivation for school children-players' participation with the game. The learner will be reluctant to play the game in order to feel the unique feelings elicited by this event. As a result, it must engage the cognitive processes necessitated by the game's integrated learning system. As a result of increased engagement and interaction (pupils with one another, with the teacher, with the game and educational materials), it is expected that essential learning objectives such as: - subject depth (acquisition of fundamental/advanced

knowledge, familiarity with many perspectives/interpretations, and connection of knowledge to everyday life) would be achieved.

Nick Pelling coined the word "gamification" in 2004 (*Marache-Francisco & Brangier, 2015*). He attempted to utilize a game-like augmented interface to make electronic transactions more interesting and engaging, such as utilizing an Automated Teller Machine (A.T.M.) or in-flight entertainment. Pelling (1981-1999), who had a background as a game designer, desired to make the transaction seem like playing a game, with an element of enjoyment. Nowadays, gamification appears to have an indirect effect on the motivation and engagement of younger students (school children) in the classroom. This results in boredom and worry for these children, as well as apathy toward schools, classes, and especially toward staff and teachers. Simply incorporating technology into school has not resulted in the same positive outcomes as games. As a result, games such as Angry Birds and World of Warcraft, which are underpinned by sound service design, are capable of instilling cognitive intrinsic incentives in players, such as emotions of mastery, attractiveness, and flexibility.

Gamification is a design strategy aimed at providing users with game-like experiences, typically with the goal of influencing users' behavior. Accordingly, game mechanics are frequently associated with learning experiences, such as assisting in the advancement of knowledge and developing collaborative abilities, such as decision making and collaboration with peers (*Nicholson, 2014*). The strengths of gamification are that it can plainly discern between purpose, errands, and actions, and that it is rewarding when it is accomplished. This, it is said, will encourage subjects to differentiate and address the issues they face in society; where individuals live, and the components of fun, scores, level-ups, and ranking rivalries are viewed as contributing to voluntary support by stimulating the subjects' internal and external motivations. Earlier research *(Lee & Hammer, 2011; Hwang et al., 2013)* suggested that video games aid in cognitive, social, motivational, and emotional development.

This paper ascertains the amount to which distant gaming is included in teaching—both contemporary and asynchronous teaching—via the use of educational digital and play-centered learning objects, determines how mixed class pupils' interest is produced, hence inspiring them to study, as indicated from previous research (*Popyk, 2020*). Another scope of this study is to investigate the role of gamification in amelioration of neurocognitive and social functions of pupils in primary education and the extent to which the application of gamification tools can promote motivation for educational process especially in distance learning settings.

2. Literature review

Definition of Gamification

Gamification was coined in the business world to refer to the incorporation of game aspects into a user interface to boost electronic client transactions. Gambling rapidly became a popular notion, supported by corporations, the private sector, and education (*Kücklich, 2008*). In 2011, science endorsed Sebastian Deterding's first widely acknowledged definition of gamification (*Deterding et al., 2011*).

Gamification is the practice of incorporating game features or game mechanisms into non-game environments. As a result, the notification box includes non-game content (for example, an airline game on its website in which customers may win free tickets depending on their flight history) (*McShaffry, 2003*). The basic characteristics of gaming are points and ratings, which are critical for customers and machine manufacturers alike (*Hellersted & Mozelius, 2018; Juul, 2010*). Each time a user properly answers a question or successfully completes a test, he earns points. The points are used to compensate him and to provide feedback. Additionally, he may monitor his own achievement and progress, as well as that of his colleagues. The levels track the user's progress and keep us informed of both his own and his colleagues' achievements (*Kirschner et al., 2006*). The levels act as a motivation for users and also act as a reference for the game's growth, since we can monitor the player's progress toward game completion. Since the early 1990s, scholars have claimed that electronic games can be employed in a variety of methods and applications at all levels of education. The challenge for educators is to leverage players' high level of engagement in the game and, in conjunction with appropriate game situations, to design learning experiences that enable player-users to acquire critical and transferable information and skills.

Gamification and Persuasive Technology

Gamification and persuasive technology have been heavily leveraged in recent years for marketing, attitude modification, and motivational pull. Simultaneously, games such as Angry Birds and World of Warcraft have demonstrated how games may be extremely effective for invoking cognitive intrinsic motives such as mastery of emotions. Additionally, social components are critical to conventional gamification services: individuals collect badges, climb high-score lists, and accumulate points for social reasons, such as recognition. Gamification is a term that relates to service design that aims to provide customers with game-like experiences, most often with the objective of influencing user behavior. Gamification is distinct from other similar developments in several critical ways:

- Gamification is frequently used to create experiences evocative of games (e.g., flow, mastery, and autonomy).
- Unlike persuasive methods, gamification aims to influence motives rather than attitude and/or behavior directly.
- Gamification refers to the process of infusing existing systems with "gaminess", rather than creating a totally new game, as is the case with "serious games".

On the other side, persuasive technologies relate to interactive computer systems that are intended to alter the user's attitude and/or behavior. Clearly, gamification and persuasive technology have some overlap. For instance, certain persuasive techniques, such as feedback and prizes, can be compared to those used in gamification. In general, most gamification services, games, social networking services, and persuasive systems have features that enable both social and gamification engagement. Depending on how we conceive different approaches to persuasive design, gamification may be viewed as an overarching notion in the sense that it can be used across several domains or as a subset of other methods to persuasive design.

2.1. Neurocognition in Learning Process

Definition of Neurocognition

The function of the brain, as part of the Central Nervous System (CNS), is to regulate most functions of the body and mind. This includes everything from vital physiological functions, such as breathing or heart rate, to more basic physiological functions, such as sleep, hunger, or sexual instinct, to higher functions, such as thinking, memory, or speech. The parts of the brain are analyzed by how the most basic vital functions are measured by the older brain structures, that is, those located in the rhomboid brain (medulla oblongata, bridge, cerebellum) and the midbrain. In contrast, the higher brain functions such as reasoning, memory, and attention are controlled by the cerebral hemispheres and lobes that are part of the cortex and refer to neurocognition. Proper stimulation can help improve the state of different cognitive abilities *(Finisguerra et al., 2019)*. Cognitive functions are the mental processes that allow us to receive, select, store, mutate, develop, and retrieve environmental information. This allows people to understand and relate to the world around them. Many times, when we talk about higher cognitive functions, we are referring to cognitive skills we need to understand and interact with the world. Although we sometimes study them as separate entities, we must keep in mind that cognitive functions are interrelated and often overlap. Some categories of higher cognitive functions are summarized below and a brief description of each of them is given:

Attention

Attention is a very complicated mental activity that cannot be reduced to a simple description, a single anatomical component, or assessed in a single test since it includes several processes. Attention is the cognitive function that selects amongst the stimuli that enter the brain simultaneously, both external (odors, sounds, pictures) and interior (thoughts, feelings), that are helpful and appropriate for performing a motor or spiritual action. In depth, it is a collection of processes of varying complexity that enables us to perform other cognitive functions properly.

Executive functions

Executive functions are the most advanced cognitive abilities. Although executive function has a variety of definitions, nearly all pertain to the management of cognitive function and the regulation of ideas and behavior via a variety of linked processes. It entails a variety of sophisticated abilities, including attention management, planning, programming, and modifying and managing voluntary behavior. They are found in the brain's frontal lobe *(Gkintoni et al, 2017)*. Executive functions are "a collection of processes concerned with the management of oneself, and one's resources in order to accomplish a goal." It is a collective name for the neurologically based abilities associated with mental control and self-regulation" *(Cooper-Kahn & Dietzel, 2017)*. Many students, who are diagnosed with a learning impairment or attention, deficit hyperactivity disorder, or ADHD, have difficulties performing their executive tasks effectively. Children with executive functioning difficulties may struggle with routine chores. They may struggle with planning and organizing. The signals may appear differently depending on the

children's ages. For example, students in elementary school who exhibit symptoms of EFD or executive functioning disorder will struggle to switch between activities, will be unable to organize themselves, will become "stuck" on an idea or topic, and/or will completely miss the point of a conversation, lesson, or lecture.

