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Perspective

RETRACTED: Gamification for Mental Health and Health Psychology: Insights at the First Quarter Mark of the 21st Century

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Abstract: The concept of gamification, originally rooted in digital media and game design, has increasingly emerged as a pivotal element in psychology and engagement strategies. Its application spans diverse domains within healthcare, offering innovative solutions to transform patient care through behavior modification and heightened engagement. This contemporary perspective explores theoretical frameworks and provides a critical interdisciplinary examination of current advancements in gamification for mental health and health psychology, identifying existing knowledge gaps and projecting future trends and research directions within these contexts. Based on this, concise criteria for designing, implementing, and evaluating gamification in healthcare, aligned with acknowledged best practices to promote ethical, fair, and trustworthy systems, are outlined, establishing a robust theoretical framework to design gamified interventions and scientifically evaluate their impact.

Keywords: gamification; health psychology; mental health; gamified intervention; governance in intelligent systems; intelligent systems ethical design

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1. Introduction

This contemporary perspective is not intended to be a systematic review, narrative review, or scoping review (for a scoping review or meta-analysis, the following references can be consulted [1,2]). Rather, it offers an insightful and forward-looking analysis of current developments, integrating insights from multiple disciplines to present a comprehensive understanding of the topic. This discussion encompasses an evaluative examination of recent advancements, identification of gaps in current knowledge, and projections regarding future trends and research directions.

1.1. The Beginning of Gamification

The use of games in healthcare contexts is not a novel idea. Many works since the 60s have included different sorts of games and game elements in healthcare settings for different purposes [3–5]. The effectiveness of applying different fun and playful methodologies has been a subject of study in many pieces of research since some decades ago to the present [6,7]. However, the term "gamification" first appeared in the scientific literature in 2008. It was initially used in digital media contexts and gained widespread academic and industry attention starting in 2010, marking its formal entry into academic discourse and its application across various fields, including education and health [8]. To a non-expert, the first impression of this term may lead to believing that it is just a matter of including some sort of games within a certain procedure. Based on this, one could say that healthcare

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has been gamified in many studies for many years, and, therefore, this is only a neologism to bring the term *serious games* again into fashion and keep it refreshed.

Gamification, although it is a relatively new term, represents more than merely incorporating *serious games* into various processes. It is emerging as a distinct discipline, aiming to enhance behavioral change and motivation through the strategic application of psychological principles. Grounded in theories such as cognitive–behavioral and self-determination, gamification goes beyond traditional game elements, offering a systematic approach to increasing engagement and effectiveness in contexts like healthcare [9,10].

From business to education, the use of gamification to engage customers and users is spreading worldwide [11,12]. The healthcare sector is no exception; it represents a significant area where gamification can have a profound impact, offering substantial benefits not only to patients but also to society [13]. The healthcare system is continuously evolving and adapting to new demands and changing resources. Currently, the focus is on personalized health and patient-centered approaches that can meet users' unique needs and requirements at reasonable costs [14]. From the beginning, information and communication technologies (ICT) have played a crucial role in placing individuals at the center of healthcare, providing them with a sense of agency over their own health [15,16]. Additionally, games and game mechanics have proven effective in motivating and engaging patients in these processes [17]. Recent studies, such as those by Cheng [18] and Fodor et al. [19], have increasingly focused on the application of game elements in health contexts, particularly for managing mental health conditions like anxiety and depression, among others. These studies have garnered substantial attention within the scientific community for their demonstration of effectiveness. Similarly, a comprehensive review by Lumsden et al. [20] synthesizes findings across various studies, indicating a generally positive impact of gamified interventions on adult mental health outcomes. These studies encompass a range of mental health aspects, including stress, depression, and anxiety, with most reporting significant improvements. Key gamification elements such as rewards, levels, and progress tracking have been instrumental in enhancing participant engagement and the overall effectiveness of these interventions. However, as discussed later, the use of such elements in isolation must not be considered a gamified approach, so their analysis of the outcome should be differentiated from that of formal gamification frameworks.

1.2. Defining Gamification

The origins of the term and principles of gamification date back to 2003 and are linked to the digital media industry [21]. Over the last few years, the term has been popularized, and several working definitions have been proposed. Some of the most widely accepted include the following:

(1) "The application of typical elements of game playing (e.g., point scoring, competition with others, rules of play) to other areas of activity, typically as an online marketing technique to encourage engagement with a product or service" [22].
(2) "The process of game-thinking and game mechanics to engage users and to solve problems" [23].
(3) "The use of game design elements in non-game contexts" [8].

In order to better understand the term in context, Deterding et al. [8] proposed a conceptual framework. As depicted in Figure 1, they define gamification based on the subtle distinctions between the actions of *gaming* and *playing* and the differences between a whole composition of elements and the isolated elements themselves. In the former distinction, *playing* is considered a spontaneous, free-form, and unstructured interaction with some system or artifact, mainly for fun, entertainment, and/or leisure purposes (not goal-oriented), whereas *games* involve rules, structure, and goals. Therefore, a whole artifact designed *to be played* is what is commonly considered a toy; a fully-fledged system designed for *gaming* purposes is what is usually known as a game (or serious games, depending on their purposes). Different elements not comprising an entire system/artifact but designed using the notion of *play* fall into the concept of *playful design*; finally, *gameful*

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design encompasses the design and use of parts of games, with *gamification* being the concept of applying such design to address non-game issues.

