Leveraging Design Patterns to Support Designer-Therapist Collaboration When Ideating Brain Injury Therapy Games

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ABSTRACT
Many therapists who work with patients who have had a brain injury (BI) include games to ameliorate boredom associated with repetitive rehabilitation exercises. However, designing effective, appropriate, and engaging games for BI therapy is challenging. Following a user-centered approach we created GaPBIT (**Ga**me Design **P**atterns for **BI T**herapy), a prototype tool that leveraged design patterns to support designer-therapist collaboration when ideating games for BI therapy. We observed the use of GaPBIT in six game ideation workshops that involved game designers and therapists. The tool effectively facilitated collaboration in the interdisciplinary teams. Findings also suggested that information tools like GaPBIT support but do not replace informative collaboration among designers and subject-matter experts (i.e., therapists in our study). We argue that our findings and research methodology generalize to other domains where communication and collaboration among interdisciplinary design teams are imperative for designing 'successful' games; i.e. games that meet the varied goals among stakeholders.

Author Keywords
Game design; game design patterns; brain injury; therapy; serious games; games for health; stakeholder collaboration.

ACM Classification Keywords
H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces (User-centered design); K.4.2. Computers and Society: Social Issues (Handicapped persons/special needs); K.8.0. Personal Computing: Games.

INTRODUCTION
Brain injuries (BI) are a major public health issue affecting many societies worldwide [39]; approximately 6.4 million children and adults in the United States live with a lifelong disability as a result of a BI [9]. The causes of BIs include traumatic incidents (e.g. car accident, falling), loss of oxygen to the brain, and cerebral vascular accidents (i.e. stroke) [10,47]. Depending on the causes and nature, a BI can result in impairments affecting both physical and cognitive abilities, which in turn, lead to diverse recovery paths. As a result, therapists need to customize rehabilitation treatments to meet each patient's individual needs and unique goals.

Many BI rehabilitation treatments require repetitive activities to reinforce practice and learning. Motivation to engage in repetitive activities is a common challenge in BI therapy [6,23,24]. To overcome this challenge, many therapists include games in their sessions; therapists use varied combinations of commercial off-the-shelf (COTS) games designed for the general public and games that are specifically designed for BI therapy [5,41,42]. However, currently available games have many limitations for this population. On one hand, COTS games are often too difficult and have too steep a challenge ramp for many who have had a BI [16,32,43]. On the other hand, games designed specifically for rehabilitation have often failed to achieve a proper balance between player experience and therapeutic efficacy [12,48]. Consequently, designing effective, appropriate, and engaging games for BI therapy is a challenging and important area for exploration.

In our previous work involving interviews with game designers who focused on games for health (i.e. serious games embedded with health-related goals), we found that designers described very user-centric approaches to their work, emphasizing early involvement of target players. [17]. The designers' 'player-centered' efforts, however, did not always ameliorate many of the challenges they met in their work. For example, several interviewees expressed frustration when consolidating different mindsets and motivations with subject matter experts (e.g. therapists in the context of BI therapy games) [17]. Specifically, subject matter experts were described as narrowly focused on the purposeful goals of the game, while the game designers often lacked knowledge about the context in which the game would be played. The interviewees voiced a need for tools to support collaboration among designers and subject-matter experts when ideating games for health [17].

To address these challenges in the context of games for BI rehabilitation, we created and evaluated a prototype tool, GaPBIT (**Ga**me Design **P**atterns for **B**rain **I**njury **T**herapy),

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that leveraged the game design patterns we identified in our previous work focused on BI therapy [18]. Design patterns, originating from Christopher Alexander's work in architecture [3], document reusable design concepts that have successfully solved recurring problems in a certain realm. Particularly, game design patterns explore reusable concepts in the design of gameplay [7,30]. In the context of serious games (i.e., games designed to convey a purposeful goal in addition to entertainment), game design patterns have been advocated as an effective tool to support design ideation and facilitate communication among game designers and other stakeholders [25,29,34].

We created and iterated the design of the GaPBIT prototype with the involvement of professional games-for-health designers. We then explored GaPBIT's ability to support collaboration in the conceptual design process through six game ideation workshops (i.e., exploratory case studies of use); the workshops included both game designers and therapists who had worked with patients who had BIs. The primary contribution of this project is twofold. First, communication and collaboration challenges among designers and subject matter experts are common and critical in serious game design but are not well addressed in the literature. This project directly targets this limitation. Second, through this project we demonstrated that tools leveraging design patterns are promising techniques for bridging designer-expert collaboration. These techniques and our research methodology generalize to other domains where communication and collaboration among interdisciplinary design teams are imperative for success.

RELATED WORK

In this section, we discuss related work in three key areas: (1) serious games for BI therapy, (2) game design patterns, and (3) game design tools.

