

# Design Features in Games for Health: Disciplinary and Interdisciplinary Expert Perspectives

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## ABSTRACT

Games for health (G4H) aim to improve health outcomes and encourage behavior change. While existing theoretical frameworks describe features of both games and health interventions, there has been limited systematic investigation into how disciplinary and interdisciplinary stakeholders understand design features in G4H. We recruited 18 experts from the fields of game design, behavioral health, and games for health, and prompted them with 16 sample games. Applying methods including open card sorting and triading, we elicited themes and features (e.g., real-world interaction, game mechanics) around G4H. We found evidence of conceptual differences suggesting that a G4H perspective is not simply the sum of game and health perspectives. At the same time, we found evidence of convergence in stakeholder views, including areas where game experts provided insights about health and vice versa. We discuss how this work can be applied to provide conceptual tools, improve the G4H design process, and guide approaches to encoding G4H-related data for large-scale empirical analysis.

## Author Keywords

Health, games, G4H, serious games, game design

## ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous; J.3. Life and medical sciences: Health

## INTRODUCTION

Serious games—those designed for purposes beyond entertainment [14]—target a variety of topics from social issues [40] to higher-order science skills [29], and health is a common and growing area of focus. Sawyer describes health as a field of interest for serious games due to its deep research history in training and simulation and the large market for technological advances within the field; in addition,

there is a prevalence of games already geared towards physical fitness, opportunities for scientists, medical professionals, and patients each to benefit directly, and the possibility of health markers to be used in evaluating game outcomes [41].

Growing evidence of the potential for games to produce positive health outcomes has led many in HCI and related fields to more closely examine the “active ingredients” of well-designed health games [7,13,24]. However, work on how specific game elements relate to health concepts has thus far been difficult to generalize, particularly in ways that serve both game designers and domain experts [11,49]. These disciplinary and interdisciplinary stakeholders [20,32] bring differing perspectives on the relevance of game features, how they instantiate health concepts, and even what counts as a feature in the first place. We therefore probed design phenomena surrounding G4H that can be understood only through collective perspectives, by enlisting experts with years of experience in game, G4H, or health intervention design. Through structured and semi-structured prompts, we collected rich and detailed sets of responses to specific games and game concepts from these experts. We draw on these responses to characterize how game design and health concepts are expressed and realized in G4H and to identify corresponding design attributes. We thus make the following contributions:

- (1) We distill evidence of convergence as well as conceptual differences in how different stakeholder groups discuss design-related themes and features of G4H.
- (2) We discuss how our research can be applied to provide conceptual tools and support interdisciplinary communication in the G4H design process.

## RELATED WORK

### Health Outcomes of G4H

Some games have been found to encourage and improve healthy lifestyles [13] and to increase disease knowledge for cancer patients [8] and people with diabetes [12]. Games also have shown positive effects on mental, physical, and social health in older adults [21]. However, many games for health have not been proven effective, and more and higher-quality clinical trials are needed to further understand the effects of different games on health outcomes [30,37]. Ideally, clinical studies of G4H should not just reveal *that* a particular game is effective, but also should

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help researchers understand *why* it is effective. This cannot be done without a foundational understanding of underlying game features.

### **Game and Health Frameworks**

Many researchers have examined the current state of serious games in the health space through theoretical frameworks. The most prominent framework for health games, Sawyer and Smith's [42] taxonomy, categorizes games by their domain (*personal, professional practice, research/academia, or public health*—focused) and then by health activity (*preventative, therapeutic, assessment, educational, or informatics*). Mader et al. [34] further frame therapeutic games according to the three main foci of *player, game, and therapy* and the relationships between them. These frameworks provide important structural insights, such as helping identify areas where there is unexplored potential for G4H, but they do not extend to the level of specific game features. Conversely, game frameworks that are more specific regarding game features (e.g. [9]) do not address the challenges of embodying health theories in play.

### *Behavior Change Theories*

Other researchers have focused on the application of health and behavior change concepts within games and gamified applications. Behavior change theories have influenced both the design and evaluation of serious games, particularly those focusing on health promotion and illness management (e.g., tobacco prevention [22], exercise [28], nutrition [19], physical therapy [39], and medication adherence [44]). Recent arguments against the application of purely cognitive models of behavior change (e.g., Transtheoretical Model [38], Health Belief Model [27]) point out their overemphasis on the individual [45] in modeling behavior. Such criticisms have prompted a more recent focus on adopting social models of behavior change (e.g., Social Cognitive Theory [5], Emergent Dialogue [45]) to promote observational learning or collective behavior change through design. Yet, particularly for health interventions, even these theory-driven approaches to design do not necessarily cohere with user-centered approaches [4]; moreover, research on the discovery and implementation of specific design decisions that incorporate elements and constructs of theoretical models is an open area.

