

The Impact of Gamification on Changing Preventive Behaviors in Public Health Education

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Article type:
Original Research

Article history:
Received 11 July 2025
Revised 27 September 2025
Accepted 06 October 2025
Published online 01 January 2026

ABSTRACT

Traditional public health education methods face challenges such as reduced motivation and audience engagement. Gamification, as an innovative approach that utilizes game elements in non-game contexts, has high potential to improve interaction and the effectiveness of health education. This study aimed to propose and validate a gamification model for teaching and strengthening disease-preventive behaviors within the cultural context of Iran. This research employed a mixed-methods design (qualitative–quantitative) and was conducted in two stages. In the qualitative phase, data were collected through semi-structured interviews with 22 experts in health, education, and technology using a grounded theory approach. Data were analyzed through open, axial, and selective coding. In the quantitative phase, a researcher-made questionnaire was developed based on the conceptual model; its validity and reliability were confirmed. The questionnaire was distributed among the statistical sample, and data were analyzed using Structural Equation Modeling (SEM) with AMOS version 24. The qualitative analysis yielded 462 open codes, 99 concepts, and 22 categories, organized into a paradigmatic model consisting of causal conditions (motivational and social applications), contextual conditions (culture and technology), intervening conditions (constraints and accelerators), strategies (incentives and technology), and outcomes (increased awareness and behavioral change). The quantitative analysis confirmed the model fit (CMIN/DF = 2.888, CFI = 0.935, RMSEA = 0.071). The hypotheses regarding the effect of motivational applications on strategies ($\beta = 0.893$) and strategies on preventive outcomes ($\beta = 0.897$) were supported at the 95% confidence level. Gamification is an effective tool for changing preventive behaviors in health education. The proposed model provides a framework for policymakers and health professionals to enhance motivation and participation, improve community health, and reduce healthcare costs.

Keywords: Gamification, game-based design, disease prevention education, behavior change, public health, structural equation modeling.

How to cite this article:

Naderizadeh, M., Mohammad Alipour, N., Rabiei, M., & Jalalpour, S. (2026). The Impact of Gamification on Changing Preventive Behaviors in Public Health Education. *Mental Health and Lifestyle Journal*, 4(1), 1-13. <https://doi.org/10.61838/mhlj.115>

Introduction

Public health education has long been regarded as one of the most effective avenues for fostering preventive behaviors and promoting healthier lifestyles. However, traditional health education approaches, which typically rely on didactic instruction, posters, and lectures, often face limitations in terms of

sustaining motivation and engaging diverse populations. In recent years, gamification, understood as the application of game design elements in non-game contexts, has emerged as a powerful tool for addressing these limitations and reshaping learning experiences (1). The concept has attracted substantial attention in both educational sciences and management research, as it provides innovative ways to increase user engagement, motivation, and behavioral change in health-related settings (2, 3).

Gamification in health education is particularly significant because of its potential to directly impact preventive health behaviors. The integration of playful mechanisms such as points, badges, leaderboards, and challenges into health promotion can support sustained engagement, encourage repeated exposure to educational content, and influence long-term behavior modification (4). The effectiveness of these strategies has been documented in multiple contexts, including digital learning environments (5), classroom-based educational programs (6), and health and wellness initiatives (7). As a result, gamification has moved from being a peripheral concept to becoming a mainstream strategy in the design of health education interventions.

One of the main contributions of gamification is its capacity to influence intrinsic and extrinsic motivation. Research suggests that while extrinsic motivators such as rewards and incentives can drive initial engagement (8), intrinsic motivators related to autonomy, relatedness, and meaningful learning sustain long-term participation (9). This dual impact makes gamification particularly relevant in the domain of health education, where both immediate behavioral compliance and long-term lifestyle changes are required. For example, gamified health applications and classroom strategies have demonstrated improvements in physical activity levels (10), adherence to healthy practices (4), and participation in wellness programs (2).