Serious Games for BI therapy

Researchers have investigated COTS games for BI rehabilitation on various gaming platforms, including Nintendo Wii [20,35], Sony Play Station [49], Microsoft Xbox [40], and web-based games [50]. Research has identified that many COTS games can provide an engaging experience for patients with BIs; some have been found effective at addressing therapeutic goals (e.g. [40]). Researchers and practitioners have also created games designed specifically for BI therapy. Much of the recent work in this area leveraged commercially available hardware (e.g. low-cost webcams [13] and Xbox Kinect [33]); some focused on providing adjustable parameters to accommodate diverse patient needs (e.g. [1]).

However, cases cited in literature have identified that currently available games have limitations in BI therapy. Beyond the too-challenging aspects of COTS games [43], some games also provide negative feedback that is inappropriate for this group of players [32]. Further, some COTS games require players to go through lengthy setup and/or cutscenes (non-interactive video clips) that take up valuable time during a therapy session [16]. As a result, therapists use COTS games with only a small portion of their patients; i.e., those who have demonstrated higher physical and cognitive abilities [42]. Meanwhile, games specifically created for BI therapy have often overly focused on therapeutic effects at the cost of player experience [11,12,48].

To address these issues, researchers have generated design guidelines for BI therapy games aimed at balancing therapeutic efficacy and engaging gameplay. For example, Flores et al. [21] generated a list of design criteria for stroke rehabilitation games focused on both rehabilitation and entertainment. Many have also argued that a successful collaboration between subject matter experts and game designers is crucial for creating engaging and therapeutically effective games [12,21]. Our work builds on research in this area by focusing on how conceptual and information tools can support games-for-health design.

Game Design Patterns

Design patterns are a collection of solutions that have successfully solved recurring problems in corresponding contexts [3]. Based on Christopher Alexander's concept, design patterns: (1) are capable of supporting communication of design knowledge and fostering creativity; (2) should contain context, the problem, and a solution to capture the invariant design knowledge; (3) should be interconnected and organized hierarchically; and (4) need to be iterated during design practice to realize their value [2,3]. The concept of design patterns has been adopted in many fields, including software engineering [14,22] and interaction design [8,19].

Applying the concepts of design patterns and pattern language in the design of gameplay has been discussed in the general game development community since the early 2000s [30]. Björk and Holopainen [7] accomplished the most comprehensive work in this field. Through an examination of common game mechanics, existing games, and game design methods, they generated a set of over 200 game design patterns organized into 11 broad categories. Thus, their patterns constituted a comprehensive common language of game design that could arguably be used to analyze and design games.

Researchers have also explored patterns in serious game design; most focused on educational games [26,29,34]. For example, Huynh-Kim-Bang et al. [26] investigated how game design patterns can help balance fun and learning elements, as well as support the collaboration between game designers and non-designers (e.g. teachers) in creating educational games. By analyzing 25 serious games and related literature, the authors provided more than 30 patterns focused on educational game design. Marne et al. [34] also investigated design patterns as a collaboration space to facilitate communication among game designers and non-designer stakeholders of educational games.

Very few studies have investigated design patterns for rehabilitation games. Goude et al. [25] mapped the general game design patterns established by Björk and Holopainen with taxonomy of common stroke rehabilitation tasks. Through analyzing data about the use of commercial games in BI therapy, our previous work has also investigated a set of game design patterns specifically focused on design considerations when addressing therapeutic goals in BI rehabilitation [18]. This paper directly builds and expands our previous research on BI therapy game design patterns.

Game Design Tools

It is a notable challenge that game designers lack conceptual and computer-aided design tools to support their ideation, communication, and documentation of game design ideas [17,37]. Attempting to address these issues, researchers have created software tools. For example, Karakaya et al. [27] developed a game ideation tool called 'Sketch-It-Up!' that affords the ability for game designers and other stakeholders to explore and communicate ideas. More closely related to our work, in his master's thesis Kuittinen [31] embedded Björk and Holopainen's game design patterns in a software tool for Computer-Aided Game Design (CAGE). In doing so, he intended to support designers to select appropriate patterns by providing a visual representation of the inter-relationships among the patterns. While preliminary, Kuittinen's work demonstrated an early effort to incorporate game design patterns in a tool.

More recently, researchers have also explored requirements for game design tools. For example, Nelson and Mateas [38] conducted job shadowing and interviews with three teams of independent game designers and identified requirements for a game design tool aimed at helping designers explore the interactions of game mechanics. Reviewing current and proposed game design approaches, Almeida and Silva [4] also identified a list of 14 general requirements for game design tools. Their requirements specified that a game design tool must: (1) define a formal structure for a collection of design concepts (e.g. game design patterns); (2) provide a software system to support the use and extension of this collection; and (3) consider both the designer's perspective and the player's perspective [4]. We followed these requirements in this project.

In our literature review, we did not find previous research focused on tools for therapy-centered game design. Our work addresses this gap by exploring meaningful ways to incorporate BI therapy game design patterns in design tools.

