

PAPER

Exploring Common Game Elements in Serious Game Interventions for Health and Obesity Awareness in Children: A Systematic Review

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ABSTRACT

Obesity is a growing health challenge. Serious game interventions can increase awareness of health and obesity, especially among children, and the effectiveness of these interventions depends on specific game elements. This review aimed to identify the most common game elements in serious game interventions for raising awareness about obesity in children. We conducted a literature search in the ACM digital library, IEEE Xplore, and Scopus databases for serious games designed and developed for obesity or health awareness. The extracted game elements are based on a pyramid with three categories: components, mechanics, and dynamics, according to Werbach and Hunter (2012). Each dimension, or category, consisted of various game elements. 1349 articles were identified. We found 27 game elements distributed across the 17 selected studies. The most common game elements were 'Points,' 'Quests,' 'Challenges,' 'Feedbacks,' 'Constraints,' 'Progression,' 'Avatar,' 'Win States,' 'Achievement,' and 'Rewards.' Serious game interventions for health promotion in children include multiple game elements that are crucial in designing and developing a game. The inclusion of these game elements depends on the learning outcomes and the purpose of the game.

KEYWORDS

serious game, game elements, gamification, obesity awareness, health awareness, children

1 INTRODUCTION

Serious games provide both educational learning and entertainment, with education as the primary objective [1]. The purpose of serious games is twofold: (i) enjoyment and entertainment, and (ii) education [2]. As much as a serious game needs to have interesting and fun features, learning should be the primary goal. Therefore, sharing information about engaging and entertaining game features is crucial. Engaging in learning through playing games allows players to acquire valuable cognitive knowledge. A study

Mohd Bazid, N.I., Ahmad, S., Diah, N.M., Buhari, S.S. (2024). Exploring Common Game Elements in Serious Game Interventions for Health and Obesity Awareness in Children: A Systematic Review. *International Journal of Emerging Technologies in Learning (iJET)*, 19(4), pp. 17–32. <https://doi.org/10.3991/ijet.v19i04.48005>

Article submitted 2024-01-16. Revision uploaded 2024-02-21. Final acceptance 2024-02-21.

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by Wouters et al. [3] suggested that serious games can effectively enhance knowledge acquisition and cognitive skills and potentially improve fine motor skills and behavior change. Serious games have demonstrated significant benefits for end users. Many gaming applications offer users opportunities to enhance their self-awareness skills. For instance, [4] implemented a serious game to raise awareness of flooding issues. The researchers found that implementing serious games has the potential to increase awareness among the population. Furthermore, children play games more frequently on various platforms. Children are the target audience because they are “digital natives.” Digital natives are individuals who are familiar with current technology [5]. According to Belghali et al. [6], children are able to comprehend, execute, and enjoy all aspects of serious gaming. Serious games can benefit children by promoting awareness of health and obesity through knowledge acquisition and enjoyable learning experiences.

In designing and developing a serious game, the inclusion of game elements is essential for a successful game deployment. Game elements were present in the majority of the games. They are associated with games and play a crucial role in gameplay [7]. According to Ferro [8], game elements are referred to as components or parts. Game elements can significantly influence people’s perceptions of cognitive activity in the game, including affective experience, motivational conflict, and subjective effort. People can be motivated to stay engaged in cognitive pursuits by integrating game elements, which can assist them in attaining greater rewards in the future [9]. According to Souza et al. [10], there is a lack of standardized definitions and terminology for game elements. For example, ‘quest’ has the same meaning as ‘goals’, whereas ‘constraints’ can be referred to as ‘rules. The authors noted that the lack of standardization in naming game elements hinders the consolidation of results in any research related to the evaluation of game elements. Despite this, various authors have proposed various taxonomies and approaches to game elements, such as Hunicke et al. [11], King et al. [12], Werbach & Hunter [13], and Deterding et al. [7]. Each taxonomy consists of different components or elements, although most attributes are similar to each other.

Hunicke et al. [11] proposed a taxonomy based on the mechanics, dynamics, and aesthetics (MDA) model. The MDA model is a framework commonly used in game design that is derived from various components of a game. In addition, King et al. [12] developed a comprehensive taxonomy of structural characteristics in video games. The taxonomy comprises five overarching structural features: social features, manipulation and control features, narrative and identity features, reward and punishment features, and presentation features. These five features are then divided into 24 different sub-features. The authors claimed that this taxonomy has the potential to influence video game playing behavior. Furthermore, Deterding et al. [7] proposed a framework that emphasizes the integration of game elements to enhance user engagement, motivation, and overall experience. This framework focuses on the concept of gamification and its application in non-game contexts. It is applicable to systems or tools that implement gamification strategies, rather than being solely intended for use in gaming applications. Next, Werbach and Hunter [13] presented a framework for creating effective gamification strategies that consists of three categories: components, mechanics, and dynamics. Each category has its own unique elements and meanings. For example, components include tangible elements such as points, rewards, and levels, while mechanics encompass elements that integrate with the gameplay experience, such as rules, win states, and challenges. The dynamics result from the integration of tangible elements in the game components and game mechanics from the gameplay experience, leading to emergent behaviors and experiences. Although each taxonomy had its own unique elements and functions, all of the taxonomies proved to be equally effective in implementing gamification strategies for the development of serious game interventions.