Gamification is also strongly aligned with broader developments in technology and education. The growth of digital platforms and virtual classrooms has provided fertile ground for game-based strategies. Studies have demonstrated that gamification in virtual learning environments can enhance students' academic motivation and performance (11, 12). This is particularly significant for preventive health education, which often relies on repeated engagement with information to change attitudes and behaviors. Furthermore, gamified approaches have been shown to promote engagement in populations that may otherwise resist traditional forms of instruction, including students with intellectual disabilities (13). Such findings highlight the inclusiveness and adaptability of gamification as an instructional strategy.

Despite the growing popularity of gamification, its implementation requires careful consideration of context. Cultural factors, organizational readiness, and technological infrastructure all shape the success of gamification-based interventions. For example, in the context of pandemics and disease outbreaks, gamified simulations have been used to teach epidemiological principles and preventive strategies effectively (14). Similarly, systematic reviews confirm that gamification has been widely applied in primary and secondary education, demonstrating both opportunities and challenges (15, 16). These insights underscore the need for context-sensitive models that integrate gamification into health education in ways that align with the cultural and organizational environment.

The theoretical grounding of gamification also reinforces its potential in preventive health education. Motivational interviewing, which emphasizes the role of intrinsic motivation in behavior change, provides an evidence-based framework for understanding why gamification can be effective (17). By integrating game

mechanics that encourage self-reflection, goal-setting, and incremental progress, gamification supports the very processes that motivational interviewing identifies as central to behavioral transformation. This integration suggests that gamification is not merely a technological trend but a pedagogical and psychological strategy rooted in established theories of motivation and learning.

In addition, gamification addresses critical challenges associated with digital lifestyles and well-being. As societies increasingly grapple with the consequences of overexposure to technology, such as reduced attention spans and increased stress, gamification offers structured and purposeful engagement (7). Rather than reinforcing addictive patterns, well-designed gamification can channel users' interaction with digital environments toward healthier behaviors, providing both immediate benefits and long-term protective effects. This highlights its importance not only for individuals but also for policymakers and institutions seeking sustainable strategies for public health promotion.

Another key dimension of gamification is its adaptability across different learning settings. For instance, gamification has been used successfully in traditional classrooms, online platforms, and blended learning environments (6). Its flexibility allows it to respond to evolving educational needs, from teaching disease prevention strategies (14) to enhancing digital literacy (5). This adaptability strengthens its potential role in health education, where diverse audiences and rapidly changing contexts demand flexible and scalable solutions.

From a managerial perspective, gamification also aligns with broader transformations in the future of work and organizational innovation. As digital technologies reshape workplaces, gamified strategies are increasingly employed to train employees, encourage healthy practices, and enhance productivity (5). These developments demonstrate that gamification is not limited to educational institutions but extends to organizational management, human resource development, and corporate health initiatives. This integration underscores the multidisciplinary relevance of gamification and its capacity to create synergies across education, health, and management domains.

The literature also indicates that gamification plays an important role in enhancing emotional engagement and promoting a sense of community. Social applications of gamification, such as collaborative games and peer competition, can reduce feelings of isolation and promote collective responsibility for health (8). These features are especially critical in preventive education, where individual behaviors often affect community outcomes. As such, gamification not only fosters personal change but also strengthens the social fabric that underpins public health.

In summary, a growing body of research underscores gamification as a dynamic, evidence-based approach to modern health education. It integrates motivational science, behavioral change theory, and digital innovation to transform how individuals and communities learn and adopt preventive health practices. However, effective application requires a robust conceptual framework that considers causal drivers, contextual influences, and actionable strategies for implementation (Corbin, 2015 #289085; Deterding, 2011 #289086). The present study builds on this body of work by developing and validating a comprehensive, culturally adapted gamification model for preventive health education.

Methods and Materials

This study, aimed at developing and testing a comprehensive model, employed an exploratory sequential mixed-methods design. In this design, the phenomenon of interest is first deeply explored through a qualitative phase to construct a conceptual model and is subsequently tested in the quantitative phase using survey data (Corbin & Strauss, 2014).