Speech
Speech is a symbolic method of communication that presents itself via languages in the case of humans. Speech is critical not just for interpersonal communication but also for the internal structure of our thoughts. Different regions of the brain are involved in speech processing, functioning in concert via a variety of functional systems, the majority of which are located in the left hemisphere.

Visual-spatial functions
Visual-spatial functions are utilized to evaluate, comprehend, and regulate our physical environment (either in two or three dimensions). Mental navigation, distance and depth perception, visual-spatial creation, and mental rotation are all examples of these functions. The occipital and parietal lobes are largely responsible for spatial analysis, face identification, map and object processing, music processing, body aesthetics, facial emotions and gestures, and motor tasks that do not need verbal control.

2.2. Gamification and Neurocognition
Gamification and Executive Functions
Gamification is the process of transferring game-like features, such as point scoring, rivalry with other players, and game rules, to other domains of activity. Additionally, it is the idea of using game mechanics and game design methods to engage and inspire others to accomplish their objectives. Gamification appeals to the users' fundamental wants and demands, which are centered on the concept of status and accomplishment. Whether you're playing a computer game or a board game, executive functions are critical in a variety of situations. When someone plays checkers or chess, the player must anticipate his or her opponent's next move. A large part of gaming is planning and arranging ideas. Additionally, in the case someone plays a video game, such as Call of Duty (which is very popular among adolescents), always required to prepare and consider the next movement. Characters may appear out of nowhere, and individuals must always be prepared for the unexpected, which keeps one on its pace. While playing a game, someone must be able to shift or move easily between situations and think flexibly to react correctly. Additionally, emotional regulation is essential when playing a game; it is described as the "capacity to modify emotional reactions by applying rational thought to experiences" *(Nouchi et al., 2012; Van Der et al., 2012)*. When objects are being thrown from all directions, it is critical to be able to control the next move and decide what to do next, even if it means losing points; someone does what is best in the long run.

Gamification and Social Function
Although gamification is often associated with expertise, competence, flow, and goal dedication *(Hamari et al., 2014)*, it is self-evident that social aspects also play

a significant role. As such, we sought to explore experimentally how social variables such as social influence, recognition, and reciprocal rewards affect attitudes and usage intentions toward gamification services. Gamification, in the form of points and levels, therefore plays a role in facilitating this social process within the group. Thus, maybe even simple "pontification" might become "meaningful" when shared among a community of like-minded individuals working toward common objectives.

Gaming and Social Function in Distance Learning Education

Because of its intrinsic and intangible nature, as well as the nature of gaming, Distance Learning is well-suited for gaming applications. Electronic learning is more visually appealing and engaging than traditional teaching. Thus, playfulness may be used to boost motivation and compensate for certain basic pedagogical faults inherent in e-learning systems, such as the absence of emotional contact between the teacher and the student in traditional education. Playfulness aids in the development and elaboration of this emotion *(Vlachopoulos et al., 2012)*. Thus, including gaming into remote education has several obvious benefits. It enhances students' commitment, motivation, achievement, and retention of the objective, as well as their personal learning and thinking talents. It is capable of shaping collaborative teams and assisting them in achieving better success through competition. Additionally, it enhances academic standards and promote digital literacy. When it comes to emotions, video games may provoke a broad variety of responses. When someone feels dissatisfied, the most fascinating example of emotional change occurs. Players have the option of failing in a totally enjoyable setting. When the differences between a two-week remote learning game and a two-week regular distance learning course were compared, the two groups that participated in the enjoyable learning utilizing fundamental gaming principles show a statistically significant boost in cognitive performance *(Antonopoulou et al., 2021b)*. This difference is sometimes difficult to establish since the addition of rules converts a gaming system into a game. Gaming and serious games both make use of game elements for objectives unrelated to the primary goal of games, which is generally to have fun. The goal is to not just make previously dull activities more enjoyable, but to also increase user participation to increase the engagement and interest of activities. According to Zicherman and Cunningham (2011), gaming is the application of logic to games (game thinking) to solve a problem and increase user engagement and interest. Additionally, the game includes ranking tables that indicate the name of the gamer and the points that have been won, allowing one gamer to be compared to others, which is a requirement of the competition. Additionally, there are prizes or insignia that act as "medals" that boost the user's confirmation and confidence while also establishing prestige and respect for those who did not perform as well. Finally, there are challenges, which are tests put on some players within the application to accomplish a task that stimulates interest and competition.

Gamification and Neurocognitive Assessment

The term "neurocognitive assessment" refers to the process of evaluating an individual's cognitive abilities (infant or adult) (e.g., working memory, attention, and executive processes). Cognitive training is a phrase that refers to the practice

of engaging in cognitive tasks to maintain or improve a certain aspect of cognitive function. Cognitive exercises are important for evaluating and educating people with cognitive impairments. Among the available solutions, gamification, defined as the process of incorporating game elements (e.g., a scoring system, a leaderboard, and a badge) into nongame contexts (e.g., education, business, and cognitive tasks), is one of the most influential and promising approaches for increasing motivation in repetitive tasks *(Lumsden et al., 2016)*. A greater understanding of human motivation allows users to maintain their motivation for cognitive tasks throughout time *(Gray et al., 2019)*. Motivation is complex and ranges from internal to extrinsic to amotivation (lack of motivation) *(Ryan & Deci, 2000)*. By mixing internal and extrinsic incentives, gamification may be utilized to boost motivation and engagement (*Vermeir et al., 2020)*. Extrinsic incentive is generated in games via the use of elements such as badges, points, game levels, a scoreboard, and avatars. These factors contribute to the collection of early user motivation *(Gray et al., 2019)*. Gamification may also assist people in increasing their intrinsic drive by including components such as suitable challenges and positive reinforcement—these elements satisfy human needs of competence. The bulk of gamified cognitive tasks were created by cognitive psychologists, not professional gamification designers, and scientists prioritize the clinical efficacy of a gamified activity above the usage of effective and innovative gamification designs (*Baniqued et al., 2012*).

In several research projects *(Baniqued et al., 2012; Lumsden et al., 2016; Lumsden et al., 2017; Dorrenbacher et al., 2014)* various gamification techniques were applied to cognitive tasks. In the present study a psychometric scale evaluating psychosocial adaptation and social functions in general, in combination with gamified cognitive tasks evaluating neurocognition and some categories of higher neurocognitive functions (for instance attention and executive functions), is proposed.

Neurocognitive Function and Videogames

Numerous studies *(Ryan & Deci, 2000; Lumsden et al., 2016; Gray et al., 2019; Vermeir et al., 2020)* indicate that video games may improve neurocognitive abilities such as attention and focus, as well as social functions such as assertiveness and leadership ability. Since video game players have a greater capacity for attention within the training zone, a test was undertaken to determine if this ability might be enhanced outside the training zone. Additionally, it appears as though video game players outperform non-players in all categories. This indicates that spatial attention of video game players increased across the visual field, even in untrained areas. The temporal features of visual attention were examined, as well as whether the pressure to act rapidly on many visual stimuli, as seen in video games, might affect the capacity to process items over time, notably the ability to avoid impediment in focus. It was observed that video game players performed better than non-gamers in detecting the stimuli of the game, resulting in a reduced attentional blink. Video games, which may benefit from more attentional resources, process several objects or actions concurrently. Certain video games need players to discard unwanted objects that might benefit from a more sophisticated selection process. Thus, when presented with distractors, video

game players exhibited an improved ability for recognizing objects both inside and outside their field of vision, as well as an accuracy advantage.