The purpose of this systematic review was to discuss the evaluation of game elements in serious game interventions aimed at promoting awareness of obesity and health. Thus, we conducted a systematic review to investigate the most common game elements in serious games designed to promote awareness about obesity and health. The remainder of this paper is organized as follows: Section 2 describes the materials and methods used in the systematic review. Section 3 presents the results of this study. Section 4 discusses the results of this study. Section 5 discusses the limitations of the study, while Section 6 concludes the paper.

2 MATERIALS AND METHODS

This systematic review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [14].

2.1 Search strategy

A systematic search was conducted using three databases: the ACM Digital Library, IEEE Xplore, and Scopus. This study focuses on the last 10 years, from 2013 to 2023. We filtered relevant published studies to identify articles or interventions related to serious games, obesity, and health awareness. The following are the keywords used: (“serious game” OR “game” OR “gamification” OR “awareness game” OR “gamified” OR “game element*” OR “game design”) AND (“obesity” OR “obesity awareness”). The search yielded 1349 articles.

2.2 Inclusion and exclusion criteria

This study reviewed the literature for articles related to the design and development of serious games for promoting obesity or health awareness in children. The articles retrieved primarily focused on using serious game interventions to promote obesity and health awareness among children, involving them as either users or participants. After a thorough search of the mentioned databases, only 17 articles met the eligibility criteria based on the inclusion and exclusion criteria. The inclusion criteria consisted of the following: (a) serious games; (b) interventions targeting obesity or health awareness; (c) targeting children as end users or participants; (d) availability of the full text; and (e) articles in the English language. The exclusion criteria were as follows: (a) gamification strategy implemented in a system or application; (b) game intervention as a small component of a larger intervention; (c) systematic review paper; (d) workshop paper, or short paper; and (e) preliminary paper.

2.3 Study selection

The study’s selection process was conducted in three phases. Duplicates were removed from the articles retrieved from the databases. Subsequently, the titles and abstracts were screened based on the inclusion and exclusion criteria. Irrelevant articles were excluded from the analysis. Next, the full-text articles were evaluated, and their contents were further aligned with the criteria for this review. The aforementioned process was performed twice for each phase to eliminate duplicates and irrelevant papers. The authors were contacted and requested to provide available

full-text papers when the papers could not be retrieved during the initial search. Out of the 1349 articles initially retrieved, only 17 were selected during the screening process. Figure 1 depicts a flowchart of the study selection and identification.

2.4 Data extraction and synthesis

17 articles met our inclusion criteria. These articles were analyzed to determine the most common game elements in serious game interventions, particularly in promoting awareness about obesity and health. Few studies have examined the taxonomy and classification of game elements, such as those by Hunicke et al. [11], King et al. [12], Werbach and Hunter [13], and Deterding et al. [7]. However, we found that the study by Werbach and Hunter [13] was the most relevant for implementation in this review. The authors conducted a study that utilized a strategy of classifying game elements into three categories: (1) components, (2) mechanics, and (3) dynamics. Each category consisted of different game elements. Elements were extracted from the 17 articles selected for review, and 27 game elements were identified. A list of the selected studies is presented in Table 1. The extracted information presented in the table below provides further details about each of the selected studies. Further analysis based on charts and tables is also presented in the Results section to offer additional insights and interpretations of the findings within the context of serious games and obesity awareness.