The choice of a mixed-methods approach was grounded in the philosophy of pragmatism. This philosophy, with its practical and reality-oriented nature, allows the researcher to integrate the strengths of qualitative and quantitative methods to achieve a more comprehensive understanding of the research problem. In the qualitative phase, the research philosophy was based on the interpretivist paradigm to deeply explore the mental frameworks and lived experiences of experts regarding gamification and disease prevention education. In the quantitative phase, the research philosophy relied on the positivist paradigm to test hypotheses and the conceptual model using objective and statistical data. This combination provides the opportunity to simultaneously explore, describe, and test relationships, which is essential for achieving the study's objectives (designing an applicable model and evaluating its effectiveness). Ethical considerations were observed in all stages, including obtaining informed consent from participants and maintaining data confidentiality.

In the qualitative phase, validity and reliability criteria were addressed according to the grounded theory approach, specifically the Corbin and Strauss (2014) methodology. The main criterion for evaluating the credibility of qualitative findings was trustworthiness, achieved through constant comparative analysis, precise coding, prolonged engagement in the field (where possible), and expert review (when necessary). Additionally, theoretical sampling and continuous data review contributed to conceptual richness and validity of the findings.

In the quantitative phase, the validity and reliability of data collection instruments (questionnaires) were assessed through content validity, construct validity (using confirmatory factor analysis), and reliability (by calculating Cronbach's alpha or other appropriate metrics). Data collection in this study utilized three main methods:

- **Library studies and document review (secondary data)**
- **In-depth semi-structured interviews (primary qualitative data)**
- **Questionnaires (primary quantitative data)**

Library studies and document review: At the beginning of the research and throughout the qualitative phase, extensive use was made of existing academic resources, including books, scientific articles (Persian and English), theses, reports, and documents related to gamification, health education, disease prevention, and associated theories (such as grounded theory). These studies supported the development of the theoretical framework, identification of initial concepts, and the design of the interview protocol.

In-depth semi-structured interviews: In the qualitative phase, semi-structured interviews were conducted with 22 experts (managers of companies active in gamification, academic faculty members in related fields, and health professionals). These interviews, each lasting between 30 and 40 minutes, aimed to identify concepts, categories, and key components related to the research topic. All interviews were audio-recorded using digital devices and transcribed for analysis.

Qualitative Stage: Model Development

Data collection: In this stage, purposive sampling was used to select 22 experts. These experts included managers of companies involved in gamification, university faculty members specializing in health and technology, and professionals from public health and disease prevention departments. The selection criterion was having relevant knowledge and practical experience related to the research subject. Data were collected through in-depth semi-structured interviews. The interview questions focused on the nature of gamification in health education, the reasons for its necessity, enabling contexts and barriers, effective strategies, and expected outcomes. Interviews continued until theoretical saturation was reached (when no new information emerged from additional interviews).

Data analysis: The data from interviews were analyzed using the grounded theory approach of Strauss and Corbin (2008) in three coding stages:

1. **Open coding:** The interview transcripts were thoroughly examined, and initial concepts or “codes” were extracted. At this stage, 462 open codes were identified.
2. **Axial coding:** Similar codes were grouped into broader conceptual categories known as “concepts.” In this step, 99 concepts were developed. These concepts were then logically organized into more abstract categories called “themes,” leading to the formation of 22 main categories.
3. **Selective coding:** In the final step, the categories were integrated into a coherent paradigmatic model. This model consisted of six main dimensions: causal conditions, core phenomenon, contextual conditions, intervening conditions, strategies (actions/reactions), and consequences.

Quantitative Stage: Model Testing

Instrument and sample: Based on the categories and concepts extracted in the qualitative phase, a researcher-made questionnaire with 22 items was developed. These items measured various dimensions of the model (causal, contextual, intervening conditions, strategies, and outcomes) using a five-point Likert scale. The content validity of the questionnaire was confirmed by 10 academic experts and practitioners. Reliability was evaluated using Cronbach’s alpha ($\alpha = 0.905$) on a pilot sample of 30 participants, indicating excellent reliability. The final questionnaire was distributed among a sample of 209 general practitioners and specialists in Shiraz, selected through cluster random sampling.