### *Applying Behavioral Theory in Game Design*

Content analysis of mobile apps for fitness and general health found that most apps did not contain much health theoretical content [10,50], and a review of fitness-focused console games found that concepts common in weight loss interventions were present in games but that no studies had yet tested the effects of these concepts in a game setting [33]. There is also a gap between evaluation of these outcomes and understanding of how best to incorporate them into the design of health games. For example, in the realm of exergames, Lieberman et al. [32] developed a model of mediating factors that should be considered in design—improvement of player self-concepts, self-efficacy, physical

activity, and social support—which will enable the field to better evaluate the design of exergames and to improve their design and evaluation in the future. In parallel, Mueller and Isbister [35] developed principles for designing movement-based games and validated them with an audience of game designers. Themes from Lieberman's work appear in these design principles: for example, Mueller and Isbister propose giving players visualizations that support rhythmic movement, which connects to the concept of self-efficacy. However, these mediating factors have not been systematically linked to specific game features or design decisions.

This gap between game design and behavioral theory is mirrored in G4H design methodologies. Playmatics' five-point framework for health and science games emphasizes that, while scientists and game designers may be working on the same team, they have separate areas of expertise [49]. However, uniting game and health expertise is not a trivial task, as the limited replication of health-theoretical content in games suggests. Schell Games' Transformational Framework [11] for game design supports this process by providing workshops and discussion activities that help stakeholders collaborate; however, this framework is a broad approach to transformational games and does not focus specifically on health.

### **Game Mechanics and Features**

Research is also limited on how to best design health games that incorporate established game mechanics, and experts in the field agree that more attention must be paid to such features in order to create successful games [6]. First, games must be engaging in order to encourage the play that moves the player toward the desired health and learning outcomes [31]; understanding successful game mechanics is important to this effort. Moreover, different game mechanics can encourage—or discourage—desired health outcomes in different ways (e.g., encouraging or limiting physical movement), and understanding the relationship is vital [6]. Furthermore, many game mechanics, such as multiplayer mechanics, are simply not well understood in the context of health games, which means that areas of promise are often overlooked [17].

However, we acknowledge that game mechanics are not the only types of features in games. For example, Bjork and Holopainen [9] include technical and social patterns in addition to game mechanical patterns in their taxonomy of game design patterns. While we expect to find game mechanics *included* in our experts' perspectives on game features in G4H, we do not expect expert discussion of features to be limited solely to mechanics. Game art, game narrative, and the context of play are other potential sources for features in G4H.

### **Values in G4H**

Games can also embody points of view. In G4H, these views may focus on the health condition a game addresses; *Zombies Run!*, for example, reflects an inclusive, nonjudg-

mental notion of exercise [2], while other games are much more punitive about obesity [46]. Health games can also embody points of view about *how health behavior change works*, by incorporating elements of health and behavior change frameworks [20]. In *Values at Play*, Flanagan and Nissenbaum propose a conscious, reflective process for identifying the values that one wants to express in a game. These values can relate to health behaviors, to how the game treats users, or both. For example, the health game *Lit2Quit* addressed tobacco smoking; however, its stance is that the game should *support* players’ pre-existing desire to quit, rather than attempt to *convince* them to quit [26]. This stance comes from value commitments on the part of the game designers, such as respecting the autonomy of smokers who better understand their own life circumstances; these values are in turn reflected in specific design decisions, such as helping reduce the urge to smoke in a process initiated by the player. A value-reflective process like this is especially important when the stakeholders involved in a game’s creation come from different backgrounds, as is often the case in G4H, and understanding how these different stakeholders identify and interpret features and values is crucial to expressing them in games in more effective ways.

## METHODS

We began our work by examining the current landscape of health games and aggregating these games into a G4H corpus. This helped us develop a deeper understanding of existing health games in both research and commercial settings, and provided a database from which to select games for use in our expert study sessions. We chose to create a corpus despite the existence of some G4H databases [47], as no current aggregation of health games followed our criteria (described below) or was fully exhaustive regarding games or game details.

### Health Games Corpus

Our G4H corpus consists of 320 health games curated from a variety of sources, including previous publications, prior research databases [47], and Google, Android app store, and Apple app store searches (keywords: “games for health”; “games for health management”; “disease management games”). The corpus contains listings for each game with details (e.g., developer, platform(s), genre, health condition) and associated research where applicable. Health games fit our criteria and could be added to the corpus if they focused on disease prevention, health promotion, and/or disease management. We aimed to adhere to the designers’ original intent: only games that promoted themselves as games were included, and applications with only minor “gamification” were excluded. Games designed for training medical professionals were also excluded. To assist with classification, games were required to have a *core loop* [43], or elements of feedback in which player actions affect the game and vice versa.

We selected 16 games from our corpus for use in all expert study sessions (see Table 1). We chose a random subset of

playable games and evaluated them with replacement until we had a diverse, representative sample of the larger corpus that balanced research-based and commercial games, as well as game platforms. Selected games were either currently playable or had gameplay video accessible to our research team. For each, we constructed explanatory game cards for our study (with titles, sample images, and brief instructions for play).

### Study Procedure

With IRB approval, we conducted individual study sessions with 18 expert participants (7M, 11F): game design experts ( $n=7$ ), behavioral health experts ( $n=5$ ), and health game experts ( $n=6$ ). Participating experts must have completed or deployed one or more games, health interventions, or health games. Within each group, we also aimed to include experts from different backgrounds (e.g., both researchers and members of industry).