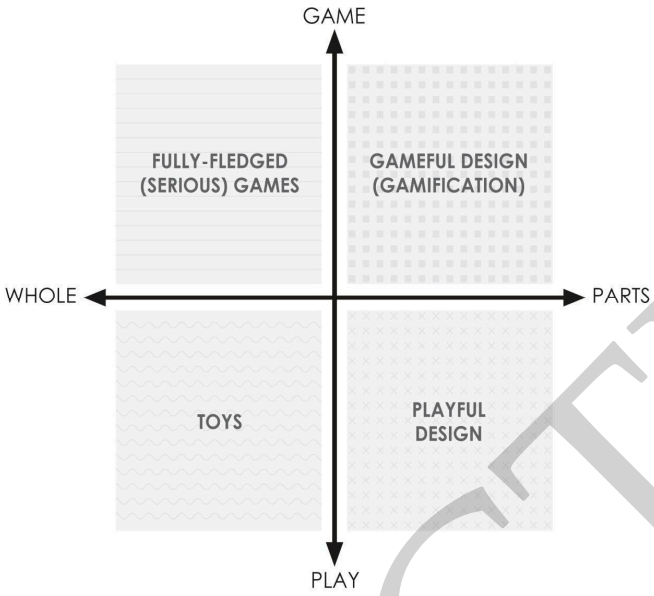


Figure 1. Conceptual definition of gamification (Adapted from Deterding et al. [8]).

While this categorization does not rely on the distinction between gamification, serious games, and game-based learning, the foundational distinctions between gaming and playing are equally critical for a comprehensive understanding of the subject. These nuances, as illustrated in Figure 1, help to establish a clear conceptual framework that is essential for contextualizing the diverse applications and implications of gamification in mental health and health psychology. These fundamental concepts provide a robust basis for understanding how gamification fits within the broader spectrum of game-related interventions, thereby enhancing the clarity and depth of our subsequent analysis.

Previous research has found that in line with self-determination theory, autonomy, competence, and relatedness determine users' motivation when playing games or engaging in various activities [24,25]. Additionally, motivational aspects must be carefully considered when thinking about how and why to gamify a specific system [26]. Some authors have made significant efforts to summarize the different core elements/processes that a gamified design should address, as well as their interrelationships [9]. Thus, game mechanics generate a series of dynamics that, in turn, favor the emergence of intrinsic motivations (see Table 1). The idea of using game elements to solve problems and engage people in tasks is not new, and as such, it can often be confused with similar concepts. In this work, we aim to establish some foundational principles to prevent confusion with other game-based technologies, such as serious games (e.g., exergames, edutainment, etc.).

Gamification in healthcare aims to leverage game design elements to enhance patient engagement and outcomes. A critical aspect of this approach is the transition from extrinsic to intrinsic motivation. Extrinsic motivators, such as earning points, completing levels, and receiving badges, serve as initial engagement tools. However, the ultimate goal is to foster intrinsic motivation, where individuals engage in behaviors out of genuine interest and personal satisfaction. To facilitate this process, the design of gamified interventions should include elements that promote autonomy, competence, and relatedness, which are core components of self-determination theory. By providing meaningful choices, challenging tasks that match users' skill levels, and opportunities for social connection, gamified systems can effectively shift the user's motivation from extrinsic to intrinsic, ultimately enhancing healthcare outcomes.

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Table 1. Game-design elements and motives.

Game mechanics	· Documents of behavior and feedback loops; · Scoring systems, badges, trophies; · Rankings; · Levels; · Group tasks; · Time pressure, quests; · Avatars, virtual worlds, virtual trade.
Game dynamics	· Exploration; · Collection; · Competition; · Acquisition of status; · Collaboration; · Challenge; · Development; · Organization.
Game motives	· Intellectual curiosity; · Achievement; · Social recognition; · Social exchange; · Relatedness; · Cognitive stimulation; · Self-determination.

Adapted from Blohm and Leimeister [9].

1.3. What Is Not Necessarily Gamification

Given the widespread adoption of web-based and mobile app-based solutions, many users have become acquainted with various elements and dynamics that may confuse them when evaluating gamified systems. Consequently, it is crucial to distinguish the fundamental characteristics of these systems from those of genuine gamification to avoid misconceptions.

Firstly, gamification is not simply about turning everything into a game. A game is a system in which players engage in artificial conflicts, defined by rules, that result in quantifiable outcomes [27]. In contrast, gamification does not necessarily create artificial scenarios or disconnect individuals from reality. When employing gamification principles, real life is usually still the context, and the objective is to select game elements that can enhance the experience and make it more beneficial. Thus, the purpose is to discover the meaningful core of those experiences and to make them more enjoyable and motivating for the individual.

