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The Role of Gamification in Enhancing Cognitive and Neuropsychological Learning: A Review

Hera Antonopoulou*

Department of Management Science and Technology

University of Patras, Greece

hera@upatras.gr

*Corresponding Author: E-mail: hera@upatras.gr

Abstract

This paper explores the intersection of gamification and educational practices, focusing on cognitive and neuropsychological dimensions. It comprehensively reviews theories and models relevant to cognitive and neuropsychological learning, highlighting gamification's potential to enhance engagement, motivation, and academic performance. The study evaluates empirical evidence supporting the efficacy of gamified interventions across mainstream, higher education, and vocational training contexts, emphasizing the importance of clear objectives, immediate feedback, and balanced challenges. The paper underscores the growing role of technology-driven advancements—such as mobile learning, virtual reality, and artificial intelligence—in personalizing learning experiences and reshaping teacher roles. Additionally, it addresses the implications of gamification in promoting mental health, emotional intelligence, and social justice within educational frameworks. The need for meticulous planning in the implementation of gamification strategies and further empirical research to validate their effectiveness is emphasized. Ultimately, this research aims to inform the development of serious games targeting cognitive and neuropsychological skills across diverse age groups and educational settings.

Keywords: *Gamification, Cognitive Learning, Neuropsychological Learning, Engagement, Motivation, Academic Performance, Mobile Learning, Virtual Reality, Artificial Intelligence, Personalized Learning*

1. Introduction

This article outlines the central focus on gamification and its rigorous influence on cognition and neuropsychological learning, promoting descriptive statements with current understandings and proposing theoretical and applied implications. The instructions are varied. Therefore, an improved understanding of cognitive learning enabled by a principle such as gamification is essential in predicting potential gains in educational, clinical, and behavioral paradigms. This review covers the history of relevant research and limitations in identified literature in 11 areas from 2001 to 2019 [1-7]. The integration of gaming elements in computational systems and products for education and training has been very much in the ascendancy over the past decade, buoyed by growing evidence that playing digital games can enhance cognitive efficiency in terms of speed of cognitive processing, selective attention, cognitive control, and decision making, as well as improving quality of life. In this review, emphasis is placed on identifying those areas of theoretical framework and empirical studies in the scientific literature that describe and support the direct improvement in the specific underlying potentially antecedent cognitive processes or executive functions supporting more general learning that can be achieved through gamification. The goal was and is to further the development of bespoke serious

games that increasingly target these cognitive and neuropsychological underpinnings accurately and safely in children, adolescents, and older adults, and to argue theoretical and original methods sections as necessary. It may also serve as a backdrop and roadmap for the imitation of earlier work in this area [8-12].

Background and Rationale

Gamification is currently a prevailing notion in educational research, and a continuously increasing number of research studies and classroom strategies are based on it. The litmus test for any new strategy based on student engagement is its effectiveness in terms of students' willingness to be engaged in active learning activities. Gamification, functioning in a blended form of play and game rules incorporated in learning activities, accomplishes this goal by enhancing students' perseverance, enthusiasm, motivation, and learning performance. By utilizing game dynamics and rules of engagement, it is believed that students are compelled to reach high levels of effort and commitment to solve complex tasks in the process of learning, and to complete their assignments in a timely manner, as there is some type of reward if they succeed. This reasoning corresponds to the challenging times in education, where passive learning from board work and classical teaching were losing their appeal for students who are highly accustomed to a digital education [13-18]. To this end, research evidence has drawn implications for classroom instruction and teaching methods, particularly for those instructors who have consistently faced the challenge of increasing student motivation and engagement. Games and gamified learning can induce positive mood states which in turn encourage learning. Playing games is both a psychological and physiological experience, and it produces feel-good chemicals such as dopamine in the brain, connecting this and proving that games are resistant to decay when snubbed after effect, good at hiding skill enhancement, and make you happy to learn. According to motivational literature, these levels of cognitive efficiency and goal accomplishment are also strong prerequisites for student satisfaction and performance accomplishment [19-23].

2. Understanding Gamification

This paper introduces gamification for cognitive and neuropsychological learning. In the first part, we will clarify what gamification is and analyze related concepts. There are several terms and concepts that are closely related to gamification, including game, play, serious games, game-based learning, goals, rules, feedback, flow, novelty, variety, challenge, risk, uncertainty, and rewards. This paper concentrates on gamification, which is the usage of game elements for non-game problems by taking game design techniques, such as points, badges, and leaderboards, and applying them to other areas to improve engagement and motivation. This works by exploiting fundamental aspects of play to facilitate educational practices [24-26]. Although incorporating game mechanics into non-game situations is the core idea behind gamification, there are some misconceptions about what this means. Related to this, although the practice has seen great success, there are negative aspects of gamification and ways in which it can go wrong. This paper will also, therefore, describe and outline some of these criticisms of gamification, before considering detailed advice on good practice for the implementation of gamified systems. This paper then navigates through psychology to help explain why gamification works. We will illustrate, through case examples, the use of gamification in cognitive and psychological training before concluding. Applying principles and elements of games to traditional, non-game learning can lead to a significant positive outcome in learning and education. This multi-disciplinary study presents a scoping review to inform the world of clinical and medical education. This is important to confirm the gamification mechanisms of how to promote learning and motivation in this educational field [27-33].

Definition and Concepts

To our knowledge, this article represents one of the first efforts to discern how thousands of available gamification resources are structured within the context of cognitive and neuropsychological learning. Although some basic principles have come to a consensus, there is a lack of empirical evidence on gamification's exact effects on different skills. Humble gamified applications still appeal to us, assuming we like to play. Gamified applications can be seen from different viewpoints, and there has been a lot of effort in this regard. Some scholars speculate about what works best, has impact, or offers future potential; others dwell more on what has or does not work, shedding light on existing problems, false beliefs, or misconceptions. A

systematic review is one that makes use of explicit, systematic methods in selecting, identifying, and appraising the available evidence [34-39]. Numerous definitions, models, or perspectives on gamification have been put forward across different domains such as psychology, information systems, media education, business, organizational behavior, and services. Particularly in education, the term gamification has been identified and defined as the use of gameful design and video game principles, including mechanics, dynamics, and aesthetics, to encourage, engage, and motivate people to achieve set goals in non-game activities. In this sense, gamification is used as a systematic way to develop tools with integrated gaming elements. These can feature either in the mechanics, rules, and process; the dynamics; the elements that prove to be more engaging; the narrative of the game in the story; or in the aesthetics of the game that provide more entertainment and game feeling. Points, badges, and leaderboards are the most addressed gamification elements in literature. Points are generally used to rank performance or tier programs and attract a higher level of user participation. By gathering points, users are encouraged to reach some pre-specified goal for achievement, raising time on applications. Users can display points or badges to receive public or private accolades for the completion of desired calls to action. Overall, gamification is said to tap into both intrinsic and extrinsic motivational behaviors depending on individual interests [40-43].

3. Cognitive and Neuropsychological Learning

Learning is a psychological process most referred to in terms of conditioning and cultural variables and seen because of them by behaviorists. It has been defined as the process of gaining knowledge and abilities because of studying, or to notice something and be aware of it. In a broad sense, learning is the system that contributes to professional development. Consequently, it can be said that the best term in educational terminology that can represent this system is learning. A total of at least 10 cognitive processes have been specified in studies showing that learning is a complex process of producing new information. These processes are as follows: attention, sensation, perception, organization, memory, reasoning, judgment, imagination, creativity, and problem-solving [44-49]. Perception is a cognitive concept reflecting what comes to the senses, while attention means increasing cognitive activity in the brain for an object or situation that has an impact, importance, and novelty for the individual. Memory, as a learning-based, organizing-remembering process, is the collection of networks formed by neurons in the brain for storage, recalling, and reprocessing. In broader terms, learning can be defined as acquiring knowledge, skills, or attitudes because of training, personal experience, or educational processes. Neuropsychology deals with the functions and mechanisms in the brain and processes the developing functions, including two major indices of the learning process: the behavioral index that reveals what has been learned, and the physiological index that reveals how the brain mechanism has been changed because of it. Several models that express cognitive functions, widely accepted in the cognitive learning process, can be listed, among which our study will benefit from Cognitive Load Theory and Multiple Memory Systems Theory [50-54].

Key Theories and Models

Theories and models are the scientific tools that allow designers of educational content to understand the learning processes comprehensively. Based on these, the cognitive and neuropsychological dimensions of learning have also been conceptualized in various theoretical and model frameworks. Although it is not possible to touch upon all of them in detail, in the following section, the most accepted and widely used theories related to cognitive and neuropsychological learning will be discussed, and to some extent, the effects of these theories on educational practice will be elaborated. Later, it will be explained how this literature about cognitive and neuropsychological learning theories points to the theoretical path for gamification, as being the aim of the paper [55-61]. Theories and models indicate the scientific foundations of the cognitive principles of constructivism, behaviorism, neurocognition, and cognitive load theory, as well as theories and pedagogical applications of topics such as instructional, environmental, and experiential learning. Each of them is approached with different types of instructional design models, including content presentations, instructional games, simulations, and instructional scenarios. The studies suggest a growing tendency to investigate the cognitive and neuropsychological benefits of these approaches in various learning environments. Naturally, although the cognitive growth processes and the theoretical and practical treatment of developmental theories may differ according to the context, they complement each other and describe the design of the gamification

system as a cognitive method that correlates with the development of the learners' brains. In the next section, the cognitive theories and models of cognitive theories will be included to better understand the following parts of the conceptual aspects of neuropsychology [62-67].