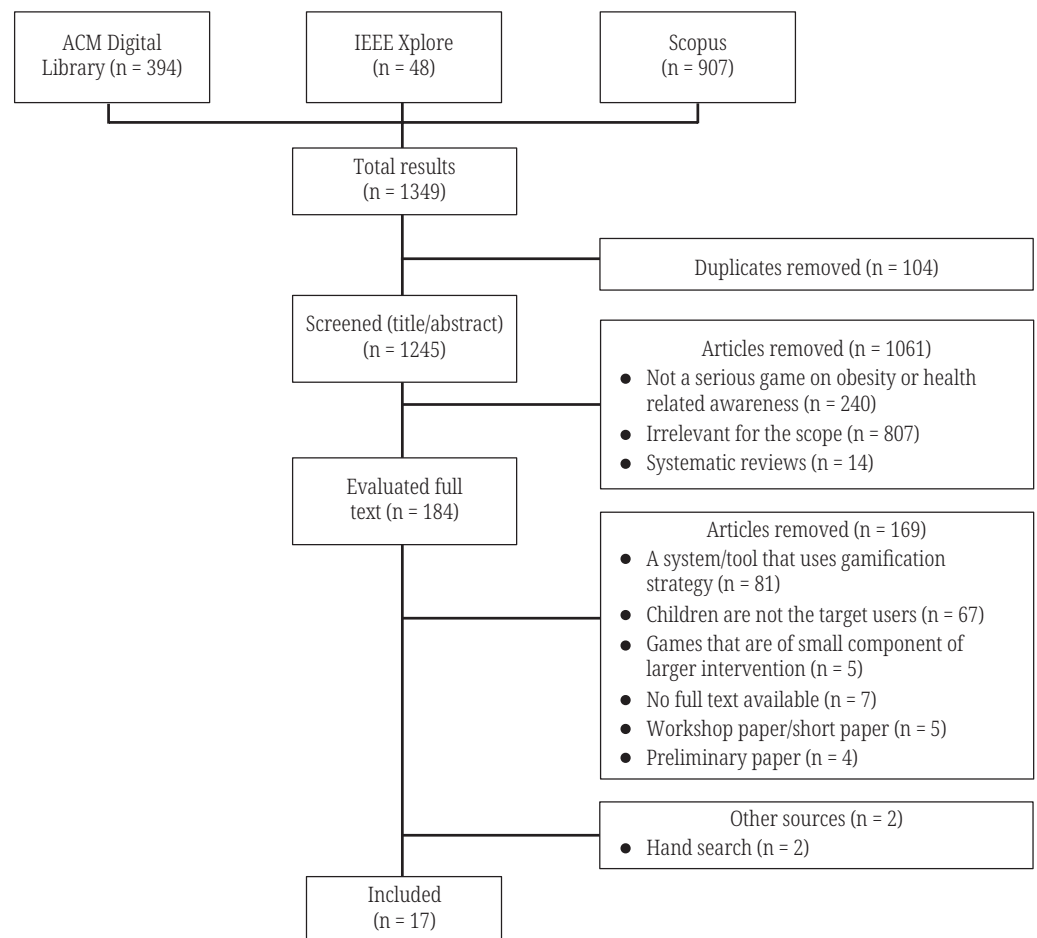


Fig. 1. Studies selection and identification flowchart

Table 1. The list of selected studies

References	Year	Game Title	Focus of Awareness
(Robles et al., 2020) [15]	2020	Run Boy Go!	Nutrition and physical activity
(Michael et al., 2018) [16]	2018	NutritionBuddy	Nutrition
(Gonçalves et al., 2020) [17]	2020	Barty	Nutrition
(Saad et al., 2018) [18]	2018	GrowHealthy	Nutrition and physical activity
(Kim et al., 2014) [19]	2014	Calory Battle AR	Physical activity
(Lindberg et al., 2016) [20]	2016	Running Othello 2 (RO2)	Physical activity
(Fadhil & Villafiorita, 2017) [21]	2017	CiboPoli	Nutrition
(Saksono et al., 2015) [22]	2015	Spaceship Launch	Physical activity
(Ma et al., 2020) [23]	2020	FitBirds	Physical activity
(Mohamed Alnaqbi et al., 2020) [24]	2021	ObeseGo	Nutrition and physical activity
(Espinosa-Curiel et al., 2020) [25]	2020	FoodRateMaster	Nutrition and physical activity
(Wang et al., 2020) [26]	2020	Exer-Learning Playground Game	Physical activity
(Dias et al., 2016) [27]	2016	DigesTower	Nutrition and physical activity
(Garde et al., 2015) [28]	2015	MobileKids Monster Manor	Physical activity
(Al-Qurishi et al., 2014) [29]	2014	StarsRace	Physical activity
(Mayr et al., 2016) [30]	2016	Aquamorra	Nutrition and physical activity
(Majumdar et al., 2013) [31]	2013	Creature-101	Nutrition and physical activity

3 RESULTS

This systematic review followed the PRISMA guidelines, as illustrated in the flow diagram (see Figure 1). The search process involved retrieving 1349 articles related to serious game interventions for obesity and health awareness in children. Seventeen studies (refer to Table 1) were considered eligible for inclusion in identifying the most common game elements of serious games that promote awareness of obesity and health.