Secondly, gamification is distinct from serious games. Serious games are fully developed games aimed at simulating real-world events or processes designed to solve problems and develop systems of thinking, such as a flight simulator. While serious games often incorporate many game mechanics that can lead to enjoyable experiences, their primary purpose is to train or educate users in specific skills. As a result, aspects like fun and engagement might sometimes be sacrificed to achieve pre-established goals [28,29]. It is important to note that a serious game, a clear element of game design, could be included as a component of a gamified system along with other game mechanics and dynamics, such as those shown in Table 1. However, merely including a serious game does not constitute gamifying a system. While there are still no universally accepted definitions, serious games are typically categorized into genres such as advergames, edutainment, simulation games, persuasive games, games for health, exergames, art games, and games with a purpose [28,30].

Regarding its purposes, gamification could be perceived as simply a marketing strategy employing certain manipulative techniques. Although many existing examples of purported gamification originate from the business sector (e.g., Nike, Coca-Cola, McDonald's, Starbucks), not all these systems strictly fit the previously mentioned definition of

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gamification. As explained earlier, gamification is a broader concept that encompasses a deeper conceptualization of using game elements for specific goals.

Concerning the compounding elements, a system is not considered gamified only because it includes points, badges, and leaderboards (hereafter, PBLs). While these elements are simple yet powerful tools that provide feedback on users' progression and achievements, it greatly oversimplifies to believe that PBLs and other extrinsic rewards alone can transform any system into an effective gamified system. In fact, a core aspect of gamification is to achieve a proper balance between intrinsic and extrinsic motivation, as well as to enable individuals to make meaningful choices [31,32].

2. Applications of Gamification in Different Mental Health and General Health Psychology Domains

The distinction between mental health and general health psychology lies primarily in their scopes and focuses within the broader field of psychology. On the one hand, mental health pertains specifically to the psychological well-being of individuals. It encompasses the emotional, psychological, and social aspects of a person's life. Mental health professionals (such as psychiatrists, psychologists, and counselors) diagnose, treat, and support individuals experiencing mental disorders or distress. On the other hand, general health psychology deals with the psychological factors that affect physical health and illness. It explores how behaviors, emotions, and thoughts impact overall health outcomes and well-being. Health psychologists study factors like stress, coping mechanisms, adherence to medical treatment, and health-related behaviors. Both fields contribute to improving overall well-being through their unique perspectives and interventions in clinical and research settings. For the purposes of this contemporary perspective, we will focus on exploring the utilization of gamification for mental health and general health psychology, focusing on the latest advancements, trends, and interdisciplinary insights. The aim is to provide a current view of the field by synthesizing recent research findings, theoretical developments, and practical applications. To achieve this, we conducted a comprehensive search of the recent literature using databases such as PubMed, PsycINFO, and Google Scholar. This search was restricted to articles published within the last 15 years to ensure the timeliness of the information. Keywords used in the search included "gamification", "health psychology", "mental health", "digital health interventions", and "behavior change", among others. Articles were selected based on their relevance to the topic, contribution to recent advancements, and potential impact on future research and practice. Also, we only considered articles if they were published in peer-reviewed journals. A total of 28 articles were selected based on these criteria, ensuring a robust and relevant dataset for this contemporary perspective.

2.1. Child and Adolescent Mental Health and General Health Psychology

In pediatric psychology, gamification strategies are particularly effective due to their alignment with children's natural inclinations toward play. Applications such as the "SuperBetter" app utilize game mechanics to help young patients tackle mental health challenges like anxiety and depression, fostering resilience through quests and power-ups that symbolize real-life coping strategies [33]. Schools have adopted gamified systems to promote physical activity, using wearable technology that rewards steps with virtual badges and unlocking levels, which has been linked to improved physical activity levels and reduced incidences of childhood obesity [34].

Expanding on these examples, the recent literature has provided further evidence of the effectiveness of gamification in pediatric settings. For instance, the "MindLight" game has shown promising results in reducing anxiety symptoms in children by teaching them mindfulness and relaxation techniques through engaging gameplay [35]. This game uses neurofeedback mechanisms where players control the game environment with their emotional state, thereby learning to manage anxiety.

Another study highlighted the use of a gamified app designed to improve adherence to asthma treatment among children. The app "Wellapets" employs a virtual pet care

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scenario where children learn to take care of a pet afflicted with asthma, mirroring their own treatment regimens. Through regular interaction with the game, children learn the importance of consistency in their asthma management, which has led to improved treatment outcomes [36]. "Wellapets" is indeed an excellent example of serious games. These games are designed to engage children and adolescents through interactive and immersive experiences that teach valuable health-related skills. However, it is important to note that these examples often function as standalone games rather than gamified experiences integrated into real-life contexts. This represents a limitation in the existing literature, as the full potential of gamification—where game elements are seamlessly woven into everyday activities—remains underexplored in this area.

Finally, a relevant example of using gamification and virtual reality (VR) in mental health for the youth is a study that investigated the impact of VR-based interventions on adolescent stress management. This study utilized immersive VR environments to engage teenagers in stress-reduction activities, using game elements to enhance their motivation and participation. The findings suggested that such VR interventions could significantly alleviate stress among adolescents, offering a promising tool for mental health promotion in this age group [37]. This study employs gamification in a VR context to manage stress among adolescents by creating immersive environments that use game-like elements to enhance engagement and motivation. The inclusion of tasks, challenges, and interactive components encourages active participation, making stress management techniques appealing and effective. This approach not only keeps the youth engaged but also promotes intrinsic motivation through rewards and positive reinforcement, illustrating gamification's potential in mental health interventions for this age group.