BRAIN INJURY THERAPY GAME DESIGN PATTERNS

GaPBIT leveraged a BI therapy pattern language we created in previous work that emerged from analyzing COTS game usage by therapists in BI rehabilitation. Following a data-driven approach, we identified 25 BI therapy game design patterns based on a large dataset about COTS game use in BI therapy [18]. These patterns were organized into two groups: (1) *efficacy-centered* patterns that focus on enforcing the effectiveness of games at addressing BI therapy goals and (2)

Efficacy-Centered Patterns

Game Rules Patterns	Physical Mechanics Patterns
• Fine Control • Minimalist Task • Optimal/Adjustable Pace • Step by Step • Unpredictable Events	• Change Hands • Integrated Standing Duration • Moving Different Body Parts • Self-Paced Weight Shifting • Weight Shifting to the Extremes
Perception Patterns	**Social Patterns**
• Focus and Distraction • Three-Dimensional Space	• Collocated Multiplayer • Turn-Based Multiplayer

Experience-Centered Patterns

Challenge Patterns	Progress Patterns
• Multiplayer Competition • Optional High-Level Challenge	• Advancing • Optimistic Performance Evaluation
Learn and Master Patterns	**Theme Patterns**
• Adjustable Speed • Gentle Challenge Ramp • Minimized Distraction • Pick up and Play	• Age Appropriate Theme • Enabling Theme • Familiar Theme

Figure 1. Summary of BI therapy game design patterns

experience-centered patterns that focus on fostering in-game experience of patients who have had a BI. We further divided each pattern group into sub-categories; Figure 1 lists the patterns we had identified.

Each pattern in the library contains (1) a name, (2) a category, (3) (for efficacy-centered patterns) a set of associated therapeutic goals, (4) a problem statement describing conflicts in design, (5) a solution proposed to resolve the problem, (6) example COTS games exhibiting this pattern to help users understand the pattern, and (7) a list of related patterns. While COTS games have limitations in use for people with a BI, it's beneficial to leverage COTS games for two reasons. First, there are very few games specifically for BI therapy that represent good game design. And second, COTS games are widely available so users of the patterns are either already familiar with them, or could easily get access to them to better understand the patterns. For details about efficacy-centered patterns, see [18]. In the following section, we provide one example experience-centered pattern.

Experience-Centered Pattern Example

The pattern ***Optional High-Level Challenge*** is a *Challenge Pattern* that focuses on a game challenge structure to avoid intimidating patients with limited abilities and at the same time engage patients with better abilities.

Problem: Because of the wide range of physical and cognitive effects of BIs, it is difficult to identify a "right" level of challenge to accommodate a range of patients who have had a BI.

Solution: Provide regular challenges throughout the play but occasionally give the player optional higher-level challenges. The high-level challenges should NOT be associated with the progress of the game; instead, they should provide appropriate incentives (e.g. bonuses) to encourage players to accomplish them and avoid frustration.

Example game – Wii Fit 'Penguin Slide': Players stand on a platform (about 2 inches high) and shift weight from side to side; this movement controls an iceberg on-screen so that a penguin character can slide to catch fish jumping from the water. Blue and green fish (easier to catch) provide lower points. Red fish are very difficult to catch and provide the highest points, but are optional (non-frustrating) challenges.

Anti-example game – Wii Fit 'Balance Bubble': A player avatar stands in a bubble suspended in a river. Players shift weight on the balance platform to control the speed and direction of the bubble to follow the river's path; the goal is to reach the finish line while avoiding the riverbank and obstacles. If a player hits an obstacle the game resets; some obstacles are extremely difficult to avoid (especially for many BI patients) resulting in a frustrating experience.

(The pattern document also included additional example games and specified the related patterns.)

BUILDING THE GAPBIT PROTOTYPE

Based on the structure of the BI therapy game design patterns, we created the initial user interface with paper wireframes (line drawings illustrating functionality and information hierarchy) and then progressed to web-based interactive versions. The concept of GaPBIT focused on allowing users to browse the pattern library via different views and providing structural and visual information for them to understand the patterns. In the following sections, we describe our user-centered design iteration process and the current interaction design of GaPBIT.

User Study Methods

We evaluated and iterated the interaction design through user studies with six professional games-for-health designers. During the studies, we first asked participants to complete four tasks using a think-aloud protocol; the tasks included identifying appropriate design patterns for a scenario and looking for specified information. After task completion, participants were asked to provide detailed feedback about the browsing features and the information provided in the patterns. Finally, we debriefed the participants about their experience using the prototype.