3.1 Study inclusion

The PRISMA flow diagram in Figure 1 shows that the databases yielded a total of 1349 results. A total of 104 duplicates were removed during the first phase, followed by the next phase. This was where articles were screened based on their titles and abstracts. We excluded 1061 articles during this screening, primarily because they were irrelevant to the scope and were not considered serious games related to obesity or health awareness. Systematic reviews were excluded in this phase. Next, we evaluated the full text of the remaining articles. Hereafter, we excluded 169 articles primarily because, upon reading the full text, the studies were deemed to focus on a system, application, or tool that utilizes gamification strategies rather than serious game intervention. In addition, other reasons include that children are not the target users, games are a small component of a larger intervention, full text is not available, it is a workshop or short paper, and it is a preliminary paper. Finally, two hand searches were performed, resulting in the inclusion of 17 studies.

Table 2. Game elements categorization taxonomy based on Werbach and Hunter [13]

Studies	Categories	Components												Mechanics						Dynamics				Total								
		Achievement	Avatar	Boss Fights	Collections	Content Unlocking	Gifting	Leaderboards	Levels	Points	Quests	Social Graph	Teams	Virtual Goods	Challenges	Chance	Competition	Cooperation	Feedbacks	Resource Acquisition	Rewards	Transactions	Win States		Emotions	Constraints	Narrative	Progression	Relationship			
(Robles et al., 2020) [15]	Game Elements	✓	✓					✓	✓	✓			✓			✓			✓	✓		✓		✓								15
(Michael et al., 2018) [16]	Game Elements	✓	✓			✓			✓										✓	✓				✓							15	
(Gonçalves et al., 2020) [17]	Game Elements	✓	✓						✓										✓	✓				✓							9	
(Saad et al., 2018) [18]	Game Elements	✓	✓						✓										✓	✓				✓							15	
(Kim et al., 2014) [19]	Game Elements	✓	✓						✓										✓	✓				✓							10	
(Lindberg et al., 2016) [20]	Game Elements	✓	✓						✓										✓	✓				✓							11	
(Fadhil & Villafiorita, 2017) [21]	Game Elements	✓	✓						✓										✓	✓				✓							18	
(Saksono et al., 2015) [22]	Game Elements	✓	✓						✓										✓	✓				✓							13	
(Ma et al., 2020) [23]	Game Elements		✓																✓	✓				✓							14	
(Mohamed Alnaqbi et al., 2020) [24]	Game Elements		✓																✓	✓				✓							13	
(Espinosa-Curiel et al., 2020) [25]	Game Elements	✓	✓						✓										✓	✓				✓							16	
(Wang et al., 2020) [26]	Game Elements																		✓	✓				✓							13	
(Dias et al., 2016) [27]	Game Elements	✓	✓																✓	✓				✓							13	
(Garde et al., 2015) [28]	Game Elements	✓	✓																✓	✓				✓							18	
(Al-Qurishi et al., 2014) [29]	Game Elements																		✓	✓				✓							8	
(Mayr et al., 2016) [30]	Game Elements		✓																✓	✓				✓							14	
(Majumdar et al., 2013) [31]	Game Elements	✓	✓																✓	✓				✓							15	
Total per game element		12	13	1	3	4	1	6	11	16	16	3	5	2	2	7	9	15	11	12	2	13	10	15	9	15	2				86	
Total per category																																51

3.2 Intervention characteristics

Table 1 presents the list of selected studies, and Table 2 categorizes the game elements based on Werbach and Hunter's [13] taxonomy of the selected studies. All studies were conducted in English and were published between 2013 and 2023. All 17 studies focused on serious game interventions aimed at promoting a healthy lifestyle for children. Furthermore, these studies varied in terms of the focus on awareness in promoting health in obesity. In this review, 18% of the studies focused on nutrition awareness, while 41% targeted the encouragement of physical activity alone and awareness of both nutrition and physical activity in serious game intervention (see Figure 2). In this study, children are considered the target users. According to the World Health Organization (WHO) [32], a standard age group classification for children is under 19 years. Based on the Convention on the Rights of the Child (CRC), a child is defined as "every human being below the age of 18 years, unless, under the law applicable to the child, majority is attained earlier" [33]. Thus, the target end users of the intervention in most of these studies were aged between three and 14 years, with one study mentioning that their intervention could be used across all age ranges.