4. The Intersection of Gamification and Learning

This comprehensive review aims to synthesize the evidence on the role of gamification when incorporated in both cognitive functioning, including memory, attentional processes, processing speed, and executive functions, as well as in modulating emotional regulation, decision-making processes, and neuropsychological status. A plethora of disciplines converge in educational sciences, in which strategies to plan lessons and develop systems that effectively enhance skills related to adult and child competence are the focus. In this context, gamification emerges as a modern tool, and the gamified proposal combines game-based elements with conventional teaching and learning objectives to stimulate learners' involvement and participation. In parallel, gaming is recognized as a lucrative sector, and the recent trend of gamification has led to the development of various gamified applications and tools promising a rapid and fun approach to learning. However, the eagerly awaited benefits of adopting a gamification perspective in teaching may not be consistent across different learners or professional learners. Moreover, the implementation process has some challenges, such as seeking a balance between the teacher-student ratio, creating a stable chat, and offering opportunities for personal problems. To provide criteria for validation, a related approach can discuss success stories in implementing online courses. Nevertheless, the use of games as a tool to improve learning outcomes is expected to enhance the perceptive capabilities of an asynchronous individual upon integration with the educational system. Through this lens, the benefits of using a more engaging, self-motivated, and interactive system are revealed, delivering learners more scaffolding and alternatives to escape cognitive overload. Thus, this involves the scaffolding of knowledge regulation in derived cognitivism, related to metacognitive activities, and includes knowledge data, including activities, for structuring knowledge to motivate, engage, and boost learning [68-72].

Benefits and Challenges

Although the educational gains obtained from gaming are far from being interpreted unequivocally in all its aspects, the implementation of gamification can enhance cognitive and neuropsychological learning in educational environments. Elevated school performance and the inspiration for professions in STEM and economics by students who did not originally receive good grades are also demonstrated in a single case of uncertain evidence in lower and upper secondary education, and in businesslike training. The benefits of implementing educational gamification are mainly reflected by the increase in students' motivation, engagement, and more enduring retention of specialized knowledge. Learning through digital gaming can increase cognitive learning, and such learning is reinforced by meaningful utilization of technology. In a computer networking course, the capture, motivation, and gaming framework in the classroom were found to enhance student engagement in the introductory course at the university level. Gamification's effects on learning outcomes in business education and consumer behavior were also associated with a substantial, albeit weaker, commitment boost. However, animosity from unexpected emotions of affected students, identity resistance, and a realistic understanding of the challenges for new teachers in the gaming environment have occurred in education and teaching experiences at higher educational levels while perfectly clear benefits of this application have been presented. The task of converting educational structures is more complex than complicated. Educational game development may also develop poorly into a non-superficial utilization of gamification and raise serious pedagogical concerns. A proper and careful, well-regulated approach must have the use of gaming, that means coming back to the drawing board. The challenges in the process of gamification could be mitigated: (i) by the knowledge of the targeting of the students, (ii) by training the use of gamification, being also necessary under negative expectations, and (iii) by the provision of adequate resources and time for the appropriate development of the courses because it needs meticulous strategizing, designing, implementation, trying, testing, aggregating, evaluating, and disciplinary fitting in height. In an intervention study in primary and high school involving students, the control group often outperformed the gamified group; no difference in terms of participation or effectiveness was made with and without gamification in an appointment process for high school students. In a series of studies, significant student differences in loyalty

gaming and students without loyalty gaming were found. It is conducive to positive outcomes by the construction of the application of gaming mechanics and operational elements of the gaming context to educational life. Gamification within the context of working with site visitors shows that different elements of the ages may be targeted for different effects on the investment of older adult families and worship attendees than students up to 14 years old [73-75].

5. Empirical Evidence

The literature reviewed provides evidence to suggest that there are effective elements and design principles that result in worthwhile cognitive and neuropsychological enhancement using game mechanics for these pedagogical purposes. This includes time on tasks, changes in engagement, motivation to engage in learning, and teacher perception of improved academic performance. The purpose of this section is to provide a critical lens through which to observe this evidence and to consolidate a narrative using the body of evidence that has been gathered from diverse educational contexts. We address the following research paradigms from studies or editorial notes, plus literature reviews where data were originally collected in a systematic way, including: data generated from a high-impact factor journal article; a critical review of intervention studies using a systematic review approach; journal articles that review the literature through systematic review processes; and multi-phase studies where data were originally collected through surveys, observation, and interviews [76-79]. A diverse range of studies from the UK to Turkey and Qatar to Australia triangulate when considering the outcome that students (and teachers) are engaged and working harder for longer when using gamified tasks in varying cognitive and neuropsychological skills training contexts. Most studies considered in this evidence-based component are drawn from mainstream education for wide learners, from primary through to higher education, and including initial teacher education. A review critically addresses the gamification literature that sits within the mainstream of educational psychology, and it was possible to consolidate a digital and non-digital offering that was likely to be pedagogically efficient for the enhancement of cognitive and neuropsychological skills needed to support inclusive education. A second study includes a narrative review of the same literature with a meta-synthesis semi-qualitative approach that adds a layer of nuance to the evidence presented here and will be further addressed in the phases of concurrent validation of the gamified framework. The authors submit that digital and non-digital game-based frameworks can arise when certain game mechanics combine to form a science and/or mathematical basis that has a digital component [80-83].

Studies on the Efficacy of Gamification

Numerous studies have been carried out to examine gamification efficacy in various educational settings, including intelligence quotient development, neuropsychological rehabilitation, and cognitive improvement. When aiming to evaluate the impact of knowledge acquisition and user engagement, I present a few examples of successful applications involving a high number of participants, which incorporate both quantitative and qualitative analyses of learning outcomes that are comparable to the control groups. The limitations of these studies regarding their application to real-world educational settings are also discussed [84-89]. Several studies have examined the efficacy of a range of gamified applications and educational platforms. A detailed case study explored the use of a platform for learning mathematical concepts. The study involved 80 participants between the ages of 9 and 11 (average age of 9.6 years), who played the game for 240 minutes over 12 separate sessions. Results showed a 77% increase in motivation and engagement with the alternative interactive game. Moreover, a two-item pre- and post-test indicated that exposure to the platform was related to an increase in student content knowledge regarding sums of 10 and 20 in base-ten households as measured by chi-square comparisons. Another study expanded upon this research to further evaluate the efficacy of the platform, citing its design elements, relatively low cost, and motivational and engagement features as positive attributes that can be helpful to teachers in targeting student math performance and conceptual knowledge. This study involved 54 students playing the game and 54 students who participated in a control group completing a math worksheet on the same topic and post-tested to compare knowledge gained across groups. The study yielded qualitative data which elucidated that student enjoyed their time using the game, reporting increased feelings of motivation and self-efficacy. Another study also played a neural video game to investigate the effects of neuropsychological recruitment [90-93].

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Another study utilized a gamified application to teach the necessary components of neuroscience, electronics, and psychology to a second-year undergraduate course in Biopsychology. A total of 72 students participated in eight labs within the gamified environment, with another 83 students in a parallel section completing the practical components of the course in a traditional manner. No significant differences in background variables existed between the teachers, courses, and semesters, demonstrating that the courses were well matched. Post-game survey data showed students perceived the game as enjoyable and understanding of relevant concepts, with 73.9% of students indicating that they felt engaged in the gamified process. The only potential barrier reported was poor application functionality, but this was supported by positive feedback regarding the applicability of the experience toward achieving intended classroom learning outcomes compared to the control conditions. Another investigation also examined the effect of an assortment of gamified laboratories [94-100].

6. Design Principles for Effective Gamification

Designing for gamification instances in real education requires knowledge and understanding of how to create an engaging experience. The following section provides several guidelines and points to consider when designers decide to immerse themselves in the gamified path in education and consider the importance of various aspects of gamification. It is paramount to fully understand the students' need to introduce gamification in an educational setting to produce an effective design. Trying through trials and experimenting to discover the perfect mathematics behind optimum instruction should be the final goal of every educator. However, considering the cognitive system of the learners who are to be confronted with a gamified educational system, some guidelines can be extracted [101-105].

The principles of clear objectives, immediate feedback, and level of challenge can constitute the basis for applying gamification in any educational system. The principles of gamification, which cultivate creativity and structure, can also provide the teacher with a way to build diversity into the procedure, offering different learning environments tailored to various learning styles, from auditory learners, who prefer lectures or listening, to kinesthetic learners, who prefer hands-on experience and practical application. Designing a framework with various optional adaptations can then increase the versatility and gamified competence of the process, while game design and the game environment that consider the learning content can be explicitly taught. With gamification, a fundamental part that controls the comfort provided to the user and has a significant amount of research proving its effect is Flow, a state in which the level of challenge matches the level of skill [106-110].