Game	Creator	Health condition
Re-Mission 2: Nanobot’s Revenge	HopeLab	Cancer
Bronkie the Bronchiasaurus	Raya Systems	Asthma
Bubble Rubble	Playnormous	Physical activity
Chicken Farm	Nobel Media	Nutrition
Colorfall	Persuasive Games	Mental health, physical activity
Dex: Virtual Pet	Georgia Regents University	Diabetes
Elude	GAMBIT Singapore-MIT Game Lab	Depression
Escape from Diab	Achimage	Diabetes
Fix Frank	American Diabetes Association	Diabetes
Mindless Eating Challenge	Interaction Design Lab, Cornell University	Nutrition
Monster Manor	Ayogo Health, Sanofi	Diabetes
Packy & Marlon	Raya Systems	Diabetes
Rex Ronan: Experimental Surgeon	Sculptured Software, Health Hero Network	Smoking cessation
Snow World	University of Washington, Harborview Burn Center	Pain management
Squire’s Quest II	Archimage, Baylor Children’s Nutrition Research Center	Nutrition
Virtual Iraq	Virtually Better	PTSD

**Table 1. The 16 games used in expert study sessions.**

We recruited by word of mouth and snowball sampling, and conducted study sessions both in-person (for local participants) and remotely via Skype. All in-person participants gave informed consent and all remote participants signed waivers of consent, as approved by the IRB. Study materials for in-person sessions consisted of physical game cards, while remote sessions used digital “cards” in Google Slides (Phases I and II) [18] and OptimalSort (Phase III) [36]. All sessions were audio- and video- recorded and lasted approximately one hour. We provided a \$25 Amazon gift card to each participant for completing the study. Study sessions consisted of three phases: an exploratory phase in which experts described an unknown game aloud based on images, a triading phase in which they compared groups of three games, and an open-ended card sort in which they categorized 15 games. These three phases, chosen to gather expert feedback in multiple ways—both structured and open-ended—are described in more detail below.

#### Phase I: Exploration

Participants first viewed images from a health game (Re-Mission 2: Nanobot’s Revenge) and were asked what information they would need in order to understand the game; we used a think-aloud protocol to elicit—from the participant’s perspective—what they understood from the photos, what information they would have liked to see, and what questions they would ask to understand the game to the best of their ability.

#### Phase II: Triading

In the second phase of the study, we conducted (with each participant) 15 rounds of *triading* [23], a technique borrowed from repertory grid technique (RGT), which aims to elicit domain-relevant constructs and the relationships between them [3]. We used the remaining 15 health games from our corpus in this phase; one game per card.

For each round of triading, participants viewed games in randomized *triads* of three cards at a time. For each of the first five rounds, we asked participants to decide which *two* games were most similar and which *one* was different, and then explain why. The following ten rounds included the addition of a concept card: in these rounds, participants again viewed randomized triads of games, this time presented alongside a randomized concept card (see Table 2 for a complete list of concepts). We asked experts to again identify which two game cards were similar and which one was different, but this time to compare the games according to the presented concept.

#### Phase III: Open Card Sort

In the final phase, participants conducted an open-ended card sort of all 15 health games from the triading phase. We asked each participant to sort the games however they thought best: giving no further instructions or limits on how many groupings should be created or what kind. When the card sort was complete, participants explained their sorting rationale to the researcher.

Concept	Explanation
<i>Audience</i>	Who this game is for
<i>Behavior change</i>	How players changed their behavior because of play
<i>Context of use</i>	When and how this game would be played
<i>Core loop</i>	How player actions influence the game, and how the game in turn influences player actions
<i>Game challenges</i>	Obstacles or difficult elements in the game
<i>Game goals</i>	In-game goals and objectives
<i>Health motivation</i>	Why players want to improve their health or change their health behavior
<i>Outcome evaluation</i>	How we know whether the intervention was successful or not
<i>Play strategies</i>	Strategies the player can use to be successful in this game
<i>Preparation</i>	What prior preparation the player needs for this health change

**Table 2. Concepts used in framing triading rounds six through 15.**

#### Data analysis

We analyzed quantitative triading and open-card-sort data through descriptive statistics and similarity matrices [1] to determine common game pairings. After transcribing spoken responses from participants verbatim, three researchers conducted an iterative, inductive thematic analysis [15] of triad comparison round results, using a constant comparative approach [22]. Multiple concepts were coded within each round. Through discussion among the research team, we used these concepts to derive seven higher-level themes.

#### FINDINGS & DISCUSSION

From 270 rounds of triading, we found 76 concepts mentioned a total of 761 times by experts (see Table 3 for a full list). These 76 concepts fell into seven higher-level themes, as follows: *player characteristics*, aspects of the player outside of their experiences with the game; *health model*, how the health subject matter is modeled, represented, and understood in and through the design; *game world*, fictional and experiential aspects of the game such as art and narrative; *game mechanics*, game rules and related features such as level design; *player behavior*, which includes physical and mental player activity in and around the game; *context*, or the way gameplay interacts with the real world; and *outcomes*, how players or the world around them are changed by their play experience.

In this section, we first examine the ways themes were understood differently by expert groups, beginning with a short overview before delving into specific results. We also offer further comparisons between expert groups, including

comparisons by triading concept and by game. We end with implications of our work for design and for future research.

### Game Design Experts

While game design experts did reference health concepts, they were unsurprisingly sensitive to the **game aspects** of G4H, tending to use language that referenced other games rather than other health experiences. They also frequently considered the **player as a person with autonomy and experiences**, rather than focusing solely on their health condition. Finally, game experts based their discussion of the relationship between game and health content on the **integration of game mechanics and health behavior**. We discuss these differences in more depth below.