These additions underscore the diverse applicability of gamification in pediatric psychology, not only enhancing physical activity and managing psychological disorders but also improving adherence to medical treatments and educating young patients about their health conditions. The continued integration of gamified elements into therapeutic contexts holds significant potential for enhancing pediatric healthcare outcomes.

2.2. Adult Mental Health and General Health Psychology

For adults, apps like "Happify" use science-based games and activities that promote emotional well-being by training users in skills related to gratitude, empathy, and mindfulness [38].

Building on these examples, additional research highlights the effectiveness of gamification in adult mental health management. The "MindBloom" app is another example where users engage in a virtual tree-growing game that encourages daily mental health practices. Each action that contributes to personal growth and well-being allows the tree to flourish, reinforcing positive habits [39].

One example of a high-quality study is the randomized controlled trial by Smith et al. [40], which evaluated the effectiveness of a gamified app for managing anxiety in adults. This study included 200 participants randomly assigned to either the intervention or control group. The intervention group used the app for 8 weeks, engaging in activities designed to reduce anxiety through gamified elements such as rewards and progress tracking. The outcomes measured included self-reported anxiety levels, physiological markers, and user engagement metrics. Results showed a significant reduction in anxiety levels in the intervention group compared to the control group, highlighting the potential efficacy of gamified interventions.

In another instance, the "SuperBetter" app, originally designed for young audiences, has shown promising results for adults in building resilience and coping with daily stressors. Research indicates that engaging with SuperBetter's challenges can significantly enhance mental resilience and decrease symptoms of depression in adults [41].

Moreover, a study on the use of gamified apps for mindfulness training, such as "Headspace", has shown that regular use could decrease work-related stress and improve focus and job performance. This app employs gamified elements like streaks and rewards

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to encourage daily practice of mindfulness exercises, making the process engaging and measurable [42].

A real-world example of using gamification and VR in mental health for adults involves Virtual Reality Exposure Therapy (VRET). This method utilizes VR technology to create immersive environments where individuals can safely confront and work through fears, such as phobias and anxiety disorders. This controlled and customizable approach allows for gradual exposure to feared stimuli tailored to the individual's comfort level, which can significantly reduce anxiety and improve coping skills over time. In this research, therapy allows for gradual adjustment in exposure levels to feared stimuli, mimicking how games let players progress through increasing difficulty levels. Also, patients receive instant feedback on their performance and progress, which can be visual or auditory, helping them understand how well they are managing their exposure to fears. Completing certain stages or levels in therapy might earn patients virtual rewards or acknowledgments, which motivate and reinforce continued participation and effort. Finally, being immersed in a controlled environment that simulates real-life scenarios allows patients to safely confront their fears, using narrative to keep them engaged and motivated. This approach is highlighted for its effectiveness in treating anxiety disorders and phobias through gradual and controlled exposure that enhances patient coping mechanisms in a safe environment [20].

Finally, the "Zombies, Run!" app combines physical activity with a narrative adventure where users listen to various story segments during their runs, effectively gamifying exercise and promoting physical and psychological health. The engagement with the narrative provides a compelling motivation to exercise, which is particularly useful for those who may otherwise find it difficult to maintain a regular fitness routine [43].

These examples further illustrate how gamification, whether used in combination with other technologies or on its own, is effectively used to enhance mental health and wellness in adults, offering innovative solutions that integrate seamlessly into everyday life and wellness strategies.

2.3. Geriatric Psychology

In geriatric populations, cognitive decline and social isolation are prevalent issues where gamification has shown promise. "Elderly-friendly" gamified applications, which include memory games and problem-solving activities, aim to enhance cognitive function while providing a social platform to interact with peers, thus addressing loneliness and cognitive deterioration simultaneously [44].

Expanding on these initiatives, recent studies have introduced additional gamified solutions specifically designed for older adults. For example, the "Sea Hero Quest" app not only entertains but also collects data to help researchers understand spatial navigation behaviors in aging populations. This game has been instrumental in identifying early signs of cognitive decline, and providing valuable insights that can lead to early interventions [45].

Manera et al. [46] utilized VR environments with gamification elements to enhance cognitive functions in the elderly through simulated market shopping tasks. This method integrates engaging, interactive elements such as tasks, challenges, and rewards in a virtual market scenario. Such a setting not only simulates real-life tasks but also provides a safe and controlled environment for cognitive training. The gamified components boost engagement, motivation, and participation, effectively encouraging the elderly to practice and refine cognitive skills that are crucial for daily activities. This demonstrates the potential of gamification and VR to improve therapeutic interventions by making them more interactive and relevant to everyday life.

Additionally, the "Fit Brains Trainer" application developed by Rosetta Stone specializes in games that stimulate cognitive skills such as focus, speed, and memory. Research has shown that consistent use of such apps can help delay cognitive decline in older adults while improving the aspects of cognitive flexibility and problem-solving skills [47].