The feeling of being part of a community, such as in social media networks, can also make a strategy fun. Other elements that can encourage competition and collaboration, in addition to game-based dynamics, can be introduced, such as leaderboards, quests, achievements, and so forth. Popularity contests, after the fullness of gameplay that matches the flow criterion, can add a touch of experience, establish a social rank, aesthetic, or social identity, and experiment as shown on different social network handles. In summary, keeping the user capable of reaching the ultimate level of engagement and establishing an organic mass that engages in gameplay necessitates ensuring the player is free to practice at their optimal capacity and time, and a multiplayer or at least dual-agent system that enables them to interact with others in order to fulfill more intrinsic mental needs such as rivalry with external power, defense of essential rights, promotion of connectedness, development of social cognitive skills, and the desire to tilt the connectedness in one's favor [111-116].

Engagement and Motivation

Research has widely investigated the motivational aspects underpinning engagement in gamified activities. Gamification is based on the adoption of game-based elements in non-game environments in order to motivate users to participate in them, learn, and complete missions. Although video games are now seen in mainstream culture, serious games and game-enhanced cognitive training approaches have only recently started to draw increasing attention from researchers. The market has also started to invest in commercial games for cognitive training and rehabilitation, except for sports or action video games. Over the past fifty years, much research has demonstrated the positive effects video games have on attention, resilience, working memory, problem-solving, and mental rotation after training. In this context, an increasing number of recent psychological and

neuroscientific studies have investigated causal relations between video gaming and cognitive changes, as well as the neural underpinnings of better cognitive performance. This paper presents a review of how games and serious games are applied to enhance neuropsychological and cognitive rehabilitation [117-120].

There is an increasing body of literature on game design principles and on how to successfully import game elements into non-game activities to raise participation and induce learning. Many game designs focus on the flow experience generated by maintaining an optimal balance between challenge and skill. As a result, learners may find it more interesting than easy game learning. Many also aim to foster autonomy to make the learning activity relevant to the learners' needs and to engage them in the learning process. Many also create shared, collaborative environments. The ability to support motivated behavior is often referred to as one of the positive aspects of games and a major reason to import game elements into non-game activities. Gamification that provides support for motivated behavior could give learners a proper jolt to engage more with the non-game activity of learning. The motivation cited most often is the ability of games to attract and maintain players' attention over time. Gamification, however, also runs the risk of failing to maintain long-term motivation. Long-term motivation and expertise development require a deeper understanding of the mechanisms that underlie the motivation that drives players' attention. The work described in this paper advocates that increasing this deeper insight starts with recognizing the need for a more articulate conception of the research domain of human play and the positive experiences that intrinsic motivation is likely to be a key ingredient of. To catch a glimpse of the complexity of this area, the present study applies a qualitative research method that may capture some of the finer dimensions of players' experiences and the workings of play as a 'motive frame,' using in-depth interviews with young video gamers for the purpose of studying the positive potential of games [121-126].

7. Applications in Different Educational Settings

Several case studies of successful implementation of gamification in different educational contexts, such as in institutions of higher education, vocational training centers, and informal learning environments, exist. Two examples of successful implementations of gamified interventions for traditional educational settings oriented to higher education are presented. A vocational training program for faculty in which gamified approaches were used for professional development is also discussed. Finally, several case studies of game-based learning in informal learning environments, which often are blended with more formal in-class experiences, are highlighted. The concreteness of the applications in different educational settings may help both instructors and designers tailor the set of elements that work better for their specific target and context. Discussions on applications of learning are generally packed with practical advice, including, for example, implementation costs and levels of entertainment of different combinations of gameful and gamified elements [127-128]. Gamification in a blended-virtual introductory Artificial Intelligence course is presented, where a gamified application was employed to engage a general population of undergraduate students from very different fields. A gamified intervention designed to help adult community members learn and retain more information regarding brain health is also discussed. Finally, some suggest design-based knowledge on the application of gamification to instructional design or learning experience design models [129-130].

K-12 Education

Today's children are digital natives, born in a digital era. Kids are surrounded by digital experiences and are exposed to digital devices in a variety of contexts. It is easier to find a young child trying to swipe right or left on a book instead of turning the pages in the same way. Since the changes in cognition are directly proportional to the changes within society, children's tasks and activities must be designed according to these technological developments. The use of digital platforms in the public school system is gaining popularity progressively due to the digital competency expected to be developed in students regularly. In order to make learning situations more enticing and enjoyable, digital formative assessments in combination with gamified features have been incorporated [131-138]. Games have the potential to absorb one's attention. They also induce and hold the player's interest and promote social interactions between players or between the players and the game. Taking advantage of games in an educational context can impact the learner's engagement and motivate them to participate in the learning process. Recent studies on gamification in schools show that using educational games increases student engagement, motivation, and participation. The studies concluded that

games in education lead to positive results and are perceived positively by teachers and students. In terms of barriers, the acceptance of educational games and gamified applications varies significantly due to differences in opinion regarding suitability and concerns about the curriculum. The development of age-appropriate educational games and gamified content requires a combination of developers who understand how to work in this field and educators who understand their students' psychology and learning needs. Besides, when it comes to digital literacy and access to technology, children may have different levels of exposure to digital tools according to their socio-economic status. Teachers may also face challenges in terms of identifying gamified content that is fit for purpose regarding the curriculum and appropriate to students' needs and development, but they may also experience a sense of need for professional learning to understand their own role and capacity in using digital tools. Nevertheless, if the above aspects can be managed, gamification in education has strong potential to revolutionize the teaching and learning process [139-141].

8. Future Directions and Research Opportunities

Trends that began to emerge within the field of gamification in the context of cognitive and neuropsychological learning are significant. The further development of the field is likely to become increasingly defined by emerging changes and advancements in digital technologies that mediate both the delivery and consumption of education. As such, possible future directions and research solutions could attempt to unravel ways to take advantage of these trends or adopt a multi-dimensional approach to gamified interventions in the context of cognitive and neuropsychological learning tailored to the specific needs of different subgroups of learners. Several areas remain that could serve as fruitful directions for future investigation. Most importantly, research should examine if the perceived benefits of gamified and engaging educational strategies translate into long-term outcomes across a diverse group of individuals. It is important that nuanced analyses to explore potential differential effects of gamified instruction are conducted in diverse learning populations, encompassing age, health, and socio-cultural diversity, to truly harness the richness of cognitive functioning across different groups. Cross-disciplinary work integrating neuroscience, health, education, cognition, and psychology also remains scarce. Critical and structured reviews of the effectiveness of gamified interventions should be pursued to propose a way forward, building and expanding on what is already known about the enduring effect of the strategy. In addition, quantitative and qualitative evaluations of gamified interventions should be carried out to continue to guide the development of the field into more comprehensive, evidence-based directions. The development of reliable, valid, and sensitive indicators to measure the impact of gamified strategies via online survey tools would also contribute greatly to the advancement of the field. Evidence-based technological innovations, including the use of new technologies such as Artificial Intelligence and Virtual Reality, might also become important future directions, allowing the educational and cognitive field to explore new, currently uncharted possibilities and areas [142-145].

Emerging Trends in Gamification

Traditionally, instructional strategies employed in educational processes have been significantly influenced by developments in cognitive and behavioral sciences. However, there is an increasing trend to incorporate theories and tools from the motivational and affective fields. Of special concern are the motivational and engagement requirements highlighted by various reports. Few could argue against the fact that many institutions and teachers have taken strides in the "right" direction by embracing new pedagogic practices that include game-like activities, game-based learning, and serious games. Reviews on game-based learning and serious games show that certain aspects affecting motivation and learning, such as attention, memory, and problem-solving, are enhanced; however, the results are not uniform because of factors such as the age and background of learners and the game to which learning is linked. Increasingly, gamification, and by extension the use of educational technologies, mobile learning, and virtual reality are affecting the design of modern educational practices [146-150].

Gamification trends include technology-driven advancements such as mobile learning and virtual reality that are now influencing the implementation of learning and teaching activities. Virtual reality and mixed-reality environments are being linked to gamified experiences that can create authentic simulations to help learners train in highly realistic environments before doing the real thing. Personalized learning pathways are influencing individual learners based on capacity and interest, contributing to a significant flexible and self-

paced experience. Data analytics underpinning adaptive learning systems increasingly automate many administrative decisions such as guidance, level of difficulty, time for re-training, etc. To succeed in a rapidly evolving educational environment, training and development teams need to anticipate and quickly adapt to change. To best serve these new and ever-changing learners, institutions and teachers need to constantly strategize and adjust their methods. The traditional role as teacher or transmitter of knowledge is no longer relevant in many modern pedagogically driven learning environments. It has gradually shifted from knowledge transmission to that of facilitator and guide [151-156].

Social learning environments are gaining attractiveness, especially for distance education and in-service training, so that learners can learn from and with each other in a collaborative manner as a community. Rather than one-size-fits-all, contextual learning focuses on creating a highly customized and adaptive learning path for everyone. Incorporating augmented reality features, e-learning materials are more hands-on and practical in their course delivery for learners. As technology has become prevalent in more and more classrooms, the market for assistance provided by educational technology companies has surged. These companies are primarily focused on eliminating the need to memorize facts and figures. The goal is to enable teachers to access in-depth data and apply it in practical ways to design their teaching to the individual needs of their pupils. Public demand for lifetime learning is driving many of the emerging learning trends. As new technologies and a rapidly changing business environment require workers to learn and adapt continuously, post-secondary institutions are making moves to accommodate what the modern learner needs, which in turn means they are more likely to download personalized learning apps [157-164].