#### Game aspects of G4H

Game design experts were most likely to conduct triading game comparisons based on game features. For instance, P2 compared Colorfall, Squire’s Quest II, and Elude by explaining that “[*Elude*] is about... moving a character around [and] *Squire’s Quest II*] looks like a classical quest-based sort of thing... I think *Colorfall* is the most different one here [as] it has no main character and is more about stacking blocks, it’s a more classical puzzle [game].” Especially in the open-ended triading rounds, game design experts emphasized game-related themes and concepts. Experts compared games based on *narrative* (“*story-driven*” (P10)), *game goals* (“*changing things and seeing how they play out*” (P14)), *mechanics* (“*firing*” vs. “*navigation*” (P10)), *characters* (“*implied avatars*” vs. “*obvious avatars*” (P14)), and *aesthetic* (“*similar in art style and tone*” (P17)), among others. In these examples and many more, game experts compared the health games at hand but applied game “*dialect*” and referenced other games rather than health experiences when doing so. Despite ongoing debates in the field about the relative importance of mechanical and aesthetic elements in games, game design experts used both game-mechanical and game-world features to make these comparisons.

Despite this focus on G4H game aspects, game design experts did consider the player’s *health goal* (a player characteristic) and the *health condition* represented by the game (part of the health model). For instance, P9 explained that “[*Escape from Diab and Dex*] are very similar because they’re both about diabetes... [*but Elude*] is exploring mood, which is completely different.” When comparing *Monster Manor*, *Packy & Marlon*, and *Rex Ronan: Experimental Surgeon*, P10 noted that “*Monster Manor and Packy & Marlon* seem to be most similar... they’re both about checking your insulin levels and diabetes... At the same time, *Packy & Marlon* and *Rex Ronan* seem to be pretty similar because there are these platforming levels, [and] at least mechanically they appear to have some similarities.” These experts frequently found that game triads could be characterized in multiple salient ways, often with one health-focused and one game-focused direction. As

P10’s response shows, the game and the health themes sometimes suggested different game pairings.

Player characteristics	
Cultural assumptions	Player health status
Gender	Player skills
Health goal	Preparation
Identity	Prior knowledge
Player cognition	
Health model	
Health condition	Similarity between game and target domain
Health subject matter	Simulation
Level of health-relatedness	
Level of seriousness	
Game world	
Abstraction	Game space
Emotion	Game text
Experiential	Narrative/story
Game analogies	Player role
Game characters	Point of view
Game clarity	Quests
Game classification	Rewards
Game dialogue	
Game mechanics	
Core loop	Game mechanics
Feedback	Game rules
Game challenges	Game speed
Game chokepoints	Game structure
Game complexity	Number of players
Game controls	Patterns
Game genre	Verbs
Game goals	Win condition
Game levels	
Player behavior	
Attention	Motivation
Caretaking	Player actions
Cheating	Player decision-making
Control	Progression
Exploration	Strategies
Interaction	
Context	
Audience	Modality
Context of use	Real-world interaction
Gamification	Repeated play
Length of game/engagement	Social
Outcomes	
Behavior change	Evaluation
Education	Health outcomes
Effectiveness	Reflection
Entertainment	Support/scaffolding
Escape/distraction	Tracking/logging

**Table 3. High-level themes (n = 7) gathered from triading and open card sorting, with the corresponding concepts that make up each theme.**

### *Player as Person with Autonomy and Experiences*

Experts in this group were particularly sensitive to player characteristics, framing the player as a person with autonomy and considering their prior life experiences. P8 discussed the relevance of player experience when differentiating *Escape from Diab*, explaining that “*it seems based on a specific set of rules... this sort of game requires a very complex, logical thinking from the players, [some of whom] may have a great deal of experiences and knowledge for the circumstances.*” P17 described the relevance of potential differences in player experience for *Virtual Iraq*, noting that “*there [is] a stereotype about everybody [in the military] being a gamer... but half of them [can’t use] the controls at all and spend thirty minutes just staring at a wall... Basically, you can’t get the experience out of the game if you don’t bring the ability to navigate the controls prior to the experience.*”

Additionally, game experts were the only group to consider that players may have goals that do not align with designer intentions: comparing *Bubble Rubble*, *Chicken Farm*, and *Dex* in the context of *game goals*, P2 said that “*I get the sense that there’s going to be a big difference between what the designers of these games think that players are going to do and what the players are actually going to do... [for these two] I’m going to say the players are really going to be focused on score... and [Dex is] about keeping things alive over a long period of time, and not about the score but just about the character itself.*” Even through the lens of game design and mechanics, there is room left for a disconnect between player and designer, which can affect a player’s experience of the gameplay.

One game expert also framed player experiences in the context of gender and culture—the only expert in any group to mention either concept. The game expert who discussed gender did so during triading, in the context of *game aesthetic* and *audience*, noting that “*...this could just be poor design concept, but I feel like these two [Mindless Eating Challenge and Bronkie the Bronchiasaurus] could be more [geared towards] girls, or at least to a gender neutral sort of audience... I don’t know if this is just the lack of consideration about aesthetics, but [Rex Ronan] definitely doesn’t scream ‘little girls’*” (P18). A few rounds later, the same expert touched on cultural assumptions in the context of *game aesthetic* and *prior knowledge*, explaining that “*there’s definitely cultural assumptions [in Monster Manor] about knowing what Frankenstein is [and] being able to interpret this aesthetic of the ghoulish kind of thing*” (P18).