Data analysis: The collected data were analyzed using AMOS version 24 and Structural Equation Modeling (SEM). First, the fit of the measurement models for each latent variable was examined, and then the overall structural model was tested to evaluate the hypotheses.

Findings and Results

The model extracted from the qualitative data illustrates the complex interaction among various factors in implementing gamification (Figure 1 — Qualitative Research Model).

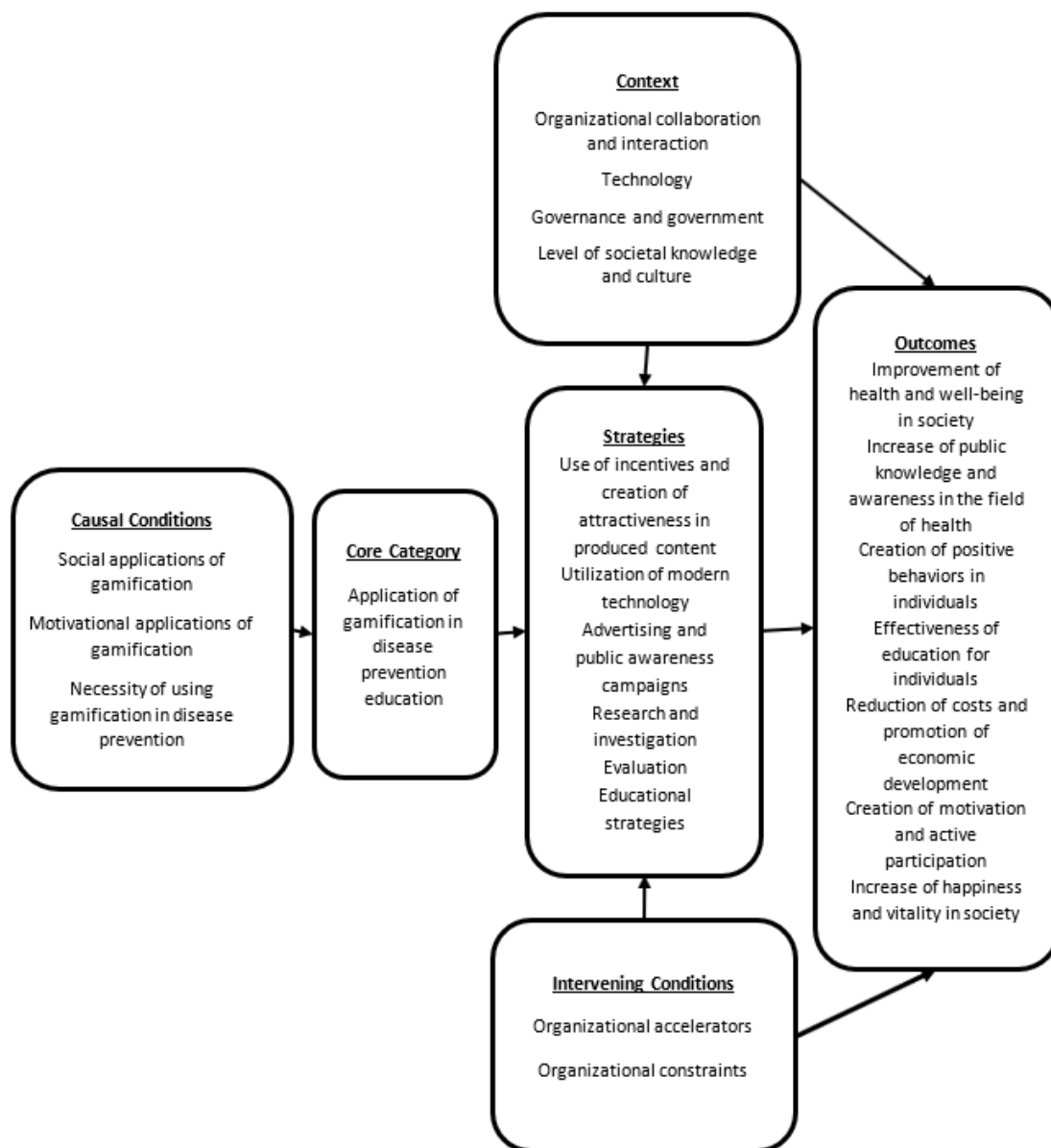


Figure 1. Qualitative Research Model on Developing an Applied Gamification Model for Disease Prevention Education

Core Phenomenon: The “application of gamification in disease prevention education” was identified as the central axis of the model.

Causal Conditions: Factors that create the necessity and motivation to adopt gamification. This section included three main categories:

- *Social applications* (such as fostering interaction and reducing vulnerability)
- *Motivational applications* (such as increasing engagement and attractiveness)
- *Necessity of use* (such as the need to establish healthy habits and address future health risks)

Contextual Conditions: The environment and setting in which the phenomenon occurs. These conditions included organizational collaboration and interaction, technology, governance and government support, and the level of societal knowledge and culture.

Intervening Conditions: Factors that either facilitate or limit the implementation of strategies. This section was divided into two subcategories:

- *Organizational accelerators* (such as managerial support and incentive policies)
- *Organizational constraints* (such as limited budgets and resistance to change)

Strategies: Actions and measures taken to manage the core phenomenon. Key strategies included utilizing incentives and creating engaging content, employing modern technology, conducting advertising and public awareness campaigns, continuous research and evaluation, and developing educational strategies.

Outcomes: The results and outputs arising from implementing the strategies. These outcomes included improving community health and well-being, increasing public knowledge and awareness, fostering positive behaviors among individuals, reducing healthcare costs, and enhancing happiness and vitality in society.