Lastly, the app "Walk to Beat" combines physical activity with gamification to combat Parkinson's symptoms in older adults. The app uses rhythmic cues to improve the walking

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pattern of Parkinson's patients, which helps reduce the risk of falls while promoting independence and mobility [48].

These examples underscore the versatility of gamification in addressing various aspects of aging, from cognitive health to physical mobility, thereby significantly enhancing the quality of life for the elderly population.

2.4. Occupational Health Psychology

In the context of occupational health, gamification is used to enhance workplace safety and ergonomics. For example, a gamified simulation that teaches proper lifting techniques can help reduce workplace injuries. Another application is in the form of stress management programs that use gamified scenarios to teach relaxation techniques, helping employees manage stress and avoid burnout [49]. Expanding further on these applications, recent innovations have introduced gamified training modules for emergency response drills, which engage employees in interactive scenarios that simulate real-life emergency situations. This approach not only enhances the retention of safety procedures but also improves the speed and effectiveness of employee responses during actual emergencies [50].

Another emerging application is the use of wearable technology that incorporates gamification to encourage movement and proper posture among office workers. For instance, the "PostureTrack" app alerts users when their posture deviates from the ideal and rewards points for periods of correct posture, effectively reducing the incidence of musculoskeletal disorders associated with sedentary work environments [51].

Additionally, the use of gamified apps for mental health at work has been gaining traction. "MoodMission" is an app that employs gamification strategies to suggest activities based on the user's current mental state. Tasks can range from breathing exercises to engagement in social activities, all designed to improve mood and resilience against stress, thereby contributing to better mental health outcomes in the workplace [52].

These tools are not only used individually but are also increasingly incorporated into employee wellness programs, demonstrating significant reductions in stress levels and improvements in overall job satisfaction.

Lastly, VR has been harnessed to create immersive safety training experiences. Companies like "SafetySkills" offer VR modules that place employees in hazardous scenarios where they must make decisions that could occur in their daily work environments. This method has been shown to dramatically improve memory retention compared to traditional training methods and significantly decrease accidents on the job [53].

These additional examples illustrate the diverse applications of gamification in occupational health, demonstrating its effectiveness in not only enhancing physical wellness but also fostering mental health resilience and safety awareness among employees.

2.5. Recent Advancements and Technologies

The integration of advanced technologies such as VR and artificial intelligence (AI) with gamification opens new avenues for highly immersive and personalized health interventions. VR-based gamification for anxiety disorders places individuals in controlled environments where they can face their fears in a safe, game-like setting, effectively reducing anxiety through repeated exposure [54]. AI algorithms can adapt game scenarios to the users' emotional responses, providing a tailored therapeutic experience. Further extending these advancements, AI-driven gamification systems are increasingly being applied to enhance cognitive behavioral therapies (CBT). For instance, a recent development involves AI systems that analyze user interactions and modify the difficulty levels or types of cognitive tasks in real time to maintain optimal challenge and engagement levels. This adaptive gamification approach ensures that therapies remain effective across varying stages of a patient's treatment journey [55]. Moreover, the use of VR in treating Post-Traumatic Stress Disorder (PTSD) has gained substantial empirical support. VR environments simulate real-world scenarios that might trigger PTSD symptoms in safe, controlled settings, allowing for therapeutic exposure that can be adjusted to each patient's needs. This method has

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shown significant success in helping veterans and first responders overcome traumatic experiences [56]. Another innovative application involves integrating wearable technology with gamified health apps to monitor physical activities and physiological responses. These devices use AI to provide real-time feedback and encouragement through gamified elements, significantly enhancing user engagement and adherence to physical rehabilitation programs [57]. In the realm of pediatric health, VR is being utilized not only to distract children during painful or uncomfortable medical procedures but also augmented reality (AR) and other forms of extended reality (XR) are gaining traction. These technologies offer similar benefits by engaging children in interactive experiences that significantly reduce perceived pain and anxiety. For instance, the recent advent of devices like Apple Vision has pushed competitors to develop analogous AR solutions that enhance the therapeutic landscape. Such innovations illustrate how XR, including AR and VR, are revolutionizing health interventions through gamification, providing personalized, adaptive, and deeply engaging therapeutic experiences. Moreover, it is essential to distinguish between traditional AI applications and Generative AI (GenAI), which the public currently understands as systems capable of producing content autonomously based on extensive data inputs. These AI-driven technologies can tailor interventions to individual needs, addressing a broad spectrum of health issues with unprecedented efficacy [58,59].

Human–robot interaction design can significantly benefit from incorporating gamification principles, enhancing patient engagement and motivation during rehabilitation exercises. By integrating gamified interfaces, robotic systems can utilize game-like elements such as scoring and real-time feedback to encourage consistent and effective completion of physical therapy routines. This approach not only improves adherence to treatment protocols but also provides valuable real-time data on patient performance, enabling more personalized and adaptive interventions [60]. Despite these benefits, the application of gamification in robotics is less developed compared to its integration into extended reality (XR) and mobile applications. In contrast, gamification has been more extensively researched and applied in mobile applications and XR technologies [61]. Studies exploring the intersection of gamification and robotics are relatively few, highlighting a need for more research in this field to match the extensive investigations found in other technological applications [62]. However, the application of gamification in robotics holds considerable potential for growth. As advancements in technology continue and research in this area expands, there are opportunities to develop more sophisticated gamified robotic systems that could enhance learning and interaction experiences beyond current applications.