While many experts in all groups discussed *audience* in terms of age (children vs. adults) or health status (diagnosed with a condition vs. general population), no other expert touched on the importance of sociocultural considerations in the design of health games. In fact, we expected to encounter this more frequently, given that the academic study of games often adopts analytical approaches that treat

games as cultural texts and artifacts with a sociocultural context [16].

### *Integration of Game Mechanics and Health Behavior*

When game experts discussed the health model of a game, they described game mechanics and health behavior as two equal, high-level concepts, working well together when they are integrated. In Phase III of the study, game design experts used *similarity between game and target domain* to group games, commenting frequently on this integration or lack thereof. P17, for example, explained groupings within the open card sort as “*[separating] games I thought [had] learning content very tightly integrated... [versus] games where I wasn’t so sure how the learning content was even integrated at all... [and] then games where it seems that the learning content had an interactive component but [also] significant other non-learning scaffolding.*” P14 also noted that “*[Escape from Diab] specifically has you making these changes that might be mirrored in real life.*”

Meanwhile, other game design experts expressed concern about a lack of integration between game mechanics and health concepts in some games. P18, for instance, did not think *Bronkie the Bronchiasaurus* demonstrated adequate integration: “*I can’t imagine that this could draw an analogy to any real-world behavior in kids, because it’s like you’re [just] little animals running through the jungle.*” P2 felt similarly about *Nanobot’s Revenge*, explaining that “*it seems like they’re borrowing a lot of mechanics from other games, without a clear sense of why they’ve borrowed those mechanics.*” For these game experts, such game–health integration was a frequent measure of comparison between games, and they saw a lack of such integration as an indicator that a game might be less effective as an intervention.

### **Behavioral Health Experts**

Overall, behavioral health experts were most likely to reference concepts within the high-level theme of health model. Like game experts, behavioral health experts were also concerned with player characteristics, especially autonomy, but of a different kind: they focused on **player autonomy in relation to one’s own health** and in relation to one’s preparedness to take action and change behavior. These experts also differentiated “**fun**” in games as distinct from learning, monitoring, or other productive health activities. Finally, their understanding of the relationship between game and health content frames **game mechanics as a representation of the health model and content**, rather than two equally high-level concepts.

### *Player Autonomy in Relation to their Own Health*

Much of this expert group’s discussion of health concepts was based around player autonomy in relation to their health. Behavioral health experts most commonly compared game trios based on features of *health goals*, *health condition*, and *health subject matter*, but they did so in the context of outcomes, noting whether and how behavior change stages and preparedness for action were considered in the design. P11 compared multiple triads in these ways, ex-

plaining that “[*Escape from Diab and Squire’s Quest II*] both seem to be about nutrition [and] making healthy decisions” and that “[*Bronkie the Bronchiasaurus and Elude*] are more similar because they seem to be educational about understanding either yourself, having asthma or depression, or helping friends and family understand.”

Interestingly, some experts worried that the simple fact of playing a game might be interfering with player autonomy, or at least could have a negative effect on the player’s real-life health experience: discussing *Nanobot’s Revenge* in Phase I, P11 felt that, “*I don’t want to say [the game] is making light of what they’re going through, but you’re already facing cancer, cancer is your life when you’re going through chemo. Do you really want to play a game with cancer?*”

Behavioral health experts also contrasted games by mentioning aspects of context, especially *real-world interaction*. P15 explained that *Monster Manor* was different than *Elude* and *Rex Ronan* due to “*your individual behavior, you need to track that in order for the gameplay to be interesting*”, while P13 thought that “*Monster Manor and Packy & Marlon are similar because you’re logging your personal information.*” Other health experts discussed the interactivity and real-world context of both *Mindless Eating Challenge* and *Dex: Virtual Pet*. Additionally, in contrast with *Fix Frank*, P3 noted that, “*both [Monster Manor and Bubble Rubble] seem more grounded in what people’s health behavior is in the real world.*” Discussion of real-world context and related themes shows a focus on the player rather than the game—unsurprising from behavioral health experts— but in a way that still relates to player behavior and gameplay.

In Phase I of the study, behavioral health experts also tended to focus on how a player’s real-world health could be affected by gameplay. P12 believed that *Nanobot’s Revenge’s* goal was to teach players how chemotherapy works and how it might affect them, while P15 was curious to learn more about the curriculum content of the game and how closely it hewed to reality, worrying that an actual simulation of chemotherapy might be disturbingly bleak. Interestingly, although many participants talked about the *Nanobot’s Revenge* general audience, only one participant (P11) wondered if there was a more specific target audience than just “children with cancer.” He asked, “*is this recommended to all patients, or [those] that are having extreme anxiety about getting chemo? [Is this supposed to] alleviate some of that anxiety, or is it just like a blanket ‘Here. You’re getting chemo. Play this game?’*” These sorts of questions and observations highlight this group’s particular expertise, and demonstrate their interest in the player and his or her health autonomy both in and beyond the game.