Quantitative Findings: Results of the Structural Model Testing

Data analysis demonstrated that the overall research model had a satisfactory fit with the collected data. The model fit indices were as follows: Chi-square to degrees of freedom ratio (CMIN/DF) = 2.888, Comparative Fit Index (CFI) = 0.935, Tucker–Lewis Index (TLI) = 0.995, and Root Mean Square Error of Approximation (RMSEA) = 0.071. All these values fall within acceptable ranges, indicating that the theoretical research model adequately explains the relationships among the variables in the statistical population.

The results of hypothesis testing, presented in Table 1, revealed significant relationships among the different dimensions of the model.

Table 1. Path Analysis and Hypothesis Testing Results

Hypothesis	Path	Standardized Coefficient (β)	t-value	Significance Level (P)	Result
First	Causal Conditions → Gamification	0.773	10.605	***	Supported
Second	Contextual Conditions → Strategies/Interactions	0.140	11.060	***	Supported
Third	Intervening Conditions → Strategies/Interactions	0.361	11.287	***	Supported
Fourth	Gamification → Strategies/Interactions	0.893	10.761	***	Supported
Fifth	Strategies/Interactions → Outcomes	0.897	10.761	***	Supported

(*** indicates significance at $p < 0.001$)

As the results show, all research hypotheses were supported. The first hypothesis indicates that social and motivational applications (causal conditions) have a very strong and positive impact on the acceptance and willingness to use gamification ($\beta = 0.773$). This finding fully aligns with the initial theoretical assumptions emphasizing the importance of these applications.

The fourth hypothesis — one of the main focal points of the research — demonstrated that the core concept of “gamification” is the strongest predictor for implementing effective “strategies and interactions” ($\beta = 0.893$). This means that a proper understanding and systematic implementation of gamification elements directly lead to the successful execution of strategies.

Finally, the fifth hypothesis showed that the implementation of these strategies has a very significant effect on achieving positive “outcomes,” such as behavior change and improved health ($\beta = 0.897$). Collectively, these findings provide empirical validation for the conceptual model of the study.