3. Research Design – Methods

3.1. Study objective

The aim of this study is to determine whether the playfulness of distance modern and asynchronous teaching, as well as the use of educational digital and play-centered learning objects, increases the interest and motivation of mixed-grade pupils to learn. It investigates whether play-centered teaching engages school children and motivates them to learn; the benefits of using play-based applications in primary school children are evaluated; and in settings where school children with special needs and abilities, learning difficulties, foreigners, and Romani people (well recognized in English by the exonym Gypsies or Gipsies), coexist, we explored what characteristics educational games should have.

Although children are exposed to internet apps, smart gadgets, and electronic games from an early age, e-learning has grown into a creative, interesting, and effective style of instruction. As a result, the participant's cognitive mechanisms connected with the learning process should be activated, as these mechanisms are included into the game. The anticipated effect is increased learner engagement and interaction with one another, the instructor, the game, and instructional materials, resulting in the achievement of critical learning objectives such as cognitive object depth (acquisition of fundamental/advanced information, familiarity with diverse perspectives/interpretations, application of information to everyday situations) and identification of cognitive and emotional parameters promoted by gamification.

3.2. Study design

Given the significance of gamification in the learning process and in education in general, the research topics investigated can be described as follows (Figure 1), based on what has been published thus far and guided by the current literature:

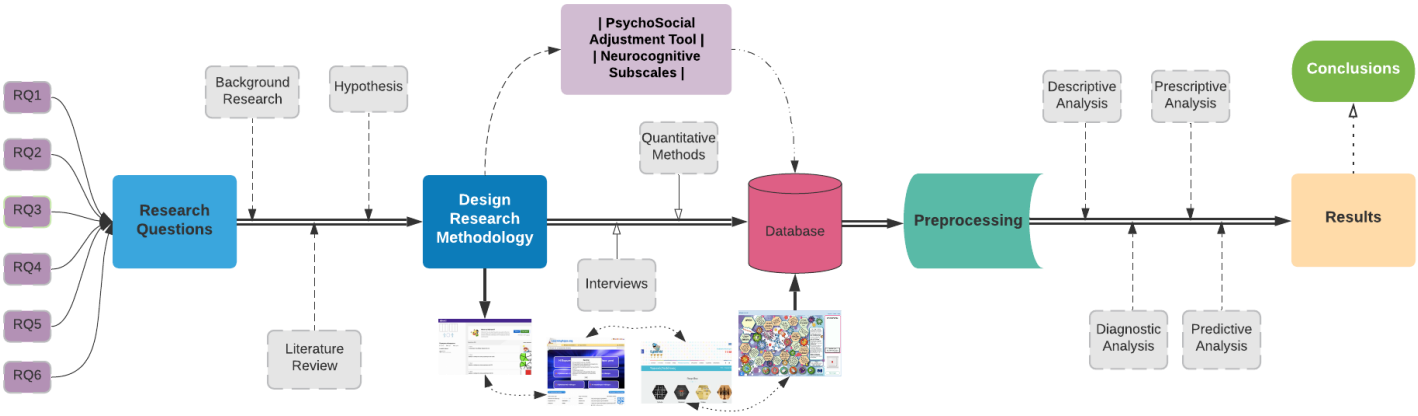

Figure 1. Flowchart of Research Methodology

- [RQ1] Does the playfulness of distance modern and asynchronous teaching, as well as the use of educational digital and play-centered learning objects, increase interest and motivation?
- [RQ2] What is the function of gamification in enhancement of interpersonal communication?
- [RQ3] What is the contribution of gamification in improvement of emotional management and self-control?
- [RQ4] How can gamification promote skills of assertiveness and leadership skills?
- [RQ5] What is the influence of gamification in neurocognition (executive functions, decision making, attention, concentration, organization/design)?
- [RQ6] What is the role of gamification in the improvement of social function?

3.3. Participants

The study surveyed 35 school children from a primary school in Western Greece between March 2021 and June 2021. Seventeen children (56.7%) were boys and the remaining (43.3%) were girls. The average age of the sample of students was 11.5 years (with a standard deviation (SD) of 0.8 years). It is worth noting that each student is assigned a code in order to maintain their anonymity.

3.4. Data Collection

Description of Psychometric Scale

The Psychosocial Adaptation Test for Preschool and School-Age Children (Psychosocial Adaptation Test) is an assessment instrument designed to evaluate skills and deficits in social, emotional, and school adaptation, as well as intrapersonal and interpersonal adjustment. The Psychosocial Adaptation Test is composed of three scales; the first two are done by the teacher and pertain to children in preschool (4-6 years) and elementary school (7-12 years), respectively, while the third (self-report) is taken by 10-12-year school children (5th and 6th school class). When administering the self-report scale, it is recommended to conduct the comparable test to the teachers to allow for comparative evaluation of the findings. Three subscales of psychosocial competence and one of behavioral issues are included in the scale for preschool and elementary school students. In addition to the four subscales mentioned above, the self-report exam includes a fifth subscale, self-perception (*Hatzichristou et al., 2011*).

The Psychosocial Adaptation Test is a standardized instrument that evaluates the multidimensional structure of a child's psychosocial adjustment by concentrating on deficiencies while also including information from the instructor. The expert can use the test to examine the psychosocial features linked with learning impairments and to discover aspects of the psychosocial profile of children identified with learning disabilities that may be predictive of issues in the child's subsequent learning—course. Additionally, the test may be used to discover the variables that contribute to the child's resilience in adapting to the school environment. This is facilitated by assessing various aspects of the child's

psychosocial competence (social competence, school competence, emotional competence, self-perception). In preschool, for example, neuropsychological, psychological, developmental, and other learning problems frequently arise, and it is sometimes impossible to measure the child's cognitive functioning. This test enables the assessment of children's behavior and thus enables timely intervention. The test can be used in the classroom or in the school setting (screening) to identify children who are at risk of having problems in the aforementioned areas. Additionally, it may be used to assess the efficacy of intervention programs performed on an individual or group basis in a regular or integrated class.

The test is comparable to measures that are often utilized in several nations. Individual scales are typically used to assess social skills *(Gresham & Elliot, 1990)*, executive functions and behaviors *(Achenbach & Rescorla, 2014; Reynolds & Kamphaus, 1992)*, emotional adequacy *(Bar-On & Parker, 2000),* and motivation and self-perception. Only lately has the need for analyzing the potential and problems associated with these theoretical approaches been emphasized *(Merrell, 1998).* Psychometric tools for detecting psychosocial difficulties in preschool and elementary school-aged children are widely used in other countries (e.g., the United States of America and the United Kingdom) and are weighted in a general population of children and clinical specimens of children with learning disabilities, attention-deficit/hyperactivity disorder, developmental disorders, and other disorders. As a result, they have been included in a systematic effort to thoroughly assess learning problems in preschool and school-aged children. According to scientific evidence, the precise characteristics are associated with the learning process, academic achievement, and, more broadly, the child's adjustment to school and home. Numerous clinical trial data also support the importance of concurrent assessment of cognitive functions (e.g., memory, attention, executive functions) and dimensions of a child's psychosocial behavior for the timely and valid identification of learning disabilities and factors contributing to school failure (*Lyon, Fletcher, and Barnes, 2003).* Dimensions of psychosocial behavior have been suggested should be included in the classification of characteristics of kids with learning impairments since they are regarded primary features. Additionally, when psychosocial factors are examined, predictive validity for detecting learning impairments is found to be excellent *(Watkins, 1996).*

The study was performed with the consent of the students' parents and guardians, who signed a responsible declaration, and with the approval of the School's Teachers' Association. School children were assigned both constructive and theoretical modules in their games. Each school child is asked to carefully read each of the 115 sentences of the questionnaire and to circle the number that indicates how much this behavior suits him, that is, how much it represents him.