Design Iteration and User Feedback

All six participants completed the four tasks. Based on participants' feedback, we made several functional and visual modifications to enhance the design. First, we improved navigation among interconnected patterns by including links that allowed users to navigate to: (1) patterns addressing the same therapy goals; (2) patterns of the same category; and (3) related patterns. Second, we included background information about game design for BI therapy and added a narrated video to provide an introduction. Third, we added a "*My Saved Patterns*" function that allows users to save patterns to a personalized library and retrieve the saved patterns.

All of our participants expressed excitement about the tool concept. For example, a designer focused on board games that address adolescent sexual health issues said, "*I totally love it. ... You are providing multiple pathways to shake loose deeper ideas, I think it really helps getting past the surface.*" Participants also commented on the potential communication value of the tool; e.g. a designer who created iPad games addressing young adults' health issues mentioned, "*I think the potential here is not only for designers, but also for therapists to think about games – to have words to talk about why games might be useful for a particular brain injury. ... Once you have these terms, they are very powerful in communicating with other people.*"

Current GaPBIT Interaction Design

The current version of GaPBIT is available at: http://gametherapy.cstcis.cti.depaul.edu:8888. The home-page of GaPBIT provides background about game design for BI therapy and indicates three main functions of the system: (1) browse game design patterns focusing on therapy goals (i.e. efficacy-centered patterns); (2) browse game design patterns focusing on player experience (i.e. experience-centered patterns); and (3) visit the user's personalized library and retrieve the saved patterns. For each pattern browsing function, the system provides different views that organize the patterns according to their names, therapy goals (for efficacy-centered patterns), categories, and interrelations among the patterns.

Users can find detailed information by clicking on the patterns in the browsing interfaces. The detailed pattern information page includes the pattern's name, category, a brief definition, the problem and solution descriptions, and the example games. The tool also provides graphs and textual descriptions explaining how each example game realized the pattern; additionally, each game included comments from the therapists who previously used it in therapy. As illustrated in Figure 2, users are able to navigate from the detailed pattern information page to the connected patterns and save patterns to their library.

EXPLORATORY CASE STUDIES USING GAPBIT

To understand how the BI therapy patterns and the GaPBIT prototype could support ideation and designer-therapist collaboration in realistic design situations, we conducted six game ideation workshops in which game concepts were conceived. Following the workshops, we invited both game designers and therapists who were not involved in the workshops to evaluate the resulting game concepts.

Methods

The workshops were designed as quasi-experimental case studies guided by three hypotheses. Hypothesis 1: GaPBIT facilitates collaboration among designers and therapists; Hypothesis 2: GaPBIT will lead to game concepts that are better perceived by both designers and therapists; and Hypothesis 3: GaPBIT is especially effective at supporting novice designers who have less established ideation methods. In the following sections, we describe our methods