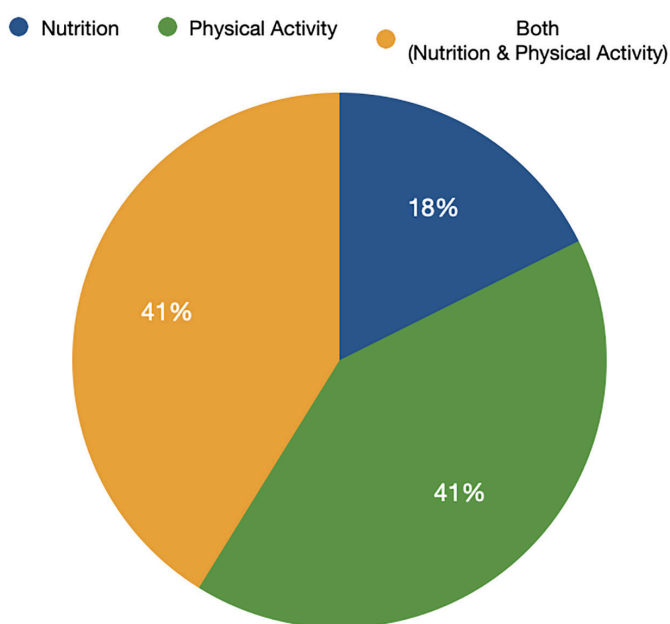


Fig. 2. Focus of awareness in serious game interventions

3.3 Intervention characteristics

In the 17 studies included in this review, all the serious games were considered unique. All games were digital games that involved various platforms, including augmented reality (AR), virtual reality (VR), and mobile applications. Most serious games are either 2D or 3D games, including platform games, board games and persuasive games. Most of these studies targeted children as the sole end users, and some serious games allow children to collaborate with their parents, guardians, tutors, and experts. Even though the targeted group is children, there are also serious games that target all age groups for intervention. Furthermore, some of the interventions

included single- and multiplayer modes and collaborative game involvement. The categories and characteristics were determined after reading the full version of the selected studies. The studies and game element categorizations are presented in Tables 1 and 2.

3.4 Game elements

In this review, we identified 27 game elements distributed among the 17 selected studies. These game elements are classified under the taxonomy of Werbach and Hunter [13], which consists of three categories: components, mechanics, and dynamics. The components layer represents the basic elements; the mechanics layer defines the rules and interactions; and the dynamic layer focuses on the emotional and social aspects of the game experience [13]. Table 2 presents the frequency of game elements from each of the selected studies, including the total number of game elements for each study, the total number per game element, and the total number of game elements per category included in this review. Under the components category, the most frequently included game elements were ‘Points’ (n = 16), ‘Quests’ (n = 16), ‘Avatar’ (n = 13), and ‘Achievement’ (n = 12) (see Figure 3). The least common game elements in this category are ‘Boss fights’ (n = 1) and ‘Virtual goods’ (n = 2). The total number of game elements mentioned in this category is 93.

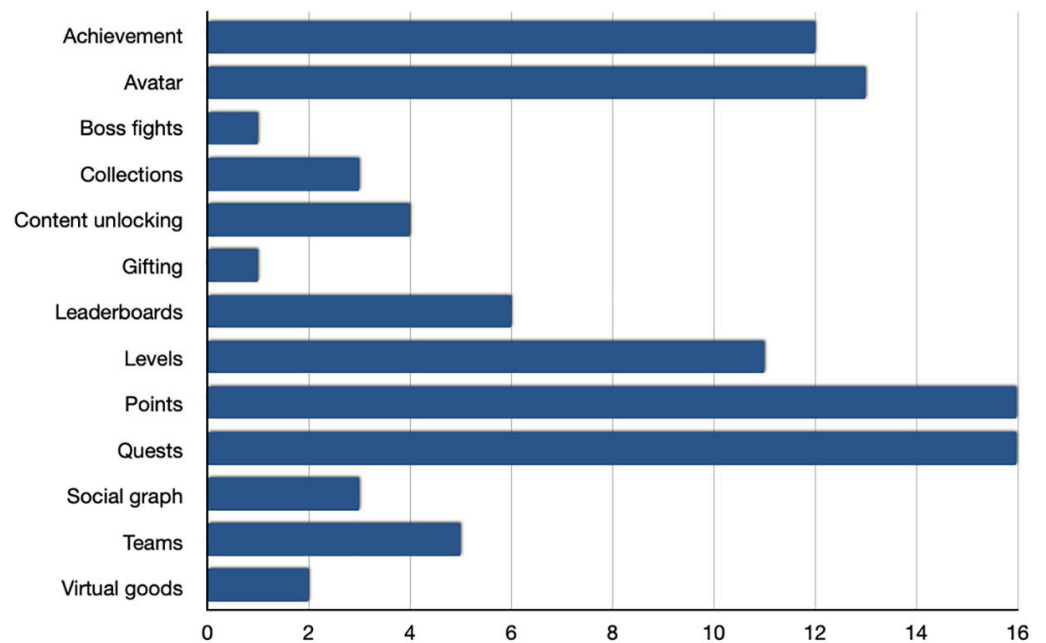


Fig. 3. Game elements in components category

Figure 4 shows the frequency of game elements in the mechanics category extracted from the taxonomy in reference [13]. It is shown that the most common game elements in this category are ‘Challenges’, ‘Feedbacks’ (n = 15), followed by ‘Win states’ (n = 13), ‘Rewards’ (n = 12), ‘Resource acquisition’ (n = 11), ‘Cooperation’ (n = 9), ‘Competition’ (n = 7), and the least common game elements extracted were ‘Chance’ and ‘Transactions’ (n = 2). The total number of game elements listed in this category is 86.