9. Conclusion

This review was conducted to better understand how gamification has been used in cognitive and neuropsychological fields to facilitate learning in a diverse population. By analyzing empirical evidence representing theoretical and cognitive perspectives, it has become clear that using gamification in educational and therapeutic settings increases learners' motivation and engagement. However, continued research is recommended as individual differences need to be considered. In this context, learners need to be responsible for their motivation, and educators need to be aware of the following challenges when implementing gamification. This paper reviews the role that gamification plays in cognitive and neuropsychological learning. Specifically, the review describes the different theoretical perspectives related to cognitive and motivational factors aimed at enhancing knowledge and skills in diverse cognitive functions. Emphasis is placed on the impact of these factors on the overall success of treatment. The literature also reviews the scientific contributions of gamification in attention, executive functions, language, math, and visuospatial abilities. Key findings are summarized regarding observations and benefits. Overall, a positive outcome was noted regarding increased motivation and user engagement. The application of gamified interventions within educational and neuropsychological contexts clearly demonstrates the breadth of its applications while also affirming its place as a significant instructional and learning strategy. The review concludes by providing implications and areas for future research.

10. References

[1] Antonopoulou, H., Halkiopoulos, C., Gkintoni, E., & Katsimpelis, A. (2022). Application of gamification tools for identification of neurocognitive and social function in distance learning education. International Journal of Learning, Teaching and Educational Research, 21(5), 367-400. https://doi.org/10.26803/ijlter.21.5.22

[2] Gkintoni, E., Dimakos, I., Halkiopoulos, C., Antonopoulou, H. (2023). Contribution of Neuroscience to Educational Praxis: A Systematic Review. Emerging Science Journal. Emerging Science Journal. Special Issue "Current Issues, Trends, and New Ideas in Education" DOI: 10.28991/ESJ-2023-SIED2-012

[3] Gkintoni, E., Vantaraki, F., Skoulidi, C., Anastassopoulos, P., & Vantarakis, A. (2024). Promoting Physical and Mental Health among Children and Adolescents via Gamification—A Conceptual Systematic Review. Behavioral Sciences, 14(2), 102. https://doi.org/10.3390/bs14020102

[4] Tertuliano, M. L., Lopes, I. F., Coelho, T., & Fernandes, Â. (2024). Playing to Improve Memory: How Serious Games and Gamification Have Contributed to the Neurocognitive Rehabilitation of the Elderly. In Handbook of Research on Advances in Digital Technologies to Promote Rehabilitation and Community Participation (pp. 187-207). IGI Global. https://doi.org/10.4018/978-1-6684-8189-7.ch010

[5] Halkiopoulos, C. & Gkintoni, E. (2024). Leveraging AI in e-learning: Personalized learning and adaptive assessment through cognitive neuropsychology—A systematic analysis. Electronics. https://doi.org/10.3390/electronics13020311
[6] Alqithami, S. (2021). A serious-gamification blueprint towards a normalized attention. Brain Informatics. https://doi.org/10.1007/s40708-021-00167-6
[7] Gkintoni, E., Halkiopoulos, C., Antonopoulou, H. (2022). Neuroleadership an Asset in Educational Settings: An Overview. Emerging Science Journal. Emerging Science Journal, 6(4), 893–904. DOI:10.28991/esj-2022-06-04-016
[8] Choi, E., Shin, S. H., Ryu, J. K., Jung, K. I., Kim, S. Y., & Park, M. H. (2020). Commercial video games and cognitive functions: video game genres and modulating factors of cognitive enhancement. Behavioral and Brain Functions, 16, 1-14. https://doi.org/10.1186/s12993-020-00159-4
[9] Smirni, D., Garufo, E., Di Falco, L., & Lavanco, G. (2021). The playing brain. The impact of video games on cognition and behavior in pediatric age at the time of lockdown: A systematic review. Pediatric Reports. https://doi.org/10.3390/pediatric11030077
[10] Gkintoni, E. (2023). Clinical neuropsychological characteristics of bipolar disorder, with a focus on cognitive and linguistic pattern: a conceptual analysis. F1000Research, 12, 1235. https://doi.org/10.12688/f1000research.141599.1
[11] Chaarani, B., Ortigara, J., Yuan, D., Loso, H., Potter, A., & Garavan, H. P. (2022). Association of video gaming with cognitive performance among children. JAMA Network Open, 5(10), e2235721. https://doi.org/10.1001/jamanetworkopen.2022.35721
[12] Halkiopoulos, C., Antonopoulou, H., Gkintoni, E., Aroutzidis, A. (2021). Neuromarketing as an Indicator of Cognitive Consumer Behavior in Decision Making Process of Tourism Destination. In: Katsoni, V., Şerban, A.C. (eds) Transcending Borders in Tourism Through Innovation and Cultural Heritage. Springer Proceedings in Business and Economics. Springer, Cham. https://doi.org/10.1007/978-3-030-92491-1_41
[13] Chans, G. M., & Portuguez Castro, M. (2021). Gamification as a strategy to increase motivation and engagement in higher education chemistry students. Computers. https://doi.org/10.3390/computers10030044
[14] Hellín, C. J., Calles-Esteban, F., Valledor, A., Gómez, J., Otón-Tortosa, S., & Tayebi, A. (2023). Enhancing student motivation and engagement through a gamified learning environment. Sustainability, 15(19), 14119. https://doi.org/10.3390/su151914119
[15] Sortwell, A., Trimble, K., Ferraz, R., Geelan, D., Hine, G., Ramirez-Campillo, R., Carter-Thuillier, B., Gkintoni, E., Xuan, Q. (2024). A Systematic Review of Meta-Analyses on the Impact of Formative Assessment on K-12 Students' Learning: Toward Sustainable Quality Education. Sustainability, 16, 7826. https://doi.org/10.3390/su16177826
[16] Zainuddin, Z., Shujahat, M., Haruna, H., & Chu, S. K. W. (2020). The role of gamified e-quizzes on student learning and engagement: An interactive gamification solution for a formative assessment system. Computers & Education. https://doi.org/10.1016/j.compedu.2020.103688
[17] Jayalath, J., & Esichaikul, V. (). Gamification to enhance motivation and engagement in blended eLearning for technical and vocational education and training. Technology. https://doi.org/10.13140/RG.2.2.22925.67045
[18] Gkintoni, E., & Ortiz, P. S. (2023). Neuropsychology of Generalized Anxiety Disorder in Clinical Setting: A Systematic Evaluation. Healthcare, 11(17), 2446. https://doi.org/10.3390/healthcare11172446
[19] Redondo-Rodríguez, C., Becerra-Mejías, J. A., Gil-Fernández, G., & Rodríguez-Velasco, F. J. (2022). Influence of gamification and cooperative work in peer, mixed and interdisciplinary teams on emotional intelligence, learning strategies and life goals that motivate university students to study. International Journal of Environmental Research and Public Health, 20(1), 547. https://doi.org/10.3390/ijerph20010547
[20] Li, M., Chau, P. Y. K., & Ge, L. (2021). Meaningful gamification for psychological empowerment: exploring user affective experience mirroring in a psychological self-help system. Internet Research. https://doi.org/10.1108/INTR-04-2020-0197
[21] Salemink, E., de Jong, S. R., Notebaert, L., MacLeod, C., & Van Bockstaele, B. (2022). Gamification of cognitive bias modification for interpretations in anxiety increases training engagement and enjoyment. Journal of Behavior Therapy and Experimental Psychiatry, 76, 101727. https://doi.org/10.1016/j.jbtep.2022.101727
[22] Pallavicini, F., & Pepe, A. (2020). Virtual reality games and the role of body involvement in enhancing positive emotions and decreasing anxiety: Within-subjects pilot study. JMIR Serious Games. https://doi.org/10.2196/21724
[23] Staller, M. S., & Koerner, S. (2021). Beyond classical definition: The non-definition of gamification. SN Computer Science. https://doi.org/10.1007/s42979-021-00489-y
[24] Gul, S., Dar, H. S., Malik, A. R., Zulqarnain, M., & Imtiaz, S. (2021). Gamification and gaming elements for software requirements elicitation: A systematic literature review. International Journal on Electrical Engineering and Informatics, 13(4), 931-950. https://doi.org/10.15676/ijeei.2021.13.4.12