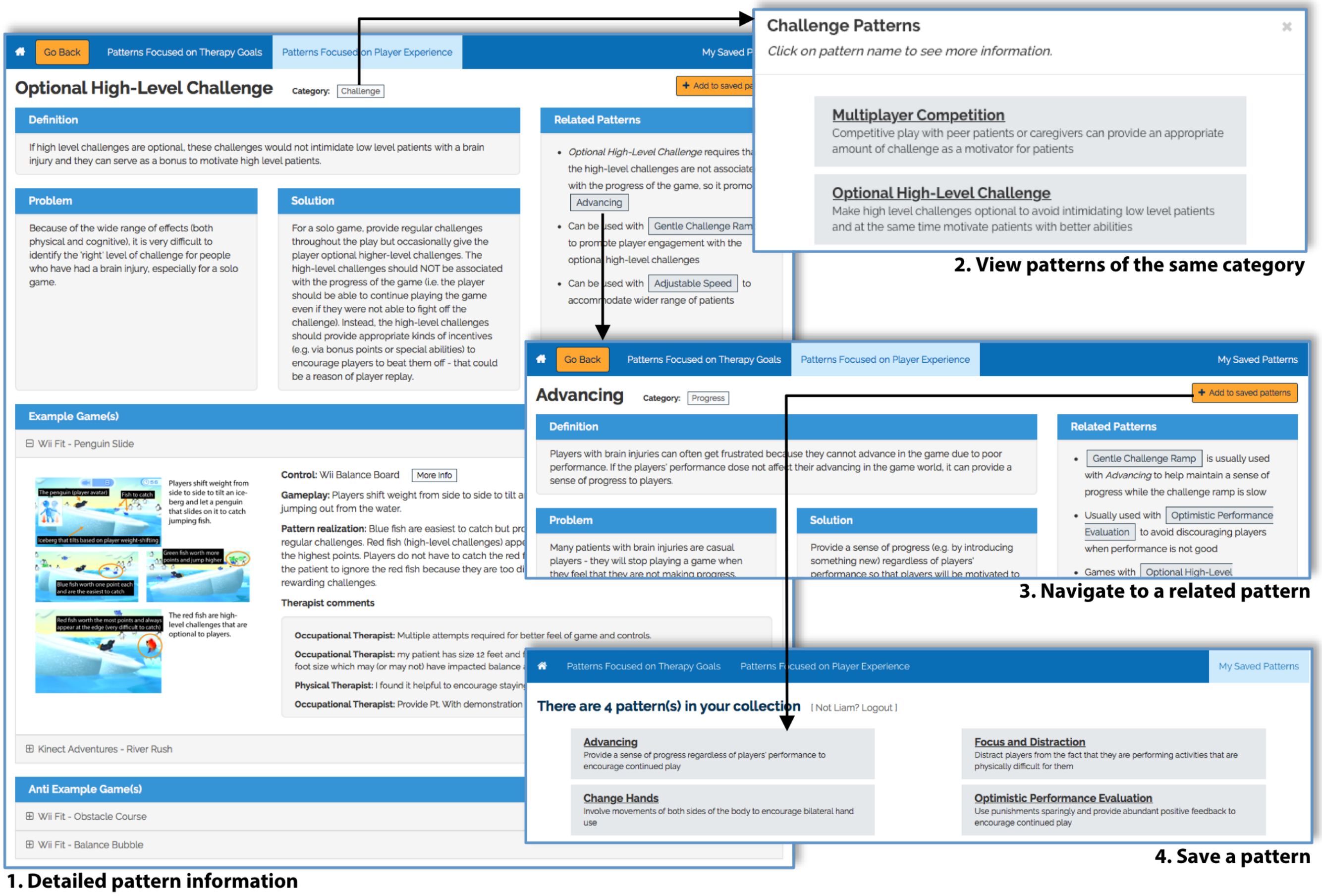

Figure 2. Example user interaction paths in the detailed pattern information page

for: (a) the game ideation workshops; (b) evaluation of the game concepts produced in the workshops; and (c) our data analysis procedures.

Game Ideation Workshops

In the game ideation workshops, we asked participants to conceive a game concept for a given BI therapy scenario and create a two-page written game design pitch to illustrate the concept and gameplay. The workshops included three conditions: (1) a designer working with a therapist (*Condition DT*); (2) a designer using the GaPBIT prototype (*Condition DG*); and (3) a designer working with a therapist while using the GaPBIT prototype (*Condition DTG*). Two workshops were held in each condition; one included a professional designer and the other included an undergraduate game design student from DePaul University. A total of six game designers participated in the workshops. Four therapists who focused on BIs participated in *Conditions DT* and *DTG*; one was an occupational therapist (OT) and three were physical therapists (PT). Table 1 summarizes our case study design.

For each workshop, we began with an introduction about game design for BI therapy. In *Conditions DG* and *DTG*, we also provided a brief tutorial of the GaPBIT prototype. We then presented the game design requirements, which described a fictional female patient who had a stroke in her 50s and was focused on improving her standing, walking, attention, and concentration abilities; the requirements also specified several hobbies (e.g. doll collector) of the patient prior to injury. Workshop participants were then asked to create a game on any platform (either digital or non-digital). We observed the design sessions from a soundproof room behind a one-way mirror. Workshop sessions were video recorded and were limited to 90 minutes. After the sessions, we debriefed the participants about their experience; debrief interviews were also video recorded and later transcribed.

Condition	Case	Participants
DT	PD+T	Professional Designer + Therapist
	SD+T	Student Designer + Therapist
DG	PD+G	Professional Designer + GaPBIT
	SD+G	Student Designer + GaPBIT
DTG	PD+T+G	Professional Designer + Therapist + GaPBIT
	SD+T+G	Student Designer + Therapist + GaPBIT

Table 1. Game ideation workshop experimental design

Game Concept Evaluation Sessions

We asked three professional game designers and three therapists (one PT, one OT, and one recreational therapist) to evaluate the game concepts created during the workshops;

evaluators were not involved in the workshop sessions. We framed the evaluation criteria so that the designer evaluators focused on player experience outcomes while therapists focused on the therapeutic value; see Table 2 for a summary of foci in the evaluation criteria for both groups. For each game concept, the evaluators were asked to rate each criterion on a five-point scale and provide an overall score from zero to ten. To mitigate order effects, we counterbalanced the design pitches using a randomized Latin Square [28]. After evaluation, we debriefed the evaluators to discuss the factors associated with the potential success of those game design concepts. Each evaluation session lasted for an hour; all were conducted over the phone and audio-recorded.

For Designer Evaluators	For Therapist Evaluators
• Game goal is clear	• Effective for the therapy goals
• Feedback is relevant	• Difficulty level is appropriate
• Mechanics are innovative	• Theme is appropriate
• Theme is appropriate	• Suitable for in-patient therapy
• Theme is unique	• Suitable for at-home therapy
• Game is re-playable	

Table 2. Foci of criteria for evaluating the design pitches

Data Analysis

We used an inductive approach in data analysis [15]. For the ideation workshop sessions, one author first coded the workshop videos in 10-second increments to identify predominant activities and events in each time slice and created a codebook. Two other authors then used the codebook and each deductively analyzed three workshop videos. We calculated the percentage of time increments in which the participants' activities were categorized in each theme. We then evaluated inter-rater reliability on these percentage values between the codebook generator and the blind coders using Intraclass Correlation Coefficient (ICC) Model 2 [36,46]. Additionally, the game design pitches were shared and discussed among all authors after the ideation workshops to identify common themes. Two authors also inductively coded the debrief interviews and combined their results.