Students' answers were graded according to the Likert five-point scale (1 - 2 - 3 - 4 - 5) as follows: 1 = if this sentence does not apply, it does not suit you at all, 2 = if it suits you well, 3 = if it suits you moderately, 4 = if it suits you very well, 5 = if it suits you very well. The total score for each dimension of the questionnaire is a

function of the number of sentences it contains (e.g., if a subscale has 7 sentences the minimum score it can get is 7 × 1 = 7 and the maximum 7 × 5 = 35). Respectively, the total score of each sub-scale is a function of the total scores of the dimensions of which it consists of. Below are presented in detail the dimensions (and the sentences from which they arise), as well as the subscales (and the dimensions from which they arise). Proposals with an asterisk (*) are inverted during the dimensional calculation process to indicate high values and a high score.

Dimensions of the Psychometric Tool:
- Skills of Assertiveness/Leadership skills: 1, 11, 22*, 41, 63, 64 and 84 (7 sentences)
- Interpersonal Communication: 2, 17, 19, 31, 33*, 42, 62, 70, 88 and 109 (10 sentences)
- Collaboration with Peers: 4, 25, 26, 43, 46, 78, 90 and 114 (8 proposals)
- Motivation: 6*, 12, 14, 20, 27, 32, 34, 54, 55, 71, 81 and 104* (12 sentences)
- Organization/Design: 5, 15, 16*, 61, 68*, 83*, 99 and 100 (8 proposals)
- School Effectiveness: 24, 30, 53, 73, 95*, 98, 102*, 103, 108 and 113* (10 sentences)
- Self-Control: 51, 65, 67, 72 and 85* (5 sentences)
- Emotional Management: 8, 28, 37, 47, 48, 77, 89 and 107 (8 sentences)
- Empathy: 56, 76, 82, 96* and 105 (5 sentences)
- Intrapersonal Adaptation: 7, 10, 50, 74*, 75, 80, 87*, 110 and 112 (9 sentences)
- Hyperactivity/Difficulties in Concentration: 9, 13, 38, 44, 57, 59* and 86 (7 sentences)
- Language Proficiency: 23, 29, 45, 66*, 69 and 101* (6 sentences)
- Mathematics Capacity: 3*, 18, 60, 79 and 106 (5 sentences)
- Learning Capacity: 21, 36, 39, 40*, 94, 111 and 115 (7 sentences)
- General Self-Esteem: 35, 49, 52, 58, 91, 92, 93 and 97 (8 sentences)

Sub-scales of the Psychometric Tool:
- Social Adequacy
- School Adequacy
- Emotional Adequacy
- Behavioral Problems
- Self-Perception

Dimensions arise from the sum of the sentences of which they are composed. Then the subscales result from the sum of the dimensions of which they are composed. In order for the dimensions and subscales to be comparable (since they do not consist of the same number of sentences), a process of converting the initial score to standard scores is required. Thus, for each of the dimensions and subscales the Initial Scores (IS) converted to equivalent Standard Scores (SS). The T-values are used for this procedure, with an average of 50 and a standard deviation of 10. To find the SS, the formula $SS = 50 + 10 * Z$ is applied, where Z is the standard values. SS ranges from 20 to 80. A score close to the upper or lower limits of 20 to 80 means that the child has "marginally low" or "marginally high" performance, respectively. It is noted that high values in the subscales "Social Adequacy",

"School Adequacy", "Emotional Adequacy" and "Self-perception" indicate a good adjustment (i.e., positive behaviors). In contrast, for the "Problem Behavior" subscale, high SS indicates severe problems (i.e., negative behaviors). In general, students with a SS below 30 belong to a "very low" grade, 30 to 40 belong to a "low" grade, 40 to 60 belong to a "medium" grade, and 60 to 70 belong to a "high" grade. category and SS higher than 70 belong to the "very high" rating category. In addition, the individual details of the children (gender, year of birth, class, and school) were recorded.

Kahoot Game

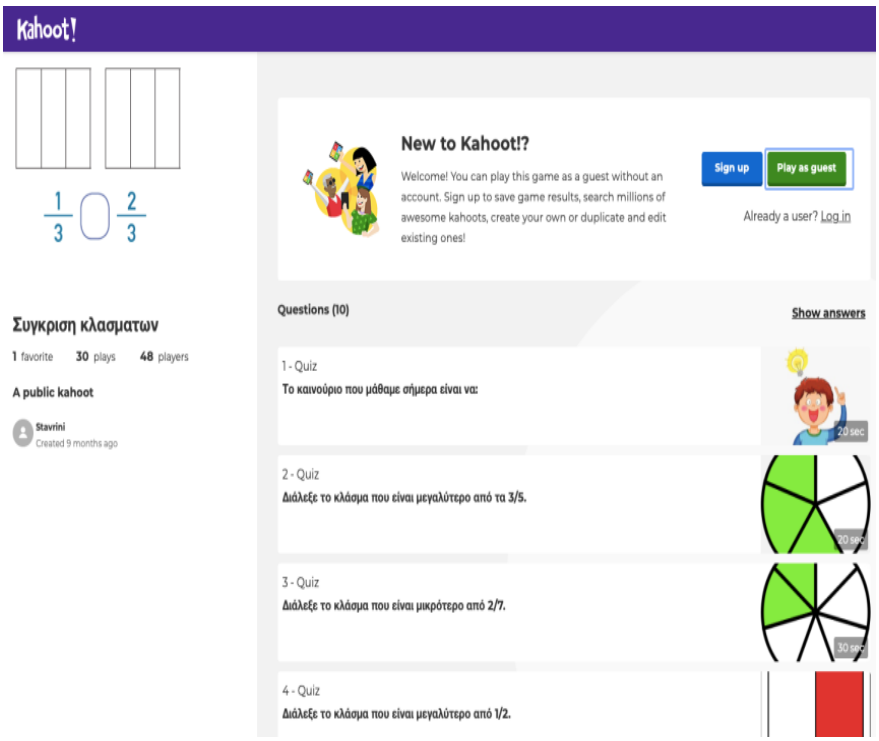

Figure 2: Kahoot Screenshot

Kahoot is a free application that enables us to create multiple-choice quizzes and responses that students may play concurrently (in a computer lab or tablet with an Internet connection). This becomes a game as students' scores are given following each response depending on their accuracy and ease with which they selected the correct answer. The teacher downloads all of the students' replies and examine their mistakes and shortcomings at the end of the game/quiz. Thus, the instructor exerts control over the choices and possible vulnerabilities for each pupil.

In this paper, we used Kahoot to teach fractions in arithmetic (Equivalent Fraction Game), which was done using the WebEx teleconferencing system (Figure 2).

LearningApps.org Game

We developed a game for European institutions using application learning apps such as the millionaire game (Figure 3) for Social and Political Education course.

Figure 3: Learning Apps Screenshot

Cyberkids Game

Games from Cyberkids is an initiative spearheaded by "Cybercrime Prosecution" (Figure 4) with the aim of educating and raising awareness about internet protection among children aged six to twelve and their parents.