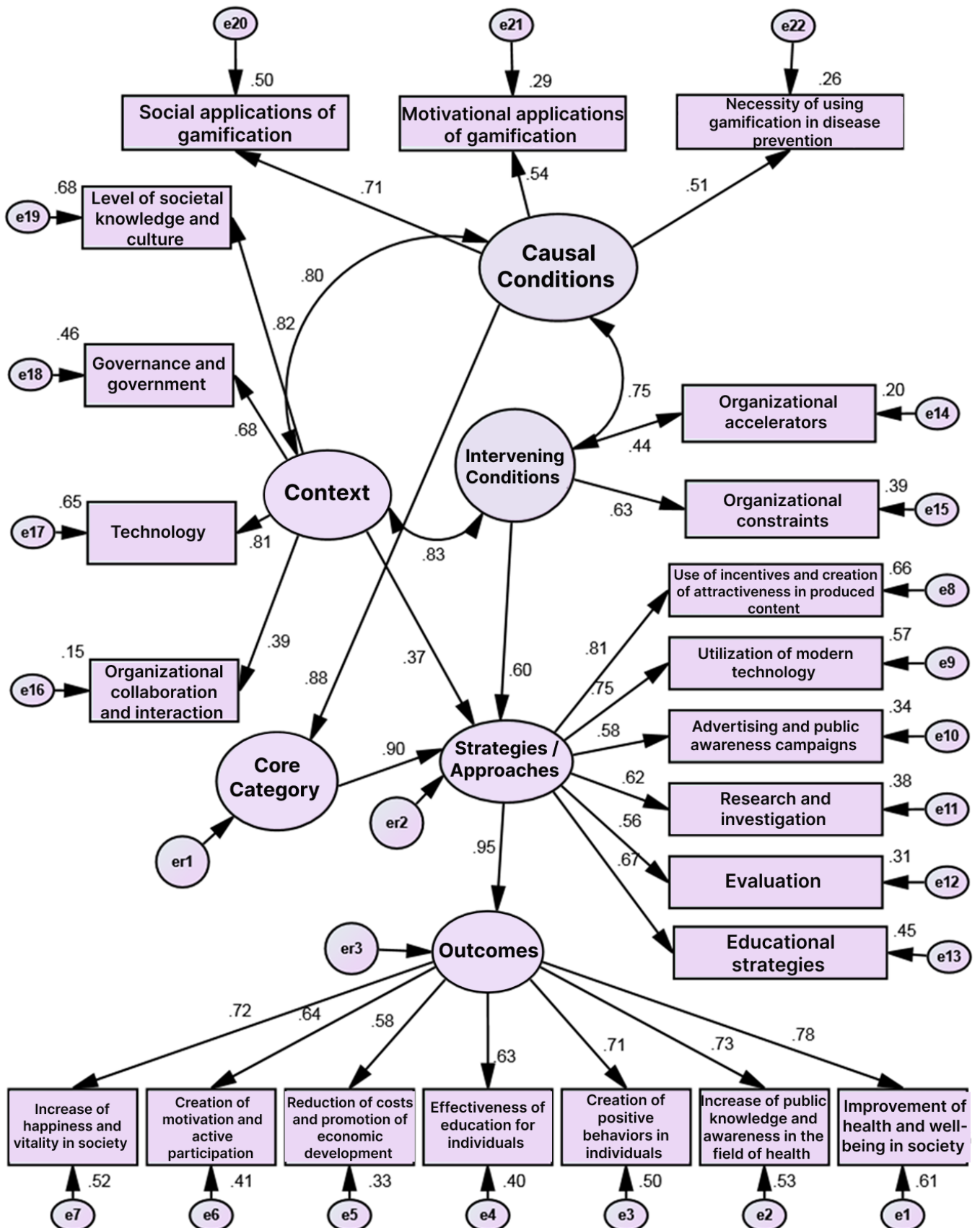


Figure 2. Structural Equation Modeling (SEM) of the Applied Gamification Model for Disease Prevention Education