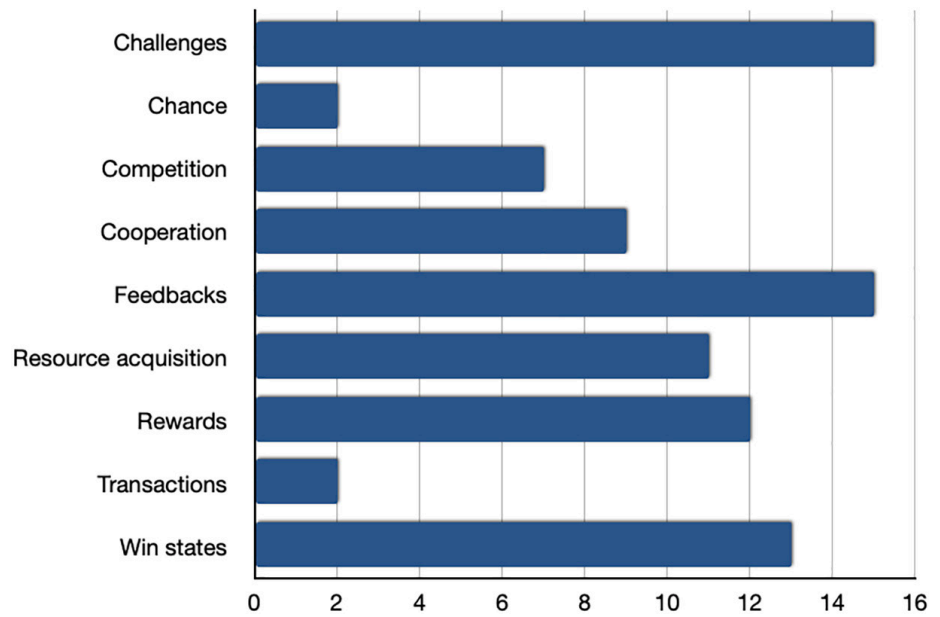


Fig. 4. Game elements in mechanics category

The dynamics category of this game taxonomy consists of five game elements that have been extracted from the selected studies. The most common game elements found were ‘Constraints’ and ‘Progression’ (n = 15), followed by ‘Emotions’ (n = 10), ‘Narrative’ (n = 9), and the least common one, ‘Relationship’ (n = 2) (see Figure 5). The number of game elements listed in this category is 51. In addition, out of the 17 studies selected for this review, two had the highest number of game elements included in a paper, with a total of 18 game elements extracted. The average number of game elements in each study was 13.

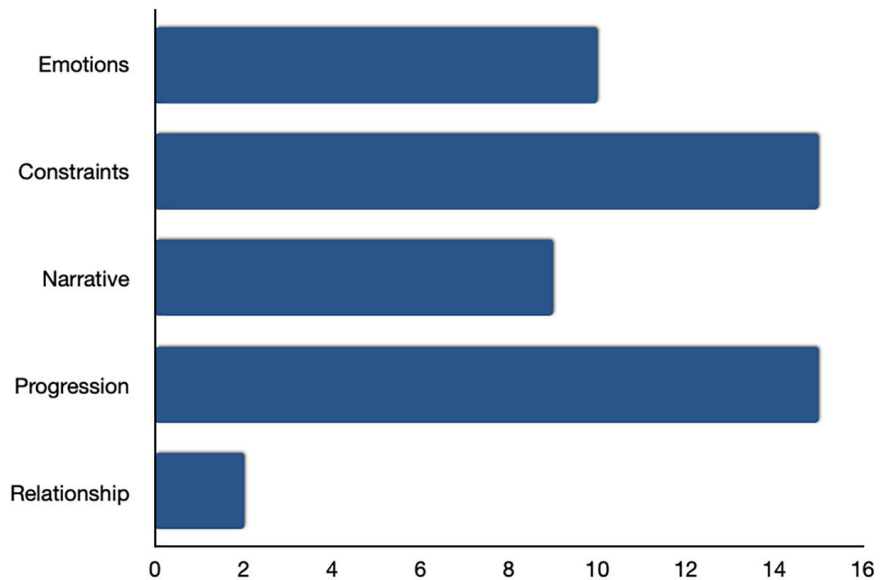


Fig. 5. Game elements in dynamics category

4 DISCUSSION

A range of studies have utilized serious games to promote health awareness across various fields, including education, medicine, and healthcare. The focus of this study was narrowed to identify relevant studies that specifically aimed to promote awareness about obesity. This systematic review aimed to gain insight into the most common game elements used in serious games to promote awareness of obesity and health.