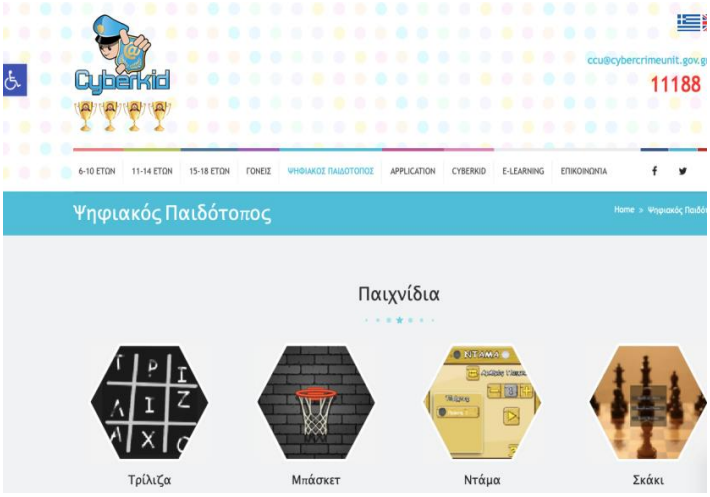

Figure 4: Cyberkids Screenshot

The Council of Europe's "Defeat the Virus" game (Figure 5), developed during a pandemic, was critical in helping children understand the virus in a simple and enjoyable way, which we found to be extremely useful.

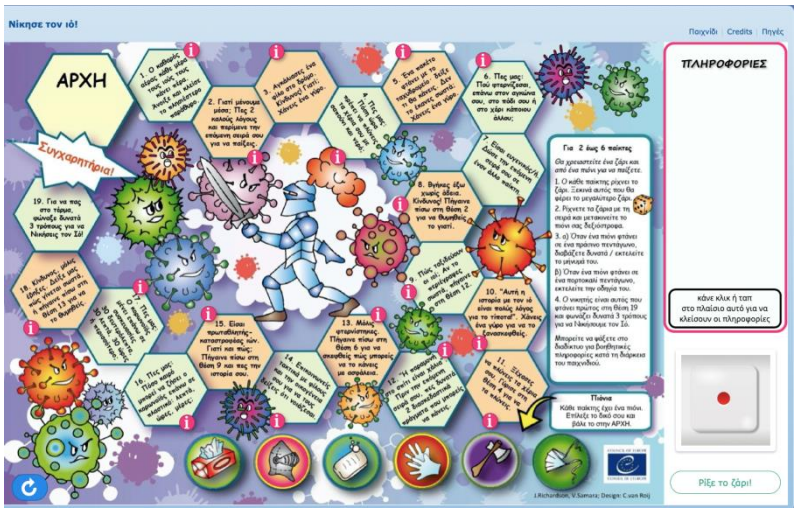

Figure 5: Defeat the Virus Screenshot

The above-mentioned game was developed as part of the Council of Europe's project on Digital Citizenship Education. Classes include students with ADHD, autism, and Roma pupils. Due to the ban on in-person classes due to COVID-19, the study focused on distant synchronous and asynchronous education. The lecture was delivered through e-class and WebEx. Students were assigned games that included both constructive and theoretical mathematics lectures about fractions, as well as social and political education. To compare the dimensions and subscales of the tool prior to and following the implementation of the games, we utilized the questionnaire "Psychosocial adaptation of children 10-12 years old," which was provided to students prior to and during the lesson. The questionnaire is self-administered and includes a list of explanations for several elements of this age group's behavior.

4. Results

The descriptive statistics of the variables were examined and analyzed. Basic location and dispersion measures, as well as frequencies and relative frequencies, were used to describe demographic characteristics. To test the reliability of the school children's answers (before and after the lesson) to the individual sentences that compose the dimensions, the Cronbach's alpha reliability index was calculated.

Following that, a psychosocial adjustment table is included for each student who participated in the study, capturing their individual score on the dimensions and subscales prior to and following the intervention. Thus, in addition to the overall investigation, an assessment of each child's psychosocial adjustment was made. Each dimension/subscale is scored using both "initial scores" (IS) and "standard scores" (SS).

Factor analysis was performed to investigate the weight (i.e., the percentage of variability that explains) each factor of the questionnaire in the composition of the individual dimensions and subscales. For the correlation of the subscales (standard variables were used) the Pearson *r* correlation coefficient was calculated. To investigate the correlation of dimensions and subscales with the demographics of students with gender, the *t*-test was used to compare two means values for independent samples (paired t-test). To predict possible behavioral problems from self-perception, emotional and social adequacy at the same time, a multiple linear regression model was applied. The dependent variable was the standard subscale "Behavioral Problems" and independent variables (possible predictor variables) were the subscales of "Self-perception", "Emotional Adequacy" and "Social Adequacy". Finally, a paired t-test was performed to differentiate the dimensions and subscales of the tool before and after the application of the toy(s).

Where values were missing, due to the non-response of some suggestions by students, they were estimated by applying a regression model to calculate the dimensions and subscales. The p-values reported are based on bilateral controls. P-values below 0.05 were considered statistically significant. SPSS software (SPSS Inc., 2003, Chicago, USA) was used to perform the statistical analysis.

Dimensions and Subscales

The following is the reliability index (Cronbach's Alpha) for checking the reliability of the various dimensions (before and after the lesson) that emerged as described above. From Table 1 it appears that the reliability index for all dimensions, both before and after the course, is over 50%. This indicates satisfactory reliability, while for most dimensions it exceeds 70% (very good reliability). The lower reliability of some dimensions may be due to the large variation of students' responses to the corresponding sentences.

Investigation before and after the application of the games

The findings are presented in Table 1. Regarding the dimensions, it appears that there is a statistically significant difference ($p < 0.05$) in the average value of the dimensions "Skills of Assertiveness/Leadership Skills" and "Interpersonal Communication" before and after the games are applied [RQ4]. More precisely, the average score for the above dimensions is higher on average following the intervention. Thus, the highest score (i.e., the most constructive behavior) following the game's implementation suggests that the intervention was effective in terms of assertiveness/leadership skills and interpersonal communication [RQ2]. Additionally, the intervention seems to have led to an improvement in the average score for the dimensions "Motivation," "Emotional Management," "Empathy," "Mathematics Capability," "Learning Capability," and "General Self-Esteem." However, it did not seem as if these variations were statistically important (Table 1) [RQ1, RQ2, RQ3, RQ5].

Table 1. Psychosocial Adjustment of Pupils 10-12 Years Old

Dimensions	Cronbach's Alpha		Number of Questions
	Pre	Post	
Skills of Assertiveness/Leadership skills	0.5	0.6	7
Interpersonal Communication	0.6	0.7	10
Collaboration with Peers	0.7	0.8	8
Motivation	0.8	0.8	12
Organization/Design	0.5	0.5	8
School Effectiveness	0.7	0.8	10
Self-Control	0.8	0.8	5
Emotional Management	0.7	0.7	8
Empathy	0.6	0.6	5
Intrapersonal Adaptation	0.8	0.9	9
Hyperactivity/Difficulties in Concentration	0.5	0.6	7
Language Proficiency	0.8	0.8	6
Mathematics Capacity	0.8	0.7	5
Learning Capacity	0.7	0.7	7
General Self-Esteem	0.7	0.5	8

The following are the basic descriptive statistics of dimensions and subscales before and after the course is applied (Table 2).

Table 2. Descriptive Statistics of Psychosocial adjustment of children 10-12 years.