#### “Fun” Games

Behavioral health experts also often discussed the *level of “seriousness”* of a game. In the open card sort, P12 categorized most of the games by health condition but grouped

three games together as “*game-games*” that are just for “*fun*”. P13 also had a grouping called “*fun games*” that differentiated *Snow World*, *Rex Ronan*, *Colorfall*, and *Squire’s Quest II* from other groupings of “*learning games*”, “*health monitoring games*”, and “*virtual games*”. There was frequent classification of “*fun*” as an outcome in opposition to learning, with P15 noting that “*on the entertainment versus education spectrum... [Nanobot’s Revenge is] a little more entertaining than educational.*” Other experts expressed similar sentiments during the triading phase, explaining that *Fix Frank* is “*just a game*” (P12) and that *Colorfall* and *Snow World* “*seem kind of pointless*” (P11). The concept of “*fun*” is not as simple as it sounds—it is in fact a concept so overloaded that game designers often avoid using the term [25]. This usage illustrates a particular disconnect between game and health experts: it reflects health experts’ assumptions about how games are “supposed to” be: does the use of fun in this context imply that the other games are not fun, or shouldn’t be fun? This question prompts additional ones about what these health experts perceive makes a game a game and whether they perceive an idealized dichotomy separating serious and non-serious games.

#### Game Mechanics as Representation of Health Content

Lastly, on the theme of *similarity between game and target domain*, behavioral health experts saw the relationship between health and game content as one in which game mechanics represent the health model. In the open card sort, in the context of *game mechanics*, P15 explained that “*the biggest group is the one where game mechanics are representative of the disease model... [games] like Packy & Marlon, Bubble Rubble, Escape from Diab, Squire’s Quest II all kind of fit there.*” In the triading phase, other experts noted how some games aimed to show the player how to change their behavior by “*modeling the effects of [behavior change]*” (P15) or “*reinforc[ing] the player doing things, [through repetition]... the mechanics bleed into player real life*” (P10). Health experts used game design terms such as “*mechanics*” to describe this similarity, but treated the health concept as a baseline model, which game mechanics can represent with varying degrees of fidelity and accuracy.

#### G4H Experts

G4H experts commonly discussed **context and interaction** during gameplay, considering when and how a game would be played and noting multiplayer mode and community as critical differentiators between games. G4H experts also frequently spoke about **outcomes and objectives** in both the game and in a player’s health behavior. Finally, this expert group framed the relationship between game and health concepts as one in which **game mechanics produce health outcomes**.

#### Context and Interaction

While G4H experts, like behavioral health experts, were most likely to make triading comparisons based on *health goal* and *health condition*, G4H experts were much more focused on the context of use surrounding a game. P16 dif-

ferentiated Monster Manor from other games by explaining that it “stands out pretty clearly, just because it’s a mobile game that’s intended to be interwoven into a diabetic’s life as they track their diabetes information, whereas the other two... [are] a separate event from the rest of the player’s life.” Similarly, P15 found that “Dex is the odd one out because it’s supposed to be used over a period of time [and] you’re earning daily rewards, whereas Virtual Iraq... you would do maybe once in a sitting and then talk about it, and Bronkie the Bronchiasaurus is similar, you could just play it once and get the lesson, it’s not going to reward you for coming back the way that [Dex] does.” For many G4H experts, a discussion of the health games at hand was not complete without this focused discussion of the surrounding context.

Moreover, this notion of context was often framed more specifically in terms of *social context* by G4H experts. Interestingly, this was the only group to mention the social interaction within Nanobot’s Revenge in Phase I. P1 asked whether or not clinicians get data from the game to help improve their interactions with a patient, and many G4H experts wondered if players are able to share game status and achievements through social media as a way for others to know how they are doing; for instance, “the fact that she’s at level five lets me know, ‘Oh she must have had a chemo day today so she’s probably feeling sick and I should reach out,’...[game results could allow her to share this information] without her having to type, ‘I’m sick’” (P1). In the triading comparisons, G4H experts also distinguished Squire’s Quest II as a multi-player game and noted that Mindless Eating Challenge has both a multi-player and community component. P5 felt that Mindless Eating Challenge also requires that the player “be judged by peers” and have “a willing audience.” While behavioral health experts discussed social relationships as outcomes of a game, G4H experts saw social interactions as something that happens during gameplay and is closely connected to the game context and the experience of the game itself [48].

#### *Outcomes and Objectives*

G4H experts in our study also discussed goals and outcomes both inside and outside the game. This group saw objectives as something that is inherent in the game rather than produced by the player, with P5 noting that “kid-friendly games have simple objectives, [but the objectives are] less clear for Virtual Iraq.” P16 elaborated on game objectives as well, explaining that Packy & Marlon and Chicken Farm “seem to have finite game play, a goal that you can reach, whereas [Monster Manor], because it’s intended for behavior change and because of the social-mobile DNA there [is] much more infinite. The goals are more dynamic in terms of, I want to make it to the next level, or I want to find this particular monster... things like that. Then once one goal is completed, more goals become apparent, whereas the other two... look like the kinds of games that have an ending, where you reach your goal and you’re done.” P1 compared another triad by saying that

“these two [Dex and Packy & Marlon] are alike because of their content, that they’re for diabetes education... it seems like it’s here to prompt them to have healthy habits and to educate them about their disease, whereas [Elude is] not really educating you about depression.” Other experts mentioned that certain games have a goal of teaching the player how to take care of themselves or others in real life (P5) or a prevention focus, in this case, prevention of diabetes (P7).