Findings

In this section we present several categories of findings that include: (1) game concepts created during the workshops and their evaluation results; (2) designer-therapist conversation during the workshops; (3) high-level design phases that emerged when we analyzed the workshops; (4) a detailed description of an example workshop session; and (5) workshop participant feedback.

Findings 1: Game Concepts and Their Evaluation Results

Although we asked the participants to consider both digital and non-digital games, all design pitches focused on digital games. Among the four cases using GaPBIT, participants incorporated between four and ten game design patterns in the game concepts. In the following sections, we summarize each design concept.

Game Concept PD+T

Participants designed a Kinect game concept in which the player explores an enchanted garden maze and catches dolls that came to life from the player's collection; during the gameplay, a mystery storyline unveils. The player is required to step to navigate the maze and moves his/her arms to catch dolls and solve various puzzles. The dolls have different behaviors, providing various physical and cognitive challenges. Players and/or therapists can also adjust required movements, the amount of visual and auditory stimulation, and maze complexity level.

Game Concept SD+T

Participants designed a concept involving a series of mini-games/activities; each requires either Wii controllers or the Dance-Dance Revolution controller to play. Example activities include a racing game in which the player shifts weight to steer and accelerate and a tower defense game in which the player steps in different directions to move the cursor and place structures. Some activities allow players or therapists to adjust the required movements.

Game Concept PD+G

The professional designer used GaPBIT to create a concept based on adult coloring activities. Players are required to stand and use a baton paintbrush to complete images on a big screen by adding textures and colors. The images were curated to the player's taste and interest. Upon full or partial completion of an image, an animation effect activates based on the player's work. At the start of the game, players can adjust the boundaries of play space based on their range of motion.

Game Concept SD+G

The student designer used GaPBIT to design a concept that uses the Wii Fit balance board in which the player experiences the growth of a flower. The game starts with the player shifting weight to allow a bud to gather sunlight; more complex mechanics that involve arm movements to control the leaves are introduced as the game progresses and the flower grows. The game also provides different adjustable modes, imposing various levels of challenges.

Game Concept PD+T+G

Participants used GaPBIT to create a concept using the Wii Fit balance board in which players cycle in increasingly complex environments, collecting items to unlock new areas to explore. The player is required to shift weight side to side to pedal and to steer using a stand that resembles a bicycle handle supporting two Wii remote controllers. Players or therapists are able to adjust the required movements, the amount of visual and auditory stimulation, and the speed of the game.

Game Concept SD+T+G

Participants used GaPBIT to create a concept involving a series of Wii mini-games based on activities in Yellowstone National Park. Example mini-games include: Log-Balancing, in which the player shifts weight to keep the avatar on a wooden log while crossing a river; and Bird

Watching, in which the player shifts weight to move binoculars looking for a certain kind of bird and holds the position to take a picture. Each mini-game introduces additional movements and puzzles as it progresses. Players or therapists can adjust the required movements and the amount of visual and auditory stimulation in the game.

Game Concepts Evaluation Results

Table 3 summarizes the average overall score (out of ten) that the designer and therapist evaluators gave for each game concept. Overall, the highest scores were achieved in *Condition DTG* (use of GaPBIT) and in *Concept PD+T*.

The therapist evaluators rated the game concepts created in *Condition DTG* as the highest. They felt those two concepts were particularly suitable for inpatient use (an average score of 4.7 out of 5 on that criterion) because they both presented a wide variety of adjustable physical and cognitive challenges. *Concept SD+G* was rated as the lowest by the therapist evaluators because of its oversimplified theme and inability to provide adequate challenge for target patients; e.g., one evaluator said, "*I think there is just not enough in the game. It might be nice for a very low-level patient who is just starting to work on their standing balance, but it seems like that the target group is higher level than that.*"

Conversely, designer evaluators rated *Concept SD+G* the highest; they praised its minimalist design and the metaphor of growth in the game. For example, one evaluator said, "*It's pretty elegant. It's not terribly complex but it does feel complex enough to be engaging. … And the metaphor of growth is very nicely embedded.*" *Concept SD+T*, on the other hand, was considered the least impressive among the designer evaluators mainly because it lacked innovative elements (the criteria "the mechanics are innovative" and "the theme is unique" were rated as 1.7 and 1.3 out of 5, respectively) and did not have a coherent theme.