2.6. Summary of Different Applications of Gamification in Mental Health and General Health Psychology

In synthesizing the applications of gamification across different age groups and health domains, several fundamental insights emerge rooted in psychological theories. Gamification draws from principles of learning psychology, developmental psychology, and motivational theories to capitalize on intrinsic motivation and engagement through game mechanics, promoting positive health outcomes.

For children and adolescents in mental health, gamification leverages their natural inclination toward play to enhance therapy adherence and foster resilience. By integrating elements such as rewards and achievements, gamified interventions align with developmental stages, empowering youth to autonomously manage their mental health [63]. This approach not only makes therapeutic activities more engaging but also supports psychological needs for competence and autonomy that are crucial for developing resilience in young populations.

In adult mental health, gamification integrates theories of self-determination and motivational psychology. By offering rewards, progress tracking, and meaningful challenges, gamified wellness programs promote sustained engagement in activities that enhance emotional well-being and stress management [63]. These interventions are designed to

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fulfill intrinsic psychological needs for competence, autonomy, and relatedness, thereby supporting long-term behavior change.

Geriatric psychology utilizes gamification to support cognitive function and social interaction among older adults. By providing stimulating activities integrated with game elements, gamified interventions address cognitive decline and loneliness, thereby enhancing quality of life [64]. These approaches align with theories of cognitive aging and social engagement, offering older adults meaningful activities that promote mental acuity and emotional well-being in a supportive, interactive environment.

In occupational health psychology, gamification enhances workplace safety and employee well-being by integrating theories of organizational behavior and motivation. Immersive simulations and incentivized learning experiences improve knowledge retention and skill acquisition, fostering a culture of safety within organizations [65]. These gamified interventions are designed to engage employees actively in health-promoting behaviors, thereby reducing workplace injuries and enhancing overall productivity.

Advancements in technology, such as virtual reality (VR) and artificial intelligence (AI), further augment the effectiveness of gamification in health interventions. VR simulations provide controlled environments for exposure therapy, aligning with learning theories that emphasize gradual desensitization and behavior modification. AI-driven adaptive gamification systems personalize interventions based on individual preferences and behaviors, enhancing engagement and efficacy across diverse populations and health conditions [66]. However, these technological advances carry some significant implications, as their current capabilities increase the likelihood of additional harms (e.g., misinformation, bias, addiction) that must be appropriately tackled at all stages of the system development. In Section 4, we delve into common guidelines and frameworks relevant to ethical and trustworthy implementations.

In addition to discussing gamification principles within all these specific cases, it is important to recognize the nuances and limitations within the existing literature. While gamification involves integrating game elements into real-life contexts to enhance experiences and outcomes, many examples in the current literature, particularly those related to child and adolescent mental health, are primarily designed as games. These games provide transferable knowledge and skills but do not always fully embody the principles of gamification as described.

In summary, gamification represents a transformative approach in healthcare, integrating psychological theories with interactive technology to promote behavior change, enhance therapeutic outcomes, and improve overall well-being across the lifespan. By leveraging the motivational aspects of gaming and aligning with developmental, motivational, and cognitive theories, gamified interventions empower individuals to actively manage their health and achieve long-term wellness goals.

3. Challenges and Future Directions

Gamification in mental health and general health psychology presents a versatile and effective approach to enhancing patient care and health outcomes across various populations and settings. As it continues to evolve, driven by technological advancements and deeper psychological insights, its potential to transform the landscape of health psychology grows. Despite the promising applications of gamification in health psychology, challenges remain, particularly regarding the sustainability of user engagement and the risk of oversimplification in serious health contexts. Future research must address these challenges by designing more sophisticated gamified applications that ensure long-term engagement without reducing the seriousness of health interventions. Additionally, ethical considerations regarding data privacy and the potential for increased screen time must be addressed to balance the benefits and risks of gamification in health settings. To further elaborate, research indicates that while gamification can significantly boost initial engagement, maintaining this interest over longer periods can be challenging. Studies have shown a drop in user engagement with gamified systems after the novelty wears

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off [67]. Therefore, incorporating adaptive learning systems that evolve based on the user's progress and changing needs can help sustain engagement [68]. Moreover, the application of gamification in health treatments might lead to oversimplification, where complex health behaviors are reduced to simple games, potentially undermining the quality of care. To combat this, gamification strategies need to be carefully designed with input from healthcare professionals to ensure that they complement traditional treatment methods rather than oversimplify them [69]. Regarding ethical concerns, the integration of gamification into health apps often involves collecting sensitive health data, which raises significant privacy issues. Ensuring compliance with global data protection regulations, such as the GDPR, is crucial for maintaining user trust and security [70]. Additionally, the increasing use of digital devices has raised concerns about screen time, which is linked to various health issues, including eye strain and reduced physical activity. Gamified health programs need to include features that encourage real-world activities and regular breaks from screens to mitigate these risks [71]. As gamification continues to mature, ongoing research and development are needed to refine these strategies, ensuring they are effective, ethical, and conducive to long-term health benefits.