Dimensions	Pre		Post	
	Mean value (SD)	Min-Max value	Mean Value (SD)	Min – Max value
Skills of Assertiveness /Leadership Skills	21 (4)	12-29	22 (4)	**14-29**
Interpersonal Communication	35 (5)	24-43	37 (4)	**25-44**
Collaboration with Peers	29 (6)	15-39	29 (5)	**13-38**
Motivation	39 (5)	29-47	40 (5)	**24-47**
Organization/Design	24 (4)	16-30	24 (3)	**17-29**
School Effectiveness	33 (3)	26-39	33 (4)	**25-40**
Self-Control	15 (2)	10-19	15 (2)	**11-20**
Emotional Management	26 (5)	15-37	27 (5)	**19-37**
Empathy	17 (3)	10-24	17 (2)	**13-22**

Intrapersonal Adaptation	24 (5)	16-33	24 (5)	**15-35**
Hyperactivity/Difficulties in Concentration	23 (4)	14-29	23 (4)	**13-29**
Language Capacity	18 (3)	12-23	18 (3)	**13-23**
Mathematics Capacity	18 (3)	12-21	18 (2)	**11-22**
Learning Capacity	21 (4)	15-29	21 (4)	**14-30**
General Self-Esteem	27 (4)	20-36	28 (4)	**18-34**
Subscales				
Social Adequacy	85 (13)	54-109	88 (12)	**54-103**
School Adequacy	96 (7)	76-107	96 (8)	**72-109**
Emotional Adequacy	59 (7)	45-78	59 (7)	**47-78**
Behavioral Problems	65 (7)	47-79	65 (7)	**46-79**
Self-Esteem	66 (6)	53-81	67 (5)	**56-84**

Investigation of Dimensions and Subscales

Tables 3 to 7 present the results of the factor analysis to determine the gravity (i.e., the percentage of variability explained by each factor) of the dimensions and subscales. The results are displayed in descending order, so the factor that appears first is also the one that has the most weight.

Therefore, in terms of " Skills of Assertiveness/Leadership Skills", the factor "I start a conversation/activity and ask for the participation of others" is more important, in "Interpersonal Communication" the factor "I apologize when needed" and in "Collaboration with Peers' "factor" I like being with other people " [RQ2, RQ4].

Table 3. Social Adequacy Factor Analysis

Dimensions			**Social Adequacy**	
	Factor	**Weight**	**Factor**	**Weight**
Skills of Assertiveness/Leadership skills	11	23.5	17	8.9
	41	20.6	19	8.4
	1	17.6	4	7.9
	22	11.8	25	5.8
	63	11.8	46	5.8
	64	8.8	26	5.3
	84	5.9	90	5.3
Interpersonal Communication	17	22.4	11	4.2
	19	21.1	42	4.2
	42	10.5	43	4.2

	2	9.2	114	4.2
	70	9.2	41	3.7
	31	7.9	2	3.7
	109	7.9	70	3.7
	88	6.6	78	3.7
	33	2.6	1	3.2
	62	2.6	31	3.2
Collaboration with Peers	4	18.8	109	3.2
	25	13.8	88	2.6
	46	13.8	22	2.1
	26	12.5	63	2.1
	90	12.5	64	1.6
	43	10.0	84	1.1
	114	10.0	33	1.1
	78	8.8	62	1.1

A correlation was found between the factors in the following three dimensions: (1)"Motivation", the factor "When I start something, I definitely want to finish it", with the dimension, (2)"Organization/Design" the factor "Usually I do not check my work for any mistakes" and with the dimension and (3)"School Effectiveness "the factor" I follow the rules of school and class ".

Table 4. School Adequacy Factor Analysis

Dimensions			School Adequacy	
	Factor	**Weight**	**Factor**	**Weight**
Motivation	12	19.5	12	8.8
	55	14.3	30	8.2
	27	13.0	55	6.4
	14	10.4	27	5.8
	54	10.4	53	5.8
	34	7.8	73	5.3
	71	6.5	14	4.7
	81	6.5	54	4.7
	32	3.9	100	4.7
	104	3.9	34	3.5
	20	2.6	15	3.5
	6	1.3	16	3.5
Organization/Design	100	20.5	83	3.5
	15	15.4	71	2.9
	16	15.4	81	2.9
	83	15.4	99	2.9

	99	12.8	102	2.9
	61	7.7	108	2.9
	68	7.7	24	2.3
	5	5.1	32	1.8
School Effectiveness	30	25.5	104	1.8
	53	18.2	61	1.8
	73	16.4	68	1.8
	102	9.1	95	1.8
	108	9.1	103	1.8
	24	7.3	20	1.2
	95	5.5	5	1.2
	103	5.5	6	0.6
	98	1.8	98	0.6
	113	1.8	113	0.6

A correlation was found between the factors in the following three dimensions: (1)"Self-Control", the factor "I react strongly when they argue with me", in (2)"Emotional Management" the factor "I understand when people are upset, even when they say nothing" and in (3)"Empathy" the factor "I can tell when one of my friends is sad."

Table 5. Emotional Adequacy Factor Analysis

Dimensions			Emotional Adequacy	
	Factor	**Weight**	**Factor**	**Weight**
Self-control	85	33.3	48	11.5
	51	16.7	56	10.6
	65	16.7	85	8.8
	67	16.7	105	8.8
	72	16.7	37	8.0
Emotional management	48	29.5	76	7.1
	37	20.5	82	6.2
	77	11.4	51	4.4
	107	11.4	65	4.4
	47	9.1	67	4.4
	8	6.8	72	4.4
	89	6.8	77	4.4
	28	4.5	107	4.4
Empathy	56	30.8	47	3.5
	105	25.6	8	2.7
	76	20.5	89	2.7
	82	17.9	28	1.8
	96	5.1	96	1.8

Regarding the dimension "Intrapersonal Adjustment", the factor "I am worried about what other children think of me" is more important, with the dimension "Hyperactivity/Concentration Difficulties" the factor "I am easily distracted by noises or activities" and with "Language Proficiency" the factor "I get good grades in Language" [RQ5].

Table 6. Behavioral Problems Factor Analysis

Dimensions			**Behavioral Problems**	
	Factor	**Weight**	**Factor**	**Weight**
Intrapersonal adaptation	74	17.4	9	7.6
	7	15.2	74	6.7
	112	15.2	59	6.7
	10	13.0	29	6.7
	110	13.0	7	5.9
	50	8.7	112	5.9
	80	6.5	13	5.9
	87	6.5	10	5.0
	75	4.3	110	5.0
Hyperactivity/ Difficulties in Concentration	9	20.9	44	5.0
	59	18.6	57	5.0
	13	16.3	45	5.0
	44	14.0	101	5.0
	57	14.0	23	4.2
	38	9.3	50	3.4
	86	7.0	38	3.4
Language Proficiency	29	26.7	80	2.5
	45	20.0	87	2.5
	101	20.0	86	2.5
	23	16.7	69	2.5
	69	10.0	75	1.7
	66	6.7	66	1.7

Regarding the dimension "Capability in Mathematics", the factor "I get good grades in mathematics" receives more weight, with the dimension "Capability to Learn" the factor "I understand what I read" and with the "General Self-Esteem" the factor "The "My parents know what I can and cannot do."

Table 7. Self-perception Factor Analysis

Dimensions			**Self-perception**	
	Factor	**Weight**	**Factor**	**Weight**
Mathematics Capacity	106	29.4	106	9.7
	79	21.6	92	9.1
	60	19.6	115	7.8
	18	15.7	79	7.1
	3	13.7	60	6.5
Learning Capacity	115	31.6	49	6.5
	36	23.7	52	6.5
	21	13.2	36	5.8
	111	13.2	93	5.8
	39	7.9	18	5.2
	40	7.9	3	4.5
	94	2.6	35	4.5
General self-esteem	92	21.5	91	3.9
	49	15.4	97	3.9
	52	15.4	21	3.2
	93	13.8	111	3.2
	35	10.8	39	1.9
	91	9.2	40	1.9
	97	9.2	58	1.9
	58	4.6	94	0.6

Investigation of the correlation between the Sub-scales

Table 8 presents the results of the correlation of the sub-scales. It appears that there is a statistically significant positive correlation between "Social Adequacy" and "School Adequacy" ($p<0.05$). This means that as students' social competence increases, so does their school competence. Similarly, there is a statistically significant positive correlation between "Emotional Adequacy" and "School Adequacy" ($p<0.05$). This means that as students' emotional well-being increases, so does their schooling. Also, there is a statistically significant negative correlation between "Self-perception" and "Behavioral Problems" ($p<0.05$). This means that the greater the students' self-perception, the less the behavioral problems they may exhibit. It is noted that there is no significant correlation between the subscales of "Emotional Adequacy" and "Self-perception", as well as between the subscales of "Emotional Adequacy" and "Behavioral Problems" [RQ6].