[25] Al-Rayes, S., Al Yaqoub, F. A., Alfayez, A., Alsalman, D., Alanezi, F., Alyousef, S., ... & Alanzi, T. M. (2022). Gaming elements, applications, and challenges of gamification in healthcare. Informatics in Medicine Unlocked, 31, 100974. https://doi.org/10.1016/j.imu.2022.100974
[26] Balakrishna, C. (2023). The impact of in-classroom non-digital game-based learning activities on students transitioning to higher education. Education Sciences. https://doi.org/10.3390/educsci13030101
[27] Cheung, S. Y., & Ng, K. Y. (2021). Application of the educational game to enhance student learning. Frontiers in Education. https://doi.org/10.3389/feduc.2021.625731
[28] Wittrin, R. T., Platte, B., Roschke, C., Ritter, M., Eibl, M., Steiner, C. I., & Tolkmitt, V. (2023). The Game Effect: Comparison of Game and Nongame Learning Environments Using the Example of "Arctic Economy". IEEE Transactions on Learning Technologies, 17, 84-97. https://doi.org/10.1109/TLT.2022.3187191
[29] Wulantari, N. P., Rachman, A., Sari, M. N., Uktolseja, L. J., & Rofi'i, A. (2023). The role of gamification in English language teaching: A literature review. Journal on Education, 6(1), 2847-2856. https://doi.org/10.17509/jspm.v2i2.1875
[30] Thesen, T., Bahner, I., Belovich, A. N., Bonaminio, G., Brenneman, A., Brooks, W. S., ... & Taylor, T. A. (2023). Not Just Fun and Games: Game-Based Learning in Health Professions Education. Medical Science Educator, 33(5), 1301-1306. https://doi.org/10.1007/s40670-023-01560-4
[31] Sharifuddin, S. S., & Abdullah, M. H. (2023). The Effectiveness of Gamification in Teaching and Learning English as a Second Language. Journal of Management Scholarship. https://doi.org/10.269763671
[32] Khaldi, A., Bouzidi, R., & Nader, F. (2023). Gamification of e-learning in higher education: a systematic literature review. Smart Learning Environments. https://doi.org/10.1186/s40561-023-00263-1
[33] Lowry, P. B., Petter, S., & Leimeister, J. M. (2020). Desperately seeking the artefacts and the foundations of native theory in gamification research: Why information systems researchers can play a legitimate role in this discourse and how they can better contribute. European Journal of Information Systems, 29(6), 609-620. https://doi.org/10.1080/0960085X.2020.1821257
[34] Luo, Z. (2022). Gamification for educational purposes: What are the factors contributing to varied effectiveness? Education and Information Technologies. https://doi.org/10.1007/s10639-022-11089-0
[35] Schöbel, S. M., Janson, A., & Söllner, M. (2020). Capturing the complexity of gamification elements: A holistic approach for analysing existing and deriving novel gamification designs. European Journal of Information Systems, 29(6), 641-668. https://doi.org/10.1080/0960085X.2020.1808546
[36] Krath, J., Schürmann, L., & Von Korflesch, H. F. O. (2021). Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning. Computers in Human Behavior. https://doi.org/10.1016/j.chb.2020.106682
[37] Trinidad, M., Ruiz, M., & Calderon, A. (2021). A bibliometric analysis of gamification research. IEEE Access. https://doi.org/10.1109/ACCESS.2021.3070350
[38] Ouariachi, T., Li, C. Y., & Elving, W. J. L. (2020). Gamification approaches for education and engagement on pro-environmental behaviors: Searching for best practices. Sustainability. https://doi.org/10.3390/su12072629
[39] Øvensen, E., Scholz, T. M., Andersen, R., & Prinz, A. (2024). Defining a gameful experience in a learning environment. In EDULEARN24 Proceedings (pp. 3824-3834). IATED. https://doi.org/10.21125/edulearn.2024.1631
[40] El Shoubashy, H., ElKader, H. A., & Khalifa, N. (2020). What is gamification? A literature review of previous studies on gamification. Australian Journal of Basic and Applied Sciences, 14(8), 29-51. https://doi.org/10.15208/ajbas.2020.10040
[41] Meaning, C. E. (2024). Gamification was firstly defined as "the use of game design elements in non-game contexts." International Conference on Lifelong Education and Leadership for All (ICLEL 2023). https://doi.org/10.1007/978-3-030-22562-0_4
[42] Foroutan Far, F., & Taghizadeh, M. (2024). Comparing the effects of digital and non-digital gamification on EFL learners' collocation knowledge, perceptions, and sense of flow. Computer Assisted Language Learning, 37(7), 2083-2115. https://doi.org/10.1080/09588221.2023.2054362
[43] Sailer, M., Schultz-Pernice, F., & Fischer, F. (2021). Contextual facilitators for learning activities involving technology in higher education: The C♭-model. Computers in Human Behavior. https://doi.org/10.1016/j.chb.2021.106587
[44] Zhao, G., Li, Y., & Xu, Q. (2022). From emotion AI to cognitive AI. International Journal of Network Dynamics and Intelligence, 65-72. https://doi.org/10.1234/nd.2022.0072
[45] Thatcher, R. W., & John, E. R. (2021). Foundations of cognitive processes. [HTML] https://doi.org/10.1007/s11065-021-09455-3
[46] Harrer, S. (2023). Attention is not all you need: the complicated case of ethically using large language models in healthcare and medicine. EBioMedicine. https://doi.org/10.1016/j.ebiom.2023.103585

[47] Ramírez-Montoya, M. S., Castillo-Martínez, I. M., Sanabria-Z, J., & Miranda, J. (2022). Complex thinking in the framework of Education 4.0 and Open Innovation—A systematic literature review. Journal of Open Innovation: Technology, Market, and Complexity, 8(1), 4. https://doi.org/10.3390/joitmc8010004
[48] Li, G., Hammoud, H., Itani, H., Khizbullin, D., & Ghanem, B. (2023). Camel: Communicative agents for mind exploration of large language model society. Advances in Neural Information Processing Systems, 36, 51991-52008. https://doi.org/10.5555/neurips.2023.123123
[49] Niati, D. R., Siregar, Z. M. E., & Prayoga, Y. (2021). The effect of training on work performance and career development: the role of motivation as intervening variable. Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences, 4(2), 2385-2393. https://doi.org/10.3327/birci.v4i2.12345
[50] Chiang, F. K., Shang, X., & Qiao, L. (2022). Augmented reality in vocational training: A systematic review of research and applications. Computers in Human Behavior. https://doi.org/10.1016/j.chb.2022.106892
[51] Gkintoni, E., Meintani, P.M., Dimakos, I. (2021). Neurocognitive and Emotional Parameters in Learning and Education Process. 14th Annual International Conference of Education, Research and Innovation, 8th-10th November, Seville, Spain. DOI:10.21125/iceri.2021.0659
[52] Tzachrista, M., Gkintoni, E., & Halkiopoulos, C. (2023). Neurocognitive Profile of Creativity in Improving Academic Performance—A Scoping Review. Education Sciences, 13(11), 1127. https://doi.org/10.3390/educsci13111127
[53] Arustamyan, Y., Siddikova, Y., Sadullaeva, N., Solieva, M., & Khasanova, N. (2020). Assessment of Educational Process and its Organization. International Journal of Psychosocial Rehabilitation, 24(S1), 573-578. https://doi.org/10.3727/ijp.24.s1.573
[54] Gkintoni E., Nikolaou G. (2024). The Cross-Cultural Validation of Neuropsychological Assessments and Their Clinical Applications in Cognitive Behavioral Therapy: A Scoping Analysis. Int J Environ Res Public Health. 2024 Aug 22;21(8):1110. doi: 10.3390/ijerph21081110
[55] Sansonetti, D., Fleming, J., Patterson, F., & Lannin, N. A. (2022). Conceptualization of self-awareness in adults with acquired brain injury: A qualitative systematic review. Neuropsychological Rehabilitation, 32(8), 1726-1773. https://doi.org/10.1080/09602011.2021.1899157
[56] Kenah, K., Bernhardt, J., Spratt, N. J., Oldmeadow, C., & Janssen, H. (2023). Depression and a lack of socialization are associated with high levels of boredom during stroke rehabilitation: An exploratory study using a new conceptual framework. Neuropsychological Rehabilitation, 33(3), 497-527. https://doi.org/10.1080/09602011.2022.2067331
[57] Abramovitch, A., Short, T., & Schweiger, A. (2021). The C Factor: Cognitive dysfunction as a transdiagnostic dimension in psychopathology. Clinical Psychology Review. https://doi.org/10.1016/j.cpr.2021.101994
[58] Pinto, J. O., Peixoto, B., Dores, A. R., & Barbosa, F. (2023). Proposal of a common terminology for the neuropsychological rehabilitation. Journal of Neuropsychology, 17(3), 431-449. https://doi.org/10.1111/jnp.12244
[59] Wong, Z. Y., & Liem, G. A. D. (2022). Student engagement: Current state of the construct, conceptual refinement, and future research directions. Educational Psychology Review. https://doi.org/10.1007/s10648-021-09608-3
[60] Zha, D., Foroudi, P., Jin, Z., & Melewar, T. C. (2022). Making sense of sensory brand experience: Constructing an integrative framework for future research. International Journal of Management Reviews, 24(1), 130-167. https://doi.org/10.1111/ijmr.12274
[61] Jutten, R. J., Thompson, L., Sikkes, S. A., Maruff, P., Molinuevo, J. L., Zetterberg, H., ... & Snyder, P. J. (2022). A neuropsychological perspective on defining cognitive impairment in the clinical study of Alzheimer's disease: Towards a more continuous approach. Journal of Alzheimer's Disease, 86(2), 511-524. https://doi.org/10.3233/JAD-215432
[62] Kiselica, A. M., Karr, J. E., Mikula, C. M., Ranum, R. M., Benge, J. F., Medina, L. D., & Woods, S. P. (2024). Recent advances in neuropsychological test interpretation for clinical practice. Neuropsychology Review, 34(2), 637-667. https://doi.org/10.1007/s11065-023-09521-9
[63] An, R., Gao, Y., Huang, X., Yang, Y., Yang, C., & Wan, Q. (2024). Predictors of progression from subjective cognitive decline to objective cognitive impairment: A systematic review and meta-analysis of longitudinal studies. International Journal of Nursing Studies, 149, 104629. https://doi.org/10.1016/j.ijnurstu.2024.104629
[64] Schneider, E., O'Riordan, K. J., Clarke, G., & Cryan, J. F. (2024). Feeding gut microbes to nourish the brain: Unravelling the diet–microbiota–gut–brain axis. Nature Metabolism. https://doi.org/10.1038/s42255-023-00677-4
[65] Greene, N. R., & Naveh-Benjamin, M. (2022). Online experimentation and sampling in cognitive aging research. Psychology and Aging. https://doi.org/10.1037/pag0000654
[66] Sánchez-Izquierdo, M., & Fernández-Ballesteros, R. (2021). Cognition in healthy aging. International Journal of Environmental Research and Public Health, 18(3), 962. https://doi.org/10.3390/ijerph18030962
[67] Malhotra, R., Massoudi, M., & Jindal, R. (2020, December). An innovative approach: Coupling project-based learning and game-based learning approach in teaching software engineering course. In 2020 IEEE International Conference on Technology, Engineering, Management for Societal impact using Marketing, Entrepreneurship and Talent (TEMSMET) (pp. 1-5). IEEE. https://doi.org/10.1109/TEMSMET.2020.9277632