4. Pillars of the Implementation of Next-Generation Digital Health Frameworks

The aforementioned challenges and directions of gamification in mental health and general health psychology interventions require the conceptualization and definition of common guidelines that boost up the gamified approach to achieve the intended outcomes while fostering the principles of ethical and responsible development and implementation.

Some efforts have already been carried out toward this goal that consider the need for stakeholder engagement, co-design and co-development with the software development team, and the consideration of feedback loops [18]. However, even though most gamified systems already harness the potential of AI mechanisms, we must take into account the huge leap experienced by the AI discipline, especially the surge of Generative AI over the last few years. This has given rise to regulatory concerns (e.g., the EU AI Act from the EP Council [72]) and the necessity of formal frameworks addressing ethical and fairness matters. In this regard, the OECD's Principles on Artificial Intelligence [73] and Guidelines for Multinational Enterprises on Responsible Business Conduct [74], together with the U.S. General Services Administration AI Guide for Government [75], provide a robust foundation that can be leveraged to define suitable frameworks for the implementation of gamified interventions, directly applicable to the context of mental health and general health psychology too. The following guidelines aim at strengthening all these principles. Starting with the five principles for trustworthy and ethical AI systems, they can be mirrored for the specific case of gamification in mental health and health psychology as follows:

1. Inclusive Development and Use: Gamified systems for mental health should be developed and used in a way that respects human rights, diversity, and the principles of equality, non-discrimination, and inclusion. This includes ensuring equal access and avoiding biases that could disadvantage certain groups;
2. Transparency and Explainability: The design, data, and algorithms used should be as transparent as possible, allowing users to understand how the system operates and make informed decisions. Explanations should be provided on how the gamified elements are intended to improve mental health outcomes;
3. Robustness, Security, and Safety: Gamified mental health and health psychology systems must be designed with robust safeguards to ensure the safety and security of users, protecting their privacy and preventing unintended harm. Mechanisms should be in place to monitor and mitigate risks;
4. Accountability: There should be clear accountability measures for the development, deployment, and use of these systems. Suitable governance structures should be in place at the organizational level to ensure that responsibilities are assigned and there are mechanisms to address any negative impacts;

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5. Respect for Privacy: The collection, use, and storage of personal data within gamified mental health systems must fully respect user privacy. Informed consent, data minimization, and strong data protection measures should be implemented.

These principles can help ensure that the gamified systems are developed and used in a trustworthy, ethical, and beneficial manner, prioritizing the well-being and rights of the individuals they are intended to support. Similarly, the following four phases (see Table 2) are commonly referenced in various AI development lifecycle models, such as those described by the OECD [73,74] and can be applied to the context of gamification for mental health and health psychology.

Table 2. Development lifecycle of trustworthy gamified systems for mental health and health psychology.

Plan	· Define the specific mental health objectives and requirements for the gamified system; · Determine the target user population and their needs, preferences, and potential biases; · Establish the governance structure and responsibilities for the development and deployment of the gamified system; · Identify key stakeholders, including mental health professionals and end-users, to ensure their input is incorporated throughout the process.
Design	· Implement a data strategy that ensures the privacy and ethical use of user data, adhering to relevant regulations and guidelines; · Determine the appropriate gamification elements and mechanics to achieve the desired mental health outcomes in collaboration with mental health experts; · Define performance metrics to evaluate the effectiveness of the gamified system in improving mental health and well-being. These metrics should be developed with input from mental health professionals and should include both objective measures (e.g., symptom reduction, improved functioning) and subjective measures (e.g., user satisfaction, perceived benefits); · Establish a plan for continuous monitoring and evaluation of the system's performance, with a focus on identifying potential unintended consequences or negative impacts on user well-being.
Development	· Build the gamified system, incorporating the planned gamification elements and mechanics; · Train and evaluate the system to ensure it meets the desired performance metrics and mental health objectives, using a combination of user testing and expert review; · Verify and validate the system to ensure it is safe, secure, and trustworthy for the target users, with input from mental health professionals and end-users; · Implement mechanisms for user feedback and reporting any concerns or issues related to the system's impact on mental health.
Implementation	· Deploy the gamified system and monitor its performance in the real-world context, with a focus on user engagement, satisfaction, and mental health outcomes; · Continuously validate the system's effectiveness and make necessary adjustments to maintain its trustworthiness and ethical use, with input from mental health professionals and end-users; · Ensure the system is maintained and updated to address any emerging issues or new requirements while continuously monitoring for potential unintended consequences or negative impacts on user well-being; · Establish clear protocols for responding to user concerns or reports of negative impacts, with a focus on providing appropriate support and resources.

Adapted from OECD AI Principles and Guidelines for Multinational Enterprises on Responsible Business Conduct [73,74].

It is worth noting that by incorporating a "human in the loop" approach throughout the development lifecycle, with input from mental health professionals and end-users, and by defining suitable performance metrics that prioritize user well-being, the development of gamified systems can be optimized to ensure they are safe, effective, and beneficial for the target population.