Discussion and Conclusion

The findings of this study provide robust empirical support for the conceptual model of gamification in preventive health education developed through an exploratory sequential mixed-methods approach. The structural model achieved excellent fit indices (CMIN/DF = 2.888, CFI = 0.935, TLI = 0.995, RMSEA = 0.071), confirming the internal coherence of the theoretical framework. All five hypothesized relationships were statistically significant, demonstrating that the identified causal, contextual, and intervening conditions collectively influence the implementation of gamification strategies and ultimately drive positive health outcomes. These results offer valuable insights for both scholars and practitioners seeking to leverage gamification to promote preventive behaviors in health education.

A major contribution of this study lies in confirming the centrality of causal conditions—particularly the *motivational and social applications of gamification*—in shaping the willingness to adopt gamification for health-related purposes ($\beta = 0.773$). This finding aligns with research showing that gamification's ability to create engaging, socially interactive experiences fosters a strong initial desire to participate in health education initiatives (1, 8). Motivation has long been recognized as a determinant of learning effectiveness, and the present results reinforce that both intrinsic factors, such as autonomy and meaningful engagement, and extrinsic incentives, such as points and rewards, play a complementary role (9). Studies in digital education environments have shown similar patterns, where gamification increases learners' willingness to engage and improves persistence in knowledge acquisition (6). The significant effect of these motivational triggers in this study further validates the theoretical underpinnings of gamification as proposed in motivational frameworks (17).

The contextual conditions also emerged as important but more moderate predictors of strategic adoption ($\beta = 0.140$). The influence of cultural and organizational environments on gamification has been highlighted in prior literature, suggesting that technological readiness, governance structures, and the level of societal health literacy can either enable or constrain gamification-based interventions (15, 16). In the present study, contextual elements such as inter-organizational collaboration, digital infrastructure, and supportive health policies contributed positively to shaping implementation strategies. This is consistent with findings in primary and secondary education settings, where adequate digital tools and organizational support have been shown to be prerequisites for effective gamification (15). Additionally, the role of governance and public sector leadership reinforces Johnson's observation that gamification initiatives in health and wellness benefit from systemic support and institutional alignment (2, 3).

The results also underscore the dual role of intervening conditions—both accelerators and constraints—in either enabling or hindering strategic execution ($\beta = 0.361$). Organizational support from leadership and the presence of incentive policies were found to strengthen the implementation of gamified strategies, while financial limitations and resistance to change acted as barriers. These findings mirror earlier work suggesting that top management commitment and policy-driven reinforcement can significantly increase the success rate of gamified learning systems (6, 13). At the same time, the identification of barriers echoes concerns raised in previous studies about the challenges of sustaining gamified interventions in environments with scarce resources and low digital maturity (16, 18). Addressing these intervening conditions is therefore critical to ensure scalability and sustainability.

One of the most striking findings is the strong predictive effect of the core gamification construct on strategy development ($\beta = 0.893$). This suggests that when the principles of gamification are well-understood and appropriately integrated—such as aligning game mechanics with learning objectives, ensuring meaningful rewards, and fostering healthy competition—they directly inform the design of effective educational strategies. This outcome aligns with previous reviews showing that clarity and depth in gamification design are critical success factors (1, 2). Studies on virtual classrooms have similarly demonstrated that well-structured gamification frameworks can increase motivation and academic performance (11, 12), while research on health-focused applications confirms that clear and purposeful gamification principles produce greater user retention and behavior change (4).

The final pathway from strategies to outcomes proved to be both powerful and statistically robust ($\beta = 0.897$), confirming that thoughtfully implemented gamification strategies—such as the use of incentives, technology-driven content, and continuous evaluation—translate directly into meaningful preventive health outcomes. These outcomes include increased public health awareness, adoption of positive behaviors, reduced healthcare costs, and improved community well-being. Prior studies in gamified health interventions have reported comparable results, noting improvements in exercise adherence (10), engagement with wellness programs (2), and general health literacy (4). In educational contexts, gamification has been linked to increased learning effectiveness and knowledge retention, which are essential precursors to behavior change (6, 14). This study adds to that evidence by empirically confirming the direct relationship between strategy implementation and broad preventive health outcomes in a public health education context.