4.1 Serious game interventions for obesity and health awareness

As per the WHO [32], the key components for weight loss are consuming healthy food and engaging in physical activity. This review found that serious game interventions focus on promoting different aspects of awareness, either by promoting healthy eating habits or encouraging physical activity. In this study, the interventions mainly focused on physical activity-related outcomes, and most authors used the term “exer-game” to promote awareness of physical health [18], [19], [20], [22]. Additionally, an equal number of interventions in this study implemented both methods to encourage good eating habits and physical activity. This suggests that promoting healthy lifestyle habits through these two methods, as recommended by [32], is essential in designing and developing serious game interventions. Although the focus on nutrition intake in the intervention is less common in this review, studies over the years have demonstrated a growing number of serious game interventions emphasizing the significance of consuming healthy foods and understanding food calories and nutritional information. Furthermore, this review reveals studies that promote collaborative gameplay involving either multiple players or the participation of parents, guardians, tutors, and experts to assist the main player. Corrigan et al. [34] emphasized the significance of collaborative learning strategies in serious games to enhance active involvement, engagement, and long-term retention of knowledge.

4.2 Game elements in serious game interventions

We analyzed the game elements most commonly used in serious game interventions aimed at promoting better health and raising awareness about obesity. Based on Tori et al. [35], game elements are the playful components embedded in a game that keep players motivated to play. In addition, integrating game elements can promote healthy competition among individuals, whether they are competing against each other or their own past performances [35]. Our findings revealed that ‘Points,’ ‘Quests,’ ‘Challenges,’ ‘Feedback,’ ‘Constraints,’ ‘Progression,’ ‘Avatar,’ ‘Win states,’ ‘Achievement,’ and ‘Rewards,’ were the most frequently included game elements. The aforementioned game elements align with the “10 ingredients of great games,” such as avatars, feedback, and constraints (time pressure) [36]. Werbach and Hunter [13] conducted an analysis of a significant number of game elements and their implementations. They found that a significant proportion of those involved in game elements were points, badges, and leaderboards for project-based learning (PBL), which later emerged from the PBL triad. In this study, “Points” was found to be the most common game element, which aligns with the PBL triad mentioned [13]. However, this is not the case for the elements ‘Badges’ and ‘Leaderboards,’ which do not even reach

a quarter of the percentage results of the selected studies in this review. This may be because they were not directly mentioned in the paper, as we extracted the game elements based on the articles' descriptions. It has been reported in a recent study on the identification of common game elements in health education [35] that the most frequently featured game elements were 'Tasks' (also referred to as 'Quests'), 'Score' (or 'Points'), and 'Level Progression' (also denoted as 'Progression'). These findings align with the top 10 most commonly included game elements outlined in this review. Furthermore, the majority of elements extracted from the review are interconnected and categorized differently. For instance, 'Points' and 'Achievement' extracted from the Components category are closely connected to 'Rewards' and 'Win States' under the Mechanics category. These elements are also closely related to "Progression" within the dynamic category. This makes sense because each category serves different purposes for various elements within the Werbach and Hunter [13] game taxonomy.

In the review, the least included game elements were 'Boss fights,' 'Gifting,' 'Chance,' 'Transactions,' and 'Relationships.' This could be attributed to various factors, such as directly extracting elements from the articles' descriptions and the game development not aligning with the learning objectives or goals of the intervention. A serious game's primary purpose is learning, and certain game elements may not be useful in achieving these objectives [37]. From the perspective of educators such as [38], serious games require a design framework that incorporates theories and game elements aligned with the intended learning outcomes to create an engaging game experience. Thus, game designers and developers have the option to consider including game elements that are relevant to the learning objectives of the designed game. This indicates the possibility of integrating these elements into serious games and enhancing their effectiveness in preventing obesity and health problems.

4.3 Components

Each element of serious game development contributes to a cohesive and coherent game experience for players. Based on the game elements extracted from the selected studies above, the most commonly used elements in serious game interventions were found to be 'Points,' 'Quests,' 'Avatar,' and 'Achievement,' as identified by Werbach and Hunter's [13] game taxonomy. Points serve as a scoring system in the game, motivating players, enhancing engagement, and helping to achieve desired outcomes or goals [39]. Quests are a fundamental aspect of gameplay that allow players to feel a sense of progression as they work towards achieving the game's objectives [40]. While both quests and goals serve the purpose of achieving tasks, objectives, or milestones in a game, they are similar in that they both aim to achieve the desired outcome. In addition, avatars represent the players in the game and convey the message or idea of the game concept [41]. In serious game interventions, the aforementioned represents the player's identification and the characteristics they wish to portray, although in reality, the player may not necessarily align with the avatar they have created. Furthermore, the player achievement system motivates players and drives them to accomplish their goals in the game. According to Grant and Betts [42], achievement is attained through the repeated completion of challenging tasks or goals, which eventually leads to game success. Thus, the implementation of specific game elements in serious game interventions is considered crucial, especially for promoting health and raising awareness about obesity among children.