These principles and adaptation to the development lifecycle stages offer a structured approach. Focusing on the mental health and health psychology context, the following key takeaways are to be considered:

1. Designing gamification strategies

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- Alignment with health goals: Ensure that the gamification elements directly support specific health outcomes, such as increasing physical activity, enhancing medication adherence, or reducing stress;
- Inclusivity: Design games that are accessible to a diverse patient population, including varying ages, abilities, and technological proficiencies;
- Behavioral Science Integration: Incorporate principles from behavioral psychology, such as reinforcement and motivation theories, to encourage desired behaviors;
- User-centered design: Engage with potential users during the design process to tailor the application to their needs and preferences, which can enhance relevance and engagement;

2. Governance concerns when implementing gamification in healthcare

- Analyze and select the most suitable governance approach according to the organizational setting and intended goals of the gamified system: there are diverse governance approaches for digital mental health systems that cover different cultural, ethical, and organizational concerns [76]. These should be leveraged and tailored to the specific requirements posed by the gamified initiative;
- Stakeholder engagement: Collaborate with healthcare professionals, patients, and caregivers to ensure that the gamified solutions are feasible and integrated smoothly into existing healthcare practices;
- Technology integration and regulatory standards: Utilize reliable and secure technology platforms that can support gamified content and ensure data privacy and security, aligning with regulations like GDPR or the EU AI Act [72];
- Implementation challenges: Despite the presence of robust frameworks, the practical implementation of these governance models can be hindered by limited resources, lack of training, and institutional stigma. The governance framework should always be conceived as a supportive tool, providing the structure for effective and fair system management. Therefore, it must be analyzed and customized to meet the actual requirements from the outset (i.e., at the Plan stage in Table 2);

3. Assessing gamification interventions

- Effectiveness metrics: Define clear metrics to evaluate the effectiveness of gamification interventions, such as engagement rates, behavior change, and health outcome improvements;
- Pilot testing: Before a full-scale launch, conduct pilot tests with the target user groups to refine gameplay, address technical issues, and assess user engagement and response;
- Continuous feedback: Implement mechanisms to collect continuous feedback from users to inform adjustments and improvements in real time;
- Long-term impact studies: Conduct longitudinal studies to assess the long-term impacts of gamification on health behaviors and outcomes, identifying any potential risks or benefits;
- Cost-effectiveness analysis: Evaluate the cost-effectiveness of gamification interventions compared to traditional treatment methods to assess value;

4. Ethical considerations

- Transparency: Be transparent with users about how their data are collected, used, and protected;
- Avoiding over-reliance on technology: Ensure that gamification complements, rather than replaces, traditional healthcare services and that it does not lead to an over-reliance on technology;
- Avoiding manipulation: Carefully balance motivational elements within games to avoid manipulative practices that may lead to ethical concerns.

By following these criteria, healthcare providers can develop, implement, and evaluate gamified solutions that are not only engaging and motivating [77] but also effective in promoting health and wellness in a manner that is ethically sound and scientifically

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validated. This comprehensive approach ensures that gamification in healthcare settings contributes positively to the evolving landscape of digital health interventions.

5. Conclusions

The integration of gamification into healthcare has been a transformative approach, utilizing the engaging and motivational power of game elements to enhance patient care and health outcomes. Gamification's potential is evident across various demographic groups, addressing significant health challenges such as chronic condition management, physical activity promotion, and mental health intervention enhancement. As technologies evolve, the incorporation of virtual reality (VR) and artificial intelligence (AI) has deepened the impact of gamification by enriching the immersiveness and personalization of healthcare solutions. These technologies facilitate sophisticated real-time monitoring and promotion of health behaviors.

The advent of extended reality (XR) and generative AI introduces exciting new dimensions to this framework. XR, encompassing VR, augmented reality (AR), and mixed reality (MR), offers unprecedented immersive experiences that can simulate complex health scenarios more realistically, thereby providing a richer platform for patient education and therapy. Generative AI can create dynamic content that adapts to individual patient needs, potentially revolutionizing personalized care plans and therapeutic interventions. However, the broader adoption of gamification in healthcare still faces challenges such as maintaining long-term user engagement, ensuring the simplicity of the games does not trivialize complex health issues, and navigating ethical concerns around data privacy and increased screen time. To address these, it is essential to ground gamification developments in robust behavioral science, with continuous input from users and healthcare stakeholders.

To maximize its benefits, a structured approach to designing, implementing, and assessing gamification strategies in healthcare is crucial. This should align with clinical goals, accommodate diverse patient needs, integrate seamlessly with existing healthcare practices, and be subject to rigorous evaluation to confirm its effectiveness and cost-efficiency. Equally important, the significant advancement of AI technologies in recent years calls for a rigorous consideration of ethics, trustworthiness, safety, and effective governance. As future gamified systems are likely to harness these capabilities, addressing these concerns becomes crucial to ensure their responsible and beneficial use.

In conclusion, as gamification in healthcare evolves, it requires concerted collaboration among healthcare professionals, designers, technologists, and researchers. This collective effort ensures that gamification not only engages and motivates patients but also adheres to the highest standards of medical care and ethical practice. By embracing these principles, gamification can become a fundamental component of future healthcare delivery, offering innovative solutions that could revolutionize healthcare models and approaches across various populations.

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