Moreover, the results affirm the conceptual integration of motivation-based and technology-enabled approaches. The interplay of motivational interviewing concepts (17) with gamified strategies illustrates that combining psychological principles with game-based mechanics enhances health education impact. This integration also resonates with meta-analytic findings indicating that while gamification significantly improves intrinsic motivation and relatedness, further refinement is needed to enhance competence development (9). The present study addresses this gap by demonstrating that a well-designed gamification model not only motivates but also supports measurable behavioral change.

The study's use of grounded theory (19) followed by quantitative validation reflects a growing methodological maturity in gamification research. Similar mixed-method frameworks have been recommended to ensure that gamification models are contextually appropriate and empirically sound (16, 18). The rigorous development and testing of the model presented here reinforce the importance of moving beyond generic frameworks toward culturally and organizationally tailored solutions. Particularly in health education, where cultural beliefs and systemic structures shape prevention behaviors, such contextual adaptation is essential (14).

Finally, this research aligns with the global shift toward digital transformation in health and education management. As digital tools become increasingly integrated into both learning and organizational practice, gamification emerges as a bridge between technology and human-centered engagement (5). In the future of work and learning, such integrative approaches will likely play a key role in preparing communities and organizations for ongoing health challenges and fostering proactive prevention (10).

Despite its contributions, this study has several limitations. First, although the mixed-methods design enhances the robustness of the findings, the quantitative phase was limited to a specific sample of health professionals in Shiraz, Iran. Cultural, organizational, and technological conditions may differ in other regions, which could influence the applicability of the model across diverse contexts. Second, self-reported data in both the qualitative interviews and survey responses may be subject to social desirability bias, potentially inflating the perceived effectiveness of gamification strategies. Third, while the structural model demonstrated excellent fit, the cross-sectional design restricts the ability to make causal inferences about long-term behavioral changes resulting from gamification-based education. A longitudinal approach would strengthen the evidence for sustained preventive behaviors over time. Finally, the study focused primarily on health professionals and did not include perspectives from patients or the general public, limiting insight into end-user experiences and acceptability.

Future research should consider expanding the scope of sampling to include diverse cultural and organizational contexts, enabling comparative studies that refine and generalize the proposed gamification model. Longitudinal studies are particularly needed to examine how gamification influences not only short-term motivation and knowledge acquisition but also long-term behavior maintenance and health outcomes. Researchers could also explore the integration of adaptive gamification technologies, such as artificial intelligence-driven personalization, to tailor preventive health education to individual users' needs and learning styles. Additionally, cross-disciplinary studies incorporating behavioral psychology, design science, and health informatics could further advance understanding of how game mechanics can be optimized to influence deep-seated attitudes and habits. Investigating the potential unintended effects of gamification, such as competition-induced stress or disengagement among low performers, would also contribute to safer and more inclusive design practices.

For practitioners and policymakers, the validated model offers a structured framework to design and implement gamification-based preventive health programs. Organizations should begin by assessing contextual readiness, including technological infrastructure and organizational support, before introducing gamified elements. Effective strategies include combining extrinsic rewards with meaningful intrinsic motivators, fostering social interaction to build community support, and employing continuous evaluation mechanisms to refine and adapt interventions. Collaboration between educational technologists, health educators, and policy leaders is essential to ensure scalability and sustainability. Additionally, health authorities can leverage gamification to complement traditional campaigns, integrating digital tools, storytelling, and interactive challenges to engage communities and reduce long-term healthcare costs. By aligning program design with cultural and organizational realities, practitioners can maximize the motivational and behavioral impact of gamification in preventive health education.

Acknowledgments

The authors express their deep gratitude to all participants who contributed to this study.

Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

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