Table 8. Correlation Results of the Subscales

Subscales	Correlation	p-value
Social/School Adequacy	0,51	0,004*
Emotional/School Adequacy	0,51	0,004*
Self-perception/Emotional Adequacy	0,11	0,578
Emotional Adequacy/Behavioral Problems	0,17	0,363
Self-perception/Behavioral Problems	-0,46	0,011*

**Statistically important result*

Investigating the correlation of Dimensions with the gender of students

Table 9 presents the results of the investigation of the differentiation of the mean standard value of dimensions and subscales, depending on the sex of the students. Thus, it seems that boys compared to girls have on average a higher score in terms of dimensions "Skills of Assertiveness/Leadership Skills", "Motivation", "Emotional Management", "Mathematical Ability" and "General Self-Esteem". On the other hand, girls have on average a higher score in the other dimensions, with the largest average difference being observed in the dimension "Language Proficiency" and "School Effectiveness". However, these differences are not statistically significant ($p>0.05$). This probability is due to the relatively small sample size and possibly with a larger sample being statistically significant. Regarding the subscales, it appears that girls on average have higher school performance compared to boys, but at the same time greater behavioral problems. However, the differences do not appear to be statistically significant ($p>0.05$) [RQ3, RQ4, RQ5].

Table 9. Gender Correlation

Dimensions **Mean value (SD)**	**Sex**			
	Male (n=17)	**Female (n=13)**	**Mean Difference[1]**	**p-value[2]**
Skills of Assertiveness / Leadership Skills	53,6 (8,2)	50,6 (10,4)	3,1	**0,371**
Interpersonal Communication	53,8 (8,3)	54,7 (10,2)	-0,9	**0,797**
Collaboration with Peers	49,8 (10,9)	50,2 (8,3)	-0,4	**0,905**
Motivation	52,0 (11,7)	51,6 (8,0)	0,4	**0,920**
Organization / Design	49,8 (10,9)	50,2 (8,3)	-0,4	**0,905**
School Effectiveness	47,3 (11,5)	51,4 (11,7)	-4,1	**0,343**
Self-control	47,1 (10,3)	48,2 (11,0)	-1,1	**0,781**
Emotional Management	52,3 (7,1)	49,7 (11,6)	2,5	**0,468**
Empathy	48,2 (5,8)	52,3 (9,3)	-4,1	**0,165**
Intrapersonal Adjustment	49,9 (10,0)	50,6 (10,3)	-0,7	**0,861**
Hyperactivity/ Difficulties in Concentration	47,9 (11,0)	51,6 (9,2)	-3,7	**0,337**
Language Proficiency	47,9 (10,0)	52,7 (8,9)	-4,8	**0,186**
Mathematics Capacity	52,4 (7,8)	50,2 (10,9)	2,2	**0,526**
Learning Capacity	49,9 (8,7)	51,9 (11,9)	-2,0	**0,591**
General Self-Esteem	52,7 (10,9)	51,3 (8,5)	1,4	**0,708**
Subscales **Mean value (SD)**				

Social Adequacy	52,5 (9,3)	52,0 (9,4)	0,5	**0,891**
School Adequacy	49,6 (12,0)	52,1 (9,2)	-2,5	**0,540**
Emotional Adequacy	49,9 (6,9)	50,2 (12,5)	-0,3	**0,929**
Behavioral Problems	48,1 (11,1)	52,2 (9,0)	-4,1	**0,285**
Self-perception	52,8 (9,1)	52,1 (9,9)	0,7	**0,849**

SD: Standard Deviation
[1]Mean difference = [Scoring Male - Scoring Female]
[2]T-test for independent samples

Predicting behavioral problems from self-perception, emotional, social adequacy

Table 10 gives the results from the application of the multiple linear regression model to predict behavioral problems from self-perception, emotional, social adequacy. It seems that self-perception has an important role in predicting behavioral problems (p = 0.019). To increase the "Self-perception" sub-scale by one unit, the behavioral problems are reduced by 0.5 units (95% confidence interval: -0.9 to -0.1 units), keeping the other variables constant. In contrast, the "Emotional Adequacy" and "Social Adequacy" subscales do not appear to be significant assessors of behavioral problems (p>0.05) [RQ6].

Table 10. Multiple Linear Regression: Behavioral Problems - Dependent Variable

Independent Variables	**β**	**95%**	**p-value**
Social Adequacy	0.2	(-0.4 till 0.8)	0.459
Emotional Adequacy	-0.1	(-0.6 till 0.5)	0.966
Self-perception	-0.5	(-0.9 till -0.1)	0.019*

**Statistically important result*

Differences in the dimensions and subscales before and after the application of the games

Table 11 presents the results of the investigation of the difference in the dimensions and subscales of the tool before and after the educational intervention. Regarding these dimensions, it appears that there is a statistically significant difference before and after the application of the games in the average value of the dimension "Skills of Assertiveness/Leadership Skills" and "Interpersonal Communication" [RQ2, RQ4].

More specifically, the average score of the above dimensions is on average higher after the intervention. Therefore, the higher score (i.e., higher positive behavior) after the application of the game indicates the success of the intervention in terms of assertiveness/leadership skills and interpersonal communication.

Also, the intervention seems to have contributed to the average increase in the scores of the dimensions "Motivation", "Emotional Management", "Empathy", "Mathematics Capacity", "Learning Capacity" and "General Self-Esteem". However, these differences did not appear to be statistically significant.

Finally, it appears that there is a statistically significant difference before and after the application of games in the average value of the sub-scale "Social Adequacy" while there is evidence of a significant difference ($p<0.10$) before and after the application of the games in the average value of the subscale "Self-perception" [RQ6].

Table 11. Correlations before and after the application of games

Dimensions Mean (SD)	Intervention		Mean Difference[1]	p-value[2]
	Pre (N=30)	Post (N=30)		
Skills of Assertiveness/ Leadership Skills	50 (10.1)	52.4 (9.1)	-2.4	0.043*
Interpersonal Communication	50.1 (10.1)	54.1 (9.0)	-4	0.007*
Collaboration with Peers	50.1 (10.0)	50.0 (9.7)	0.1	0.922
Motivation	49.9 (10.0)	51.9 (10.0)	-2	0.154
Organization / Design	50 (10.0)	49.9 (9.2)	0.07	0.966
School Effectiveness	50.2 (9.9)	49.3 (11.5)	0.9	0.543
Self-control	50.0 (9.9)	47.4 (10.4)	2.6	0.213
Emotional Management	49.9 (10.0)	51.1 (9.3)	-1.1	0.474
Empathy	50 (10.0)	50.1 (8.0)	-0.1	0.958
Intrapersonal Adjustment	50 (10.1)	50.1 (10.0)	-0.1	0.905
Hyperactivity/ Difficulties in Concentration	50 (10.0)	49.5 (10.2)	0.5	0.707
Language Proficiency	50.1 (9.9)	50 (9.6)	0.1	0.974
Mathematics Capacity	50.2 (9.9)	51.4 (9.2)	-1.3	0.340
Learning Capacity	49.9 (10.1)	50.7 (10.1)	-0.7	0.561
General Self-Esteem	50 (10.1)	52.1 (9.8)	-2.1	0.175

Finally, it appears that there is a statistically significant difference before and after the application of games in the average value of the sub-scale "Social Adequacy" while there is evidence of a significant difference ($p < 0.10$) before and after the application of the games in the average value of the subscale "Self-perception".