4.4 Mechanics

The most included game elements in the mechanics category were ‘Challenges,’ ‘Feedback,’ ‘Win states,’ and ‘Rewards.’ Challenges present players with obstacles or tasks of varying difficulty to overcome and are commonly integrated into the game through level selection. However, incorporating the element of challenges into the game should be carefully balanced. The tasks given should not be too easy or too difficult to avoid demotivating players. Hence, achieving a balance in creating task difficulty is crucial to enabling players to fully immerse themselves in the game, develop the skill to think outside the box, and enhance knowledge acquisition [43]. In addition, integrating feedback into serious games enhances player engagement, encouraging them to continue playing. In particular, positive feedback can boost players’ confidence and encourage them to persist in challenging tasks [44]. However, negative feedback, such as penalization in serious games, should be minimized to prevent players from becoming frustrated and demotivated [45]. Moreover, winning states are considered in-game rewards, which include virtual badges, achievements, power-ups, and desirable objects [46]. The ability to win the game at the end of a level or the entire game provides rewards and positive reinforcement to the players. Additionally, incorporating rewards into a game promotes engagement and improves desired behavior change [47]. In a study conducted by Mulcahy et al. [48], a short-term game design that utilized game rewards encouraged players to continue playing the game. This ultimately resulted in repeated gameplay, reinforcement of learned information, and a strong desire to change behavior. It is essential to incorporate game elements that present challenges, offer feedback to enhance players’ gaming experience, and provide incentives and win conditions to boost their motivation to continue playing.

4.5 Dynamics

In the dynamics category, ‘Constraints’ and ‘Progression’ are two game elements commonly utilized in serious game interventions for health and obesity awareness. Constraints provide the structure, rules, and focus of gameplay. It provides boundaries and limitations within the game that guide players in achieving specific goals or tasks. Garris et al. [49] mentioned that the rules and constraints of a game constitute the goal structure of a game. Clear and well-defined rules are essential to facilitate learning. However, unclear and boring rules can hinder motivation to continue playing. Furthermore, progress in a game can be displayed in various ways, such as during gameplay, at the end of the game, or at specific levels. This information is beneficial not only to players but also to those involved in the game progression, such as therapists, parents, or educators [46]. Therefore, it is important to display a player’s progress and performance while simultaneously increasing the complexity or difficulty of the game as they improve [46]. This highlights the importance of both limitations and progress being integrated with each other in game design and development.

5 LIMITATIONS

There are a few limitations uncovered in this review. The potential for extracting game elements in serious game interventions may have been underestimated due to publication bias, which could have impacted the quality of our systematic review. The quality assessment was considered biased because it was primarily conducted

by a single author multiple times without input from other authors. Furthermore, relying solely on descriptions of games in the included articles for extracting game elements may have resulted in the misclassification or exclusion of certain elements. Finally, the results of the review may have been influenced exclusively by the taxonomy of Werbach and Hunter [13], which we utilized for extracting game elements. Even though we utilized the most relevant taxonomy, certain game elements may have been overlooked due to the specific taxonomy employed.

6 CONCLUSIONS

We conducted a review to identify the most common game elements used in serious game interventions aimed at increasing awareness of obesity. Our review found that the most frequently included game elements were 'Points' and 'Quests,' with almost all selected papers incorporating these elements into their study interventions. These are followed by 'Challenges,' 'Feedback,' 'Constraints,' 'Progression,' 'Avatar,' 'Win States,' 'Achievement,' and 'Rewards.' Additionally, serious games utilize multiple game elements from various categories, and these interventions seem to be effective in promoting health and positive behavior change in users. The inclusion of these game elements depends on the learning outcomes and the purpose of the game. However, it is important to note that while the knowledge gained after the intervention may lead to short-term effects, further research is needed to determine if these effects can also have a positive impact on users in the long term. In future evaluations, it is crucial to enhance the standardization, comprehensiveness, and quality of serious game interventions aimed at promoting obesity and health awareness by incorporating high-quality game elements.

7 FUNDING

This research was supported by Universiti Teknologi MARA through University Research Grant 600-RMC/GIP 5/3 (063/2021).

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