	Condition DT		Condition DG		Condition DTG	
Case	PD+T	SD+T	PD+G	SD+G	PD+T+G	SD+T+G
Therapist Evaluators	7.7	6.7	7.0	5.7	8.0	8.0
Designer Evaluators	6.3	4.3	6.0	7.3	6.3	6.0
Combined	7.0	5.5	6.5	6.5	7.2	7.0

Table 3. Average overall score for each game idea

Findings 2: Designer-Therapist Conversation

We examined the designer-therapist conversation during the workshops through video coding. Recall, we coded the workshop videos in 10-second increments and evaluated inter-rater reliability using ICC2. In this and the following sections, we only report on themes in which inter-rater correlation was considered statistically significant based on F-test with an alpha level of .05 [36].

Observed Events Among Therapists and Designers

When a therapist was involved (*Conditions DT* and *DTG*), we identified several prominent events during the conversation between the designer and the therapist; those events were attributed to the individual participants and included: (1) asked a question to acquire information; (2) suggested a game design idea; and (3) voiced disagreement or concern about the other party's opinions. During sessions when GaPBIT was used (*Condition DTG*), therapists provided more game design suggestions and both the therapist and the designer voiced considerably less disagreements or concerns (see Figure 3 and Figure 4).

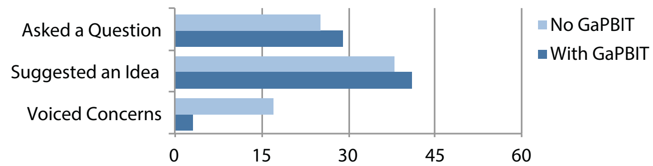

Figure 3. Counts of designer conversation events

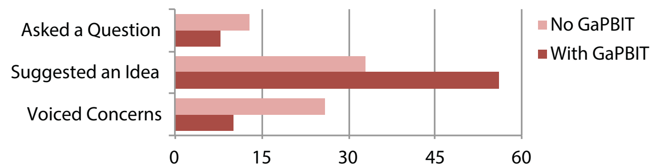

Figure 4. Counts of therapist conversation events

Further, when GaPBIT was not used, the discussion around disputable issues was often intense. E.g., in *Case PD+T* the participants had a heated discussion about adjusting the game's challenge level after the designer wrote, "*the maze will start simple and get more challenging*":

Therapist: Does that statement there mean that we can change the variables for the maze? …

Designer: [hesitantly] Well, if the complexity could be changed, then it would probably be a procedurally generated maze. I don't know how that'd work…

Therapist: I mean the maze can get a little harder each level. That's fine. But maybe in one level, as far as the cognitive layers we've been discussing …

Designer: Well, as far as the actual mechanics, you could go with something that is completely flexible, but then I'm essentially giving you a toolbox and say, "put it together." Then you'll have to be the game designer and determine the challenge. Alternatively, we could say we design a learning curve that we decide would make a good puzzle. But it is what it is. I mean it's possible to do it either way, but I think it'd put a big burden and take a lot of time for a therapist to set it up.

Therapist: Well. I am just thinking it would be nice like when she is on level one and she needs to find five dolls in ten minutes, and it is taking her six minutes to get the first one. … So it would be nice if I could pause it and change the objectives a little bit. Or if she's been super distracted all the birds that fly by, I can get rid of some of those things. …

Eventually, both compromised and agreed to include only some adjustable variables. In *Condition DTG*, we did not witness this type of intense discussion. This suggested that the design patterns presented as part of the GaPBIT prototype helped both designers and therapists realize potential issues early, resulting in more efficient discussion. We also observed that the patterns presented in GaPBIT facilitated discussion of game concepts. For example, in *Case PD+T+G* participants discussed how to incorporate several design patterns:

Therapist: Since she [the patient] is a cycler, maybe we can use some platform that she can hold on to, allowing her to stand and shift weight side to side to mimic that.

Designer: Yeah. With "*Moving Different Body Parts",* I think we can integrate the balancing with the hand motion to pick things up, to collect things. … And it also goes with "*Self-Paced Weight Shifting"*. … I think the motivation to continue playing would be that you go farther and you see new things, instead of like you are trying to beat a certain distance. …

Therapist: Yeah. And just in terms of "*Focus and Distraction"* and increasing the level of difficulty, it could be just about the setting. She could start out in a very non-busy area and go to more maybe…

Designer: Like a meadow into a forest, then into a city.

Therapist: Yeah. And sound-wise too.