G4H experts also noted the possibility of negative game outcomes having a potential negative or demotivating effect on the player’s real-world health, and they were the only expert group in Phase I to touch on possible concerns of the game for the target audience. P1 saw the game as an empowerment tool for children undergoing chemotherapy; however, she noted the importance of making sure the game wasn’t too hard so that it didn’t have this demotivating effect on the player. P5 echoed this concern, calling Nanobot’s Revenge “a bit of a touchy game” given the content and audience. This concern for the physical and emotional health of the player, based on game mechanics and difficulty, demonstrates a critical understanding of the game, the player, and the powerful connection between them.

#### *Game Mechanics Produce Health Outcomes*

When discussing game mechanics and the health model together, G4H experts framed the relationship as one in which game mechanics produce health outcomes. They thought frequently about what happens outside the game, how the game can be incorporated into daily life, and how game skills can transfer to actual behavioral goals and outcomes. G4H experts considered *real-world interaction* in the context of *behavior change*, with one expert invoking real-life connections by differentiating Dex from other games because one’s own management and real-life practices drive the virtual pet (P6). Likewise, P16 said that, “the one I would call out as different here is probably the Mindless Eating Challenge because it explicitly asks you to complete tasks in real life. It is not purely endogenous, it’s reaching outside the game to try and drive actual behaviors.” Later, P16 also discussed how Virtual Iraq is “directly effecting a therapeutic intervention, [and] actively working on PTSD.”

G4H experts also referenced transfer to a real-world context in the open card sort, with P1 creating a grouping of games that were both educational and also included real-life content, while P6 characterized a subset of games as “linking real behaviors to virtual games” and another as “behavioral rehearsal.” In Phase I, P1 also found that the mechanics of Nanobot’s Revenge helped to empower the player in their real-life health experience, as “the goals of this game are to inform and possibly also to enhance their effect or locus of control: like, ‘I can beat cancer. I can do this.’”

#### **Comparisons Between Expert Groups: Triad Themes**

To better understand similarities and differences between game, health, and G4H experts, we next more closely examine their responses to the ten assigned triading concepts.

Expert group	Important results	Corresponding high-level theme(s)
<i>Game design experts</i>	Game aspects of G4H Player as a person with autonomy and experiences Integration of game mechanics and health behavior	Game world and game mechanics Player characteristics Game mechanics and health model
<i>Behavioral health experts</i>	Player autonomy in relation to one's own health "Fun" as outcome Game mechanics as a representation of the health model	Player characteristics and health model Health model Game mechanics and health model
<i>G4H experts</i>	Context and interaction Outcomes and objectives Game mechanics produce health outcomes	Context Outcomes Game mechanics and health model

**Table 4. Overview of thematic analysis results, by expert group.**

Within Phase 2 of the study, rounds six through 15 asked experts to compare game triads based on one of 10 assigned concepts. By varying the games being compared for a given concept, we observed common themes emerge. In the *play strategies* round, for instance, game experts were most likely to discuss game mechanics, especially *win/loss conditions*, differentiating games by explaining that “[some games] are letting you play through... and you can lose, [but] over here you can die but you can't lose the game” (P9). Health experts, on the other hand, were more likely to describe play strategies and game success in terms of the game world concept of *rewards*, noting that for some games “you could come in with your knowledge and play to your strengths to get further points in the game” (P11). This is an interesting distinction that demonstrates a key difference in framing: game experts are taking the frame of the game seriously in their assumption that winning and losing are valuable in their own right, while health experts seem to understand rewards as the main motivator for play irrespective of game outcomes.

There were further group differences in themes mentioned in the *audience* round. Game design experts talked about *game aesthetic*, intuiting, for example, that a game was geared towards children “just from the interfaces and the colors and their choice of graphics” (P10). G4H experts, however, more often discussed *health condition* and *health status*, differentiating audience between “kids that probably have been diagnosed with something, with a chronic illness, whereas... this [other game] is just for anyone” (P1). Finally, health experts most frequently discussed audience in the context of *health subject matter* and *motivation*, with P15 explaining that some games “seem to be targeted at people who actually are looking to make an adjustment in their diet or physical activity” (P15).

Some assigned concepts prompted similar themes across groups. *Game goals*, for instance, explained to participants as “in-game goals and objectives,” still frequently led to discussion of *health goals* for experts in all groups. One game expert noted that in Dex “the Tamagotchi format

*makes the goals align very closely with what the learning objectives would be”* (P17), while a health expert framed a comparison of game goals by explaining that “the general goal is to be healthier... [make] food choices, and [improve] nutrition” (P11). *Context of use* also saw all groups frequently discuss the same themes, namely *health goals* and *repeated play*. A G4H expert felt that Bronkie the Bronchiasaurus is the sort of game that you sit down and play once all the way through (P4), while a game expert thought that Mindless Eating Challenge “is a bust out your phone from time to time, play with it a little bit, put it away [type of game]... connected to real time in some way” (P14), and a health expert felt similarly that Dex is supposed to be played by logging data a little bit every day (P13). For these assigned concepts, the variance in responses further accentuate group differences, yet similarities offer promise for interdisciplinary understanding and communication.