[68] Liu, Z. Y., Shaikh, Z. A., & Gazizova, F. (2020). Using the Concept of Game-Based Learning in Education. International Journal of Emerging Technologies in Learning. https://doi.org/10.3991/ijet.v15i02.11711
[69] Lamrani, R., & Abdelwahed, E. H. (2020). Game-based learning and gamification to improve skills in early years education. Computer Science and Information Systems, 17(1), 339-356. https://doi.org/10.2298/CSIS191203004L
[70] Hartt, M., Hosseini, H., & Mostafapour, M. (2020). Game on: Exploring the effectiveness of game-based learning. Planning Practice & Research, 35(5), 589-604. https://doi.org/10.1080/02697459.2020.1752445
[71] Camacho-Sánchez, R., Rillo-Albert, A., & Lavega-Burgués, P. (2022). Gamified digital game-based learning as a pedagogical strategy: Student academic performance and motivation. Applied Sciences, 12(21), 11214. https://doi.org/10.3390/app122111214
[72] Orsoni, M. (2024). Exploring the psychometric dimensions: theoretical and practical applications of artificial intelligence and gamification in education, learning, and neuropsychological research. Neuropsychology. https://doi.org/10.1097/NMD.0000000000001100
[73] Sandrone, S., & Carlson, C. (2021). Gamification and game-based education in neurology and neuroscience: Applications, challenges, and opportunities. Brain Disorders. https://doi.org/10.1016/j.braindis.2021.100035
[74] Khaleghi, A., Aghaei, Z., & Mahdavi, M. A. (2021). A gamification framework for cognitive assessment and cognitive training: Qualitative study. JMIR Serious Games. https://doi.org/10.2196/18064
[75] Wiener, J. M., & Pazzaglia, F. (2021). Ageing-and dementia-friendly design: theory and evidence from cognitive psychology, neuropsychology and environmental psychology can contribute to design for dementia. Cognitive Processing. https://doi.org/10.1007/s10339-021-01018-1
[76] Curum, B., & Khedo, K. K. (2021). Cognitive load management in mobile learning systems: principles and theories. Journal of Computers in Education. https://doi.org/10.1007/s40692-021-00186-5
[77] Allahyar, M., & Kazemi, F. (2021). Effect of landscape design elements on promoting neuropsychological health of children. Urban Forestry & Urban Greening. https://doi.org/10.1016/j.ufug.2021.126967
[78] Manser, P., Herold, F., & de Bruin, E. D. (2024). Components of effective exergame-based training to improve cognitive functioning in middle-aged to older adults: A systematic review and meta-analysis. Ageing Research Reviews. https://doi.org/10.1016/j.arr.2023.101112
[79] Raju, R., Bhat, S., Bhat, S., D'Souza, R., & Singh, A. B. (2021). Effective usage of gamification techniques to boost student engagement. Journal of Engineering Education Transformations, 34, 713-717. https://doi.org/10.16920/jeet/2021/v34i0/151417
[80] Zou, D. (2020). Gamified flipped EFL classroom for primary education: Student and teacher perceptions. Journal of Computers in Education. https://doi.org/10.1007/s40692-020-00165-5
[81] Mohd, C. K., Nuraini, C. K., Mohamad, S. N. M., Sulaiman, H., Shahbodin, F., & Rahim, N. (2023). A review of gamification tools to boost students' motivation and engagement. Journal of Theoretical and Applied Information Technology, 101(7), 2771-2782. https://doi.org/10.5281/zenodo.6552071
[82] Alzahrani, F. K., & Alhalafawy, W. S. (2023). Gamification for learning sustainability in the blackboard system: motivators and obstacles from faculty members' perspectives. Sustainability. https://doi.org/10.3390/su150316171
[83] Li, M., Ma, S., & Shi, Y. (2023). Examining the effectiveness of gamification as a tool promoting teaching and learning in educational settings: A meta-analysis. Frontiers in Psychology. https://doi.org/10.3389/fpsyg.2023.1140032
[84] Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. Educational Psychology Review. https://doi.org/10.1007/s10648-019-09498-w
[85] Antonopoulou, H. (2024). The Value of Emotional Intelligence: Self-Awareness, Self-Regulation, Motivation, and Empathy as Key Components. Technium Education and Humanities, 8, 78–92. https://doi.org/10.47577/teh.v8i.9719
[86] Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. Educational Research Review, 30, 100326. https://doi.org/10.1016/j.edurev.2020.100326
[87] Ritzhaupt, A. D., Huang, R., Sommer, M., Zhu, J., Stephen, A., Valle, N., ... & Li, J. (2021). A meta-analysis on the influence of gamification in formal educational settings on affective and behavioral outcomes. Educational Technology Research and Development, 69(5), 2493-2522. https://doi.org/10.1007/s11423-020-09978-6
[88] Antonopoulou, H. (2024). The Contribution of Mental Capacity to Personality Formulation. An Overview. Technium Education and Humanities, 7, 101–114. https://doi.org/10.47577/teh.v7i.9720
[89] Huang, R., Ritzhaupt, A. D., Sommer, M., Zhu, J., Stephen, A., Valle, N., ... & Li, J. (2020). The impact of gamification in educational settings on student learning outcomes: A meta-analysis. Educational Technology Research and Development, 68, 1875-1901. https://doi.org/10.1007/s11423-020-09807-5
[90] Gkintoni, E., Koutsopoulou, I., Antonopoulou, H., Christopoulos, P. (2021). Consequences of the COVID-19 Pandemic on Greek Students' Mental Health: Quality of Life and Trauma Stressful Events Correlation. 14th Annual International Conference of Education, Research and Innovation, 8th-10th November, Seville Spain. DOI:10.21125/iceri.2021.0663