Discussion Topics Among Therapists and Designers

We identified eight major categories of topics that emerged from the designer-therapist conversation:

- *BI therapy practices*: Participants discussed general goals and typical practice of BI therapy.
- *Target player attributes*: Participants discussed target player attributes from the scenario; attributes included physical and cognitive abilities, and/or taste and interest.
- *Game – High-level concerns*: Participants discussed high-level design considerations for the proposed game. E.g., in Case SD+T+G, during an early stage of design the therapist said, "*We need to keep it simple, being able to customize without taking too much time*"
- *Game – Platform/controller*: Participants discussed which game platform and/or controller to use.
- *Game – Fictional layer*: Participants discussed the game's genre, theme, and/or story. E.g., in Case PD+T, the designer proposed the enchanted garden idea and expressed willingness to include a storyline, then the therapist suggested the idea of using a garden maze to promote problem solving.
- *Game – Core mechanics*: Participants discussed the core mechanics of the game (i.e. the essential play activities players perform repeatedly in a game [44]).
- *Game – Features/variations*: Participants elaborated the game design idea and discussed the game's additional features. E.g., in Case PD+T+G, the designer suggested the idea to use music as an indirect reward: "*It could be that the music plays with more instruments if you go faster – as a 'non-essential' reward for moving faster.*"
- *Design patterns*: When participants used GaPBIT, they discussed which design patterns to choose and how to incorporate the patterns in their game.

Findings 3: GaPBIT Use in Design Phases

The concept of design phases emerged from analysis of the workshop sessions. We found that each design session included three high-level phases. The first was an *Exploration* phase**.** All design sessions started with participants reading the requirements document. The participants then explored the problem and solution spaces of game design through discussion and/or using the GaPBIT prototype. Initial discussion topics were usually about BI therapy practices and the target player attributes; discussion then shifted to topics about high-level game design considerations, the game's platform or controller, and its core mechanics. Next came the *Elaboration* phase. When a core concept of the game is settled (indicated either in written notes or verbal discussion), participants took extensive notes and focused on expanding the game's core mechanics and theme; the discussion topics covered all categories and were mainly focused on the game's fictional layer and its features and variations. Last, the design process moved into a *Finalization* phase when participants started writing the design pitch. While mostly focused on typing and editing, participants also refined their design ideas during the finalization phase.

The GaPBIT prototype was used most frequently in the *Exploration* phase (See Figure 5), in which participants explored various design patterns and regularly "saved" patterns into their library; when a therapist was involved (*Condition DTG*), GaPBIT helped frame the discussion about the high-level design considerations and the game's core mechanics. Particularly, participants focused on examining the patterns' problem and solution descriptions and explored related patterns to identify the most relevant ones and paid less attention to the example games in this phase. In the *Elaboration* and *Finalization* phases, participants revisited their saved patterns, especially the example games included in each pattern, to seek clarification and inspiration for game design ideas. The discussions about the game's features and variations were usually shaped by patterns in GaPBIT. Figure 6 summarizes the average percentage of time participants spent using different GaPBIT functionalities in the three design phases.

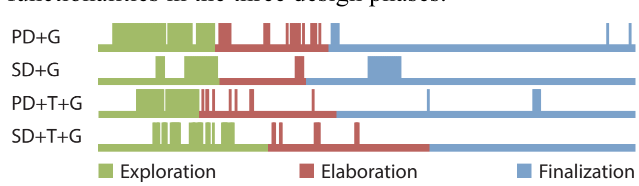

Figure 5. Frequency of GaPBIT use by phase. Each vertical bar indicates a 10-second increment in which GaPBIT is used.

	Browse patterns	'My saved patterns' list	Pattern descriptions	Example games	Related patterns
Exploration	30%	1%	53%	9%	8%
Elaboration	18%	33%	27%	22%	0%
Finalization	25%	43%	23%	8%	0%

Figure 6. Average percentage of time spent on GaPBIT functionalities by design phase

Findings 4: Example Case SD+T+G

To illustrate how participants approached game concept design during the workshops, we provide the details of an example workshop case: *SD+T+G*. The designer involved in this case was a junior-year undergraduate student in the game design program at DePaul University. He worked with an occupational therapist who had used video games in therapy. Figure 7 and Figure 8 illustrate their ideation workshop timeline.

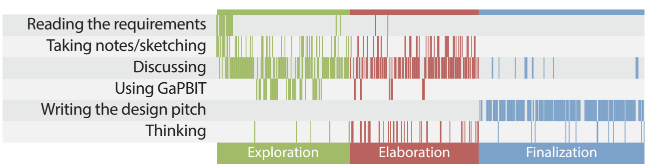

Figure 7. Major activities of participants in *Case SD+T+G*

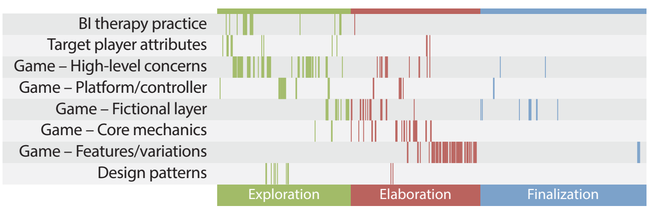

Figure 8. Discussion topics in *Case SD+T+