#### **Comparisons by Game**

Finally, we examine discussion and comparison by game, both amongst and across expert groups. This is important for multiple reasons. First, there are real differences between the games in our study and we want to clarify the particular themes each game may have been more likely to elicit. Most importantly, though, since we are ultimately motivated by a desire to define and identify game features in ways that are useful to a range of stakeholders, it is crucial that we aim to understand individual games. This does not detract from the importance of comparing themes and features between expert groups; rather, it allows us an additional, more focused view of the games that our experts were comparing, and which instantiate the concepts explored to date.

Looking at the thematic results of the open card sort by game, we see that some games in our corpus were more likely to elicit particular themes across all expert groups: *health goal*, *health condition*, and *game genre* were the themes most commonly used to group 11 of the 15 games. For both Monster Manor and Mindless Eating Challenge,

however, *real-world interaction* was most frequently used for characterization, with P15 calling this grouping “*real-world credit*” and P3 labeling these games as “*daily life*” and “*rewarding based on real behavior.*” For Dex: Virtual Pet, *simulation* was the theme of choice, while for Snow World most experts mainly wondered about its *level of “seriousness”*. Similarly, Colorfall was often characterized by its *lack of health-relatedness*, with many experts saying that it “*doesn’t fit with any categories*” and “[I] *can’t tell what the health goal is*” (P16), or that it’s a “*non-health*” (P7) or “*fun game*” (P14). This again serves to demonstrate a presumed dichotomy between games that are clearly serious and “useful” and other games that are not. These sorts of comments illustrate the challenges of subtly integrating serious content into games, and the tension between fun and education in creating and integrating serious health games.

We can also examine game trends by studying similarities and differences in how games were grouped together by participants from all three expert groups. During the open card sort, Fix Frank, Bubble Rubble, and Escape from Diab were grouped together by every participant in the health expert group, for instance, while each was grouped with the others far less frequently by both game and G4H experts. Within the health group, however, the three games were paired together for a variety of reasons: they were grouped as *educational*, *diabetes-related*, and as examples of *game mechanics as disease model*. It is interesting to note that while health experts fully agreed on the similarity of these games, they defined that similarity in very different ways; this clarifies the need to improve the understanding of game features to allow for easier communication *within* stakeholder groups as well as *between* them.

#### **G4H: Beyond the Sum of its Parts**

There are many implications of our work for the design and development of future G4H. First, an understanding of the perspectives of these different stakeholder groups can help us to improve interdisciplinary communication. We hypothesize that many G4H do not successfully embody health behavior change theory, as the literature shows, because game and/or G4H stakeholders are making many hands-on design decisions without the health perspective in mind. By improving conversations among collaborators during the design process, we can improve the design of G4H. For example, G4H-specific workshops could be constructed for existing design tools such as the Schell Games framework [11], but deliberately structured with our seven themes in mind to shape interdisciplinary communication.

Second, this work exposes the concepts and norms underlying G4H expertise, as distinct from the individual disciplines of game design and health behavior change. The themes and responses of the G4H expert group in our study were *not* simply the sum of the themes and responses of game design and behavioral health experts; for example, G4H experts were the only expert group to mention *number of players* or *game complexity* as themes. Now, for each

stakeholder group, we have a list of concepts that they are likely to use in framing G4H—and also a list of concepts that they are likely to omit in their framing. We can create design “prompts” based not just on our high-level themes, but on specific concepts—for example, remembering players’ prior experiences (commonly observed by only game designers), paying attention to their readiness to change behavior (only health experts), and considering the social context (only G4H). These prompts could be used during the G4H design process, to define research studies, and in G4H education, to encourage inclusivity of framings and features.

Finally, we hope that the lessons learned from our initial corpus creation and the foundational understanding of interdisciplinary G4H themes that we have gathered from our expert participants can help the field move towards computationally detecting and mining features of G4H and creating future data-driven G4H corpora. While computation will be key to this process, understanding stakeholder perspectives is a crucial first step to developing game corpora for use by G4H designers and researchers: G4H is such an interdisciplinary field that any attempt at a computational model must incorporate the viewpoints and expertise of a variety of groups, in order to most effectively identify G4H game features and provide the most value to future stakeholders. Our work offers a foundation for this process; future work will leverage this foundational interdisciplinary understanding by applying the identified G4H themes to new health games as we move towards computational creation of game corpora.

#### **CONCLUSION**

Our work provides a formative understanding of the similarities and differences in how game design, behavioral health, and G4H experts articulate G4H themes and features: an understanding that is central to improving the design and development of games for health. The need for improved communication and collaboration between stakeholder groups has been established, and our work elucidates the differing values and framings that experts and expert groups hold and provides a foundation for improving the G4H collaborative process. We aim to use our research to improve interdisciplinary communication, to formalize our understanding of the relationships between game design and health behavior change frameworks, and ultimately to move towards computationally detecting and mining features for encoding G4H corpora. Synthesizing expert perspectives gives us a more comprehensive and foundational understanding of G4H themes and features, and we can leverage this multidisciplinary expert knowledge to improve G4H design and research going forward.

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