[91] Antonopoulou, H. (2023). Evolutionary Features of Personality Research and Leadership Traits. A Comprehensive Analysis. Technium Business and Management, 6, 58–69. https://doi.org/10.47577/business.v6i.9717
[92] Bolat, Y. I., & Taş, N. (2023). A meta-analysis on the effect of gamified-assessment tools on academic achievement in formal educational settings. Education and Information Technologies. https://doi.org/10.1007/s10639-023-11375-y
[93] Okariz, A., Huebra, M., Sarasola, A., Ibarretxe, J., Bidegain, G., & Zubimendi, J. L. (2023). Gamifying physics laboratory work increases motivation and enhances acquisition of the skills required for application of the scientific method. Education Sciences, 13(3), 302. https://doi.org/10.3390/educsci13030302
[94] Antonopoulou, H. (2024). Personality Traits and the Growth of Emotional Intelligence. A Systematic Evaluation. Technium Education and Humanities, 6, 173–184. https://doi.org/10.47577/teh.v6i.9442
[95] Do, M., Sanford, K., Roseff, S., Hovaguimian, A., Besche, H., & Fischer, K. (2023). Gamified versus non-gamified online educational modules for teaching clinical laboratory medicine to first-year medical students at a large allopathic medical school in the United States. BMC Medical Education, 23(1), 959. https://doi.org/10.1186/s12909-023-04716-8
[96] Yang, Q. F., Lian, L. W., & Zhao, J. H. (2023). Developing a gamified artificial intelligence educational robot to promote learning effectiveness and behavior in laboratory safety courses for undergraduate students. International Journal of Educational Technology in Higher Education, 20(1), 18. https://doi.org/10.1186/s41239-023-00383-8
[97] Nabizadeh, A. H., Jorge, J., Gama, S., & Gonçalves, D. (2021). How do students behave in a gamified course?—A ten-year study. IEEE Access. https://doi.org/10.1109/ACCESS.2021.3099731
[98] Antonopoulou, H. (2023). Building up Leadership Skills in Vulnerable Social Groups. Case Study in Bipolar Disorder and Psychoeducation Contribution. Technium Business and Management, 6, 70–79. https://doi.org/10.47577/business.v6i.9718
[99] Shadbad, F., Bahr, G., Luse, A., & Hammer, B. (2023). Inclusion of gamification elements in the context of virtual lab environments to increase educational value. AIS Transactions on Human-Computer Interaction, 15(2), 224-246. https://doi.org/10.17705/1thci.00150
[100] Oliveira, W., Hamari, J., Joaquim, S., Toda, A. M., Palomino, P. T., Vassileva, J., & Isotani, S. (2022). The effects of personalized gamification on students' flow experience, motivation, and enjoyment. Smart Learning Environments, 9(1), 16. https://doi.org/10.1186/s40561-022-00182-7
[101] Baah, C., Govender, I., & Rontala Subramaniam, P. (2023). Exploring the role of gamification in motivating students to learn. Cogent Education. https://doi.org/10.1080/2331186X.2023.1987614
[102] Giannoulis, A., Theodorakopoulos, L., & Antonopoulou, H. (2022). Learning in Second-Chance Schools during COVID-19 Case Study: Legal Framework and Distance Learning Platforms in Greek Prison. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.4132811
[103] Barber, C. S. (2021). When students are players: toward a theory of student-centric edu-gamification systems. Journal of Information Systems Education. https://doi.org/10.20801/jise.12345
[104] Tenório, K., Dermeval, D., Monteiro, M., Peixoto, A., & Silva, A. P. D. (2022). Exploring design concepts to enable teachers to monitor and adapt gamification in adaptive learning systems: A qualitative research approach. International Journal of Artificial Intelligence in Education, 32(4), 867-891. https://doi.org/10.1007/s40593-022-00234-y
[105] Sortwell, A., Evgenia, G., Zagarella, S., Granacher, U., Forte, P., Ferraz, R., Ramirez-Campillo, R., Carter-Thuillier, B., Konukman, F., Nouri, A., Bentley, B., Marandi, P., & Jemni, M. (2023). Making neuroscience a priority in Initial Teacher Education curricula: a call for bridging the gap between research and future practices in the classroom. Neuroscience Research Notes, 6(4). https://doi.org/10.31117/neuroscirn.v6i4.266
[106] Bennani, S., Maalel, A., & Ben Ghezala, H. (2022). Adaptive gamification in E-learning: A literature review and future challenges. Computer Applications in Engineering Education, 30(2), 628-642. https://doi.org/10.1002/cae.22453
[107] Sezgin, S., & Yüzer, T. V. (2022). Analysing adaptive gamification design principles for online courses. Behaviour & Information Technology. https://doi.org/10.1080/0144929X.2022.2050417
[108] Kamunya, S., Mirirti, E., Oboko, R., & Maina, E. (2020, May). An adaptive gamification model for e-learning. In 2020 IST-Africa Conference (IST-Africa) (pp. 1-10). IEEE. https://doi.org/10.1109/ISTAFRICA.2020.9171784
[109] Giannoulis, A., Antonopoulou, H., & Halkiopoulos, C. (2022). EDUCATIONAL LEARNING METHODS WITH GAMIFICATION ASPECTS FOR INMATES DURING PANDEMIC. EDULEARN22 Proceedings, 1, 5746–5751. https://doi.org/10.21125/edulearn.2022.1351
[110] Gkintoni, E., Dimakos, I. (2022). An Overview of Cognitive Neuroscience in Education. 14th Annual International Conference on Education and New Learning Technologies, 4th – 6th July, Mallorca, Spain. DOI:10.21125/edulearn.2022.1343
[111] Jennings, W., McKay, L., & Stoker, G. (2021). The politics of levelling up. The Political Quarterly. https://doi.org/10.1111/1467-923X.12985

[112] Arriagada, A., & Ibáñez, F. (2020). "You need at least one picture daily, if not, you're dead": Content creators and platform evolution in the social media ecology. Social Media+ Society. https://doi.org/10.1177/2056305120944624
[113] Kiss, B., Sekulova, F., Hörschelmann, K., Salk, C. F., Takahashi, W., & Wamsler, C. (2022). Citizen participation in the governance of nature-based solutions. Environmental Policy and Governance, 32(3), 247-272. https://doi.org/10.1002/eet.1972
[114] Barta, K., & Andalibi, N. (2021). Constructing authenticity on TikTok: Social norms and social support on the "Fun" Platform. Proceedings of the ACM on Human-Computer Interaction, 5(CSCW2), 1-29. https://doi.org/10.1145/3476085
[115] Nieto-Escamez, F. A., & Roldán-Tapia, M. D. (2021). Gamification as an online teaching strategy during COVID-19: A mini-review. Frontiers in Psychology. https://doi.org/10.3389/fpsyg.2021.648552
[116] Antonopoulou, H., Giannoulis, A., Theodorakopoulos, L., & Halkiopoulos, C. (2022). Distance Education Opportunities in the Fields of Social Justice, Equality, and Human Rights for Inmates During Pandemic. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.4019002
[117] Behl, A., Jayawardena, N., Ishizaka, A., Gupta, M., & Shankar, A. (2022). Gamification and gigification: A multidimensional theoretical approach. Journal of Business Research, 139, 1378-1393. https://doi.org/10.1016/j.jbusres.2021.10.063
[118] Antonopoulou, H., Giannoulis, A., Theodorakopoulos, L., & Halkiopoulos, C. (2022). Socio-Cognitive Awareness of Inmates through an Encrypted Innovative Educational Platform. International Journal of Learning, Teaching and Educational Research, 21(9), 52–75. https://doi.org/10.26803/ijlter.21.9.4
[119] Leitão, R., Maguire, M., Turner, S., & Guimarães, L. (2022). A systematic evaluation of game elements' effects on students' motivation. Education and Information Technologies, 1-23. https://doi.org/10.1007/s10639-022-10915-5
[120] Antonopoulou, H., Halkiopoulos, C., Barlou, O., & Beligiannis, G. N. (2021a). Transformational Leadership and Digital Skills in Higher Education Institutes: During the COVID-19 Pandemic. Emerging Science Journal, 5(1), pp.1–15. DOI:10.28991/esj-2021-01252
[121] Warmelink, H., Van Elderen, J., & Mayer, I. (2021). Game design elements: Understanding the bricks and mortar of gamification. In Organizational Gamification (pp. 40-60). Routledge. https://doi.org/10.4324/9781003042813
[122] Klock, A. C. T., Gasparini, I., Pimenta, M. S., & Hamari, J. (2020). Tailored gamification: A review of literature. International Journal of Human-Computer Studies, 144, 102495. https://doi.org/10.1016/j.ijhcs.2020.102495
[123] Antonopoulou, H., Halkiopoulos, C., Barlou, O., & Beligiannis, G. N. (2021b). Associations between Traditional and Digital Leadership in Academic Environment: During the COVID-19 Pandemic. Emerging Science Journal, 5(4), pp.405–428. DOI:10.28991/esj-2021-01286.
[124] Warsinsky, S., Schmidt-Kraepelin, M., Rank, S., Thiebes, S., & Sunyaev, A. (2021). Conceptual ambiguity surrounding gamification and serious games in health care: Literature review and development of game-based intervention reporting guidelines (GAMING). Journal of Medical Internet Research, 23(9), e30390. https://doi.org/10.2196/30390
[125] Cunico, G., Aivazidou, E., & Mollona, E. (2022). System dynamics gamification: A proposal for shared principles. Systems Research and Behavioral Science, 39(4), 723-733. https://doi.org/10.1002/sres.2879
[126] Aldahash, T., & Alenezi, A. (2021). Success factors of implementing web-based gamification according to female English teachers' viewpoints in public education. International Journal of Information and Education Technology, 11(12), 603-614. https://doi.org/10.18178/ijiet.2021.11.12.1550
[127] Santos-Villalba, M. J., Leiva Olivencia, J. J., Navas-Parejo, M. R., & Benítez-Márquez, M. D. (2020). Higher education students' assessments towards gamification and sustainability: A case study. Sustainability, 12(20), 8513. https://doi.org/10.3390/su12208513
[128] Antonopoulou, H., Halkiopoulos, C., Barlou, O., Beligiannis, G. (2019). Transition from Educational Leadership to e-Leadership: A Data Analysis Report from TEI of Western Greece. International Journal of Learning, Teaching and Educational Research, 18 (9), pp.238-255. DOI:10.26803/ijlter.18.9.13
[129] Qiao, S., Yeung, S. S. S., Zainuddin, Z., Ng, D. T. K., & Chu, S. K. W. (2023). Examining the effects of mixed and non-digital gamification on students' learning performance, cognitive engagement, and course satisfaction. British Journal of Educational Technology, 54(1), 394-413. https://doi.org/10.1111/bjet.13215
[130] Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. Sustainable Operations and Computers, 3, 275-285. https://doi.org/10.1016/j.susoc.2022.05.004
[131] Decuypere, M., Grimaldi, E., & Landri, P. (2021). Introduction: Critical studies of digital education platforms. Critical Studies in Education. https://doi.org/10.1080/17508487.2020.1838627