Table 12. Correlation Effects before and after the application of games

Dimensions Mean (SD)	Intervention		Mean Difference[1]	p-value[2]
Subscales Mean (SD)	**Pre (N=30)**	**Post (N=30)**		
Social Efficacy	50.0 (10.0)	52.4 (9.2)	-2.4	0.042*
School Efficacy	50 (9.9)	50.8 (10.8)	-0.8	0.624
Emotional Efficacy	50 (10.0)	50 (9.5)	0.0	0.983
Behavioral problems	50 (10.0)	50 (10.2)	0.1	0.924

Self-perception	49.9 (10.0)	52.5 (9.4)	-2.5	0.085

5. Discussion

This study validated the usefulness of an educational intervention applied to learning environments in the development of psychosocial functions and in a long-term level, the amelioration of neurocognition via gamification. Undoubtedly, Covid-19 pandemic is a catalyst in shaping new working and educational conditions in various professional environments. Traditional education tends to be completely replaced by digital distance education. For this reason, the application of innovative distance learning techniques that will promote the motivation and the psycho-emotional and cognitive development of students is considered an inescapable necessity.

Increased cognitive, social, and emotional competence translates into increased academic competence. On the contrary, diminished self-perception has an effect on cognitive function and results in an increase in behavioral difficulties. This conclusion holds true even when cognitive social and emotional adequacy are considered concurrently. Additionally, gender does not appear to be a significant predictor of psychosocial adjustment in school children aged 10-12.

Finally, the educational intervention via gamification empowered cognition significantly improved the assertiveness/leadership skills and interpersonal communication of school children, as well as their social competence and self-perception. Also, motivation seems to be increased with the integration of playfulness in distant modern and asynchronous teaching.

Gamification is a reward system method that has been used in a variety of sectors, including commerce, health, and education. However, a paradigm change in the meaning of gamification has occurred, as evidenced by the literature study. To add value to the gamification process, meticulous planning is required before incorporating game elements into the system and its primary customer, the students. One of the primary benefits of gamification is that it can be implemented in both traditional and electronic learning environments. However, with careful planning and integration of gamification into teaching and learning, such as a user-centered top-down system approach, elements of fun that create a loop of fun, and adequately supported challenges, a meaningful gamification system can hopefully be created, thereby improving students' cognitive levels.

According to the literature, there are both positive and negative consequences on the cognitive success of a gamified system. Even though the research enhanced levels of involvement, Dominguez et al. (2013) found no difference in achievement between students in the traditional classroom and those in the gamified classroom. Thus, the gamified system may have lost its function, as users claimed that certain activities were not interesting enough to drive them to compete. They, too, suffered losses because of the leader board system. As a result, the flow has been interrupted, impairing the important parts of gamification. Inability to see the consumers' needs leads in the game parts being rejected *(Gkintoni et al, 2015; 2021)*. When it came to cognitive achievement, *Barata et al. (2013)* had the same

difficulties. This was due to the undesirable job, which might divert attention away from the basic aim of learning. Users discovered engagement aspects in posting and contributing, but progressively lost interest when confronted with unnecessary obstacles such as correcting spelling errors in course notes. This did result in a sense of meaningless gamification, the opposite of meaningful mental engagement, which resulted in users not delving deeply into the material they were learning.

Meanwhile, *Esper et al. (2013)* have effectively incorporated gaming aspects. They enhanced cognitive features by including the evaluation into the game and emphasizing the importance of successfully completing it as part of the tale developed by the game creators. This was shown to boost their cognition in programming abilities and to keep them captivated in utilizing it more, resulting in increased learning.

The results of the present study are combined with findings from other studies as described below. The gamified approach transformed the tedious process of learning to code and program into an entertaining activity. *Green & Bavelier (2003)* examined the cognitive factors when examining the influence of games on cognitive characteristics. It was discovered that gamers' attentional and blink capabilities were much greater than those of non-gamers, and this effect was more pronounced in action video gamers than in non-gamers. In a follow-up research, *Green & Bavelier (2006)* examined gamers' attentional ability and discovered that they could identify distractors faster and more accurately than non-gamers, indicating a clear cognitive advantage over non-gamers. This compensates for the research conducted by *Tong & Chignell (2013)* exploring the use of a simple game to help the elderly enhance their cognition. The tapping mechanisms in these games can aid improve coordination, which could have ramifications for assisting the aged and infirm.

As a result of the debate, most gamification studies succeeded in engaging and motivating users but fell short of developing cognitive abilities such as observing, undertaking, retention, and problem solving *(Dominguez et al., 2013; Barata et al., 2013)*. Incorporating gamification into a system without considering the needs of the users or the business results in meaningless gamification fails to increase the user's accomplishment. Games that have a strong plot and make even the most difficult activities attractive for new learners show significant increase in accomplishment *(Lee et al., 2013)*. Additionally, according to study by *Green & Bavelier (2003;2006)*, games can assist users enhance their attentional resources, which was observed in gamified systems by *(Tong & Chignell (2013)*; therefore, improving the cognitive capabilities of older individuals. Though the method utilized disabled individuals, it is on the proper track toward discovering a great cognitive application in gamification. This is critical for gamifying education and learning. These would enable the use of gamification to engage and motivate students while also boosting their cognitive abilities when learning science and mathematics.

This study demonstrated the critical role of playfulness in the cognitive and social development of primary school students enrolled in distance learning. The

research questions that were addressed have been covered by the research methodology and the findings. Gamification technologies in distant learning appeared to increase students' interest and motivation. Thus, the pandemic's learning process was effective because to the use of Information and Communication Technologies (ICTs) *(Antonopoulou et al., 2021a)*. Simultaneously, when combined with the component of interpersonal communication, gamification technologies appeared to substantially predict students' assertiveness and leadership skills. Respectively, aspects such as emotion regulation, empathy, cognitive skills, mathematical abilities, and general learning capacity appeared to be suitably benefited.

6. Conclusion

The experience of schools being forced to close because of the Covid-19 pandemic has prompted the entire educational community to seek new methods and practices to ensure that distance learning does not lag in terms of cognitive achievement and teacher contributions to improving the quality of communication and interpersonal relationships.

The study revealed that the usage of gamification in distant education and conventional games in lifelong learning functioned as a motivator for students, improving the enjoyment and attractiveness of the lesson while also enhancing cognitive functions such as executive function, attention, concentration, self-control, empathy, and the student group's connections. Simultaneously, to reinforce the findings of this study with qualitative data, we may say that all this procedure via gamification assisted in the acceptance of pupils with inferior performance, as they gained their classmates' appreciation through the game's different stages. These students were able to experience achievement and overcome prior academic failures in the regular classroom by participating in the electronic game. This boosted their neurocognition, self-esteem and enthusiasm for the topic, while also acknowledging their value in front of the whole class.

Finally, school children who previously demonstrated excellent performance retained them while being more receptive and helpful to their less fortunate classmates. From the teacher's perspective, we believe that initial tension was replaced by a sense of fulfillment, as students' accomplishments, in addition to maintaining the lesson's standard, strengthening interpersonal relationships within the student group, and boosting the self-confidence of low-achieving students, motivated them to continually develop and use new games and incorporate them into his teaching.

Further research will be to demonstrate the value of gamification in cognition and in psychosocial development in a larger sample of school children, in children with special needs, via the use of several cognitive tasks and standardized neuropsychological tools in combination with e-games and other psychometric scales for social functions in various educational environments of all levels of education.

Limitation and Recommendations

Other studies may use additional research instruments, such as surveys, questionnaires, focus groups, and qualitative methods such us individual interviews, to enhance learning materials and obtain a better understanding of the study's findings.

Author Contributions

H.A., C. H., E.G. & A.K. contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Ethical Approval

Participants with prior approval from their parents, gave their written consent to use their anonymous data for statistical purposes.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

Acknowledgements

We would like to express our gratitude to the children, their parents, and the instructors who participated in this study.

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