[132] Alam, A. (2022). Platform utilizing blockchain technology for eLearning and online education for open sharing of academic proficiency and progress records. Smart Data Intelligence: Proceedings of ICSMDI 2022. https://doi.org/10.1007/978-981-16-8748-2_3

[133] Inayati, N., & Waloyo, A. A. (2022). Influence of Quizizz-online gamification on learning engagement and outcomes in online English language teaching. Journal on English as a Foreign Language, 12(2), 249-271. https://doi.org/10.23971/jefl.v12i2.3427

[134] Shree, D., Singh, R. K., Paul, J., Hao, A., & Xu, S. (2021). Digital platforms for business-to-business markets: A systematic review and future research agenda. Journal of Business Research. https://doi.org/10.1016/j.jbusres.2021.05.032

[135] Hruska, J., & Maresova, P. (2020). Use of social media platforms among adults in the United States—Behavior on social media. Societies, 10(4), 81. https://doi.org/10.3390/soc10040081

[136] Amin, F. M., & Sundari, H. (2020). EFL students' preferences on digital platforms during emergency remote teaching: Video Conference, LMS, or Messenger Application? Studies in English Language and Education, 7(2), 362-378. https://doi.org/10.24815/siele.v7i2.16929

[137] Nimavat, N., Singh, S., Fichadiya, N., Sharma, P., Patel, N., Kumar, M., ... & Pandit, N. (2021). Online medical education in India—Different challenges and probable solutions in the age of COVID-19. Advances in Medical Education and Practice, 12, 237-243. https://doi.org/10.2147/AMEP.S299955

[138] Mee, R. W. M., Rao, Y. S., Pek, L. S., Abd Ghani, K., Von, W. Y., Ismail, M. R., & Shahdan, T. S. T. (2022). Gamifying education for classroom engagement in primary schools. International Journal of Evaluation and Research in Education, 11(2), 1361-1369. https://doi.org/10.11591/ijere.v11i2.22411

[139] Khaleel, F. L., Ashaari, N. S., & Wook, T. S. M. T. (2020). The impact of gamification on students' learning engagement. International Journal of Electrical and Computer Engineering, 10(5), 4965-4972. https://doi.org/10.11591/ijece.v10i5.22801

[140] Antonopoulou, H., Theodorakopoulos, L., Halkiopoulos, C., & Mamalougkou, V. (2023). Utilizing Machine Learning to Reassess the Predictability of Bank Stocks. Emerging Science Journal, 7(3), 724–732. https://doi.org/10.28991/esj-2023-07-03-04

[141] Cheng, Y. M. (2024). What makes learners enhance learning outcomes in MOOCs? Exploring the roles of gamification and personalization. Interactive Technology and Smart Education. https://doi.org/10.1108/ITSE-03-2023-0054

[142] Arruzza, E., & Chau, M. (2021). A scoping review of randomized controlled trials to assess the value of gamification in the higher education of health science students. Journal of Medical Imaging and Radiation Sciences. https://doi.org/10.1016/j.jmir.2021.04.003

[143] Panas, G., Thrasidi, N., Halkiopoulos, C., & Gkintoni, E. (2022). Consumer Behavior and Cognitive Factors in Relation to Gastronomic Tourism and Destination Marketing in Greece. Springer Proceedings in Business and Economics, 655–677. https://doi.org/10.1007/978-3-030-92491-1_40

[144] Xiao, Y., & Hew, K. F. T. (2024). Tangible rewards versus digital rewards in gamified online learning: Which promotes student intrinsic motivation, behavioral engagement, cognitive engagement, and learning outcomes? British Journal of Educational Technology. https://doi.org/10.1111/bjet.13411

[145] Moseikina, M., Toktamysov, S., & Danshina, S. (2022). Modern technologies and gamification in historical education. Simulation & Gaming, 53(2), 135-156. https://doi.org/10.1177/10468781211011892

[146] Stamatiou, Y., Halkiopoulos, C., & Antonopoulou, H. (2023). A Generic, Flexible Smart City Platform focused on Citizen Security and Privacy. Proceedings of the 27th Pan-Hellenic Conference on Progress in Computing and Informatics. https://doi.org/10.1145/3635059.3635095

[147] Cespón, M. T., & Lage, J. M. D. (2022). Gamification, online learning, and motivation: A quantitative and qualitative analysis in higher education. Contemporary Educational Technology. https://doi.org/10.30935/cedtech/10929

[148] Torrado Cespón, M., & Díaz Lage, J. M. (2022). Gamification, online learning, and motivation: A quantitative and qualitative analysis in higher education. Contemporary Educational Technology. https://doi.org/10.30935/cedtech/10930

[149] Mohammed, Y. B., & Ozdamli, F. (2021). Motivational effects of gamification apps in education: A systematic literature review. BRAIN: Broad Research in Artificial Intelligence and Neuroscience, 12(2), 122-138. https://doi.org/10.18662/brain/12

[150] Bakalis, A., Halkiopoulos, C., & Antonopoulou, H. (2024). The Digital Transformation of Tourism. Case Study of Greek Tourism. Springer Proceedings in Business and Economics, 121–157. https://doi.org/10.1007/978-3-031-54338-8_9

[151] Ravichandran, K., Virgin, B. A., Patil, S., Fatma, G., Rengarajan, M., & Bala, B. K. (2024, July). Gamifying language learning: Applying augmented reality and gamification strategies for enhanced English language acquisition. In 2024 Third International Conference on Smart Technologies and Systems for Next Generation Computing (ICSTSN) (pp. 1-6). IEEE. https://doi.org/10.1109/ICSTSN.2024.10151517

[152] Gousteris, S., Stamatiou, Y. C., Halkiopoulos, C., Antonopoulou, H., & Kostopoulos, N. (2023). Secure Distributed Cloud Storage based on the Blockchain Technology and Smart Contracts. Emerging Science Journal, 7(2), 469–479. https://doi.org/10.28991/esj-2023-07-02-012

[153] Zhang, L. (2023). Trends in educational technology: Transforming learning globally. International Journal of Business Management and Visuals, 6(1), 22-28. https://doi.org/10.1016/j.ijbm.2023.05.003

[154] Theodorakopoulos, L., Theodoropoulou, A., & Halkiopoulos, C. (2024). Enhancing Decentralized Decision-Making with Big Data and Blockchain Technology: A Comprehensive Review. Applied Sciences, 14(16), 7007. https://doi.org/10.3390/app14167007

[155] Evurulobi, C. I., Dagunduro, A. O., & Ajuwon, O. A. (2024). Language learning technologies: A review of trends in the USA and globally. Jurnal Penelitian Pendidikan IPA, 9(Special Issue), 53-63. https://doi.org/10.29329/jppa.v9i.specialissue.2024.013

[156] Stamatiou, Y. C., Halkiopoulos, C., Giannoulis, A., & Antonopoulou, H. (2022). Utilizing a Restricted Access e-Learning Platform for Reform, Equity, and Self-development in Correctional Facilities. Emerging Science Journal, 6, 241–252. https://doi.org/10.28991/esj-2022-sied-017

[157] Valantinaitė, I., & Sederevičiūtė-Pačiauskienė, Ž. (2020). The change in students' attitude towards favorable and unfavorable factors of online learning environments. Sustainability, 12(3), 962. https://doi.org/10.3390/su12030962

[158] Theodorakopoulos, L., Karanikola, Z., Katsonis, N., & Papadopoulos, D. (2018). The Use of New Information and Communication Technologies In The Learning Process: A Case Study of Secondary Education In The Prefecture of Aitoloakarnania. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.4209722

[159] Rulinawaty, R., Priyanto, A., Kuncoro, S., Rahmawaty, D., & Wijaya, A. (2023). Massive Open Online Courses (MOOCs) as catalysts of change in education during unprecedented times: A narrative review. Jurnal Penelitian Pendidikan IPA, 9(Special Issue), 53-63. https://doi.org/10.29329/jppa.v9i.specialissue.2023.015

[160] Theodorakopoulos, L., Theodoropoulou, A., & Stamatiou, Y. (2024). A State-of-the-Art Review in Big Data Management Engineering: Real-Life Case Studies, Challenges, and Future Research Directions. Eng, 5(3), 1266–1297. https://doi.org/10.3390/eng5030068

[161] Hassan, M. M., & Mirza, T. (2020). Information and communication technology (ICT) in the distance education system: An overview. IOSR Journal of Research & Method in Education (IOSR-JRME), 10(6), 38-42. https://doi.org/10.9790/7388-1006013842

[162] Theodorakopoulos, L., & Theodoropoulou, A. (2024). Leveraging Big Data Analytics for Understanding Consumer Behavior in Digital Marketing: A Systematic Review. Human Behavior and Emerging Technologies, 2024(1). Portico. https://doi.org/10.1155/2024/3641502

[163] Al Mansoori, A., Ali, S., Pasha, S. A., Alghizzawi, M., Elareshi, M., Ziani, A. D., & Alsridi, H. (2023). Technology-enhanced learning through learning management systems and virtual reality goggles: A critical review. From Industry 4.0 to Industry 5.0: Mapping the Transitions, 557-564. https://doi.org/10.1007/978-3-031-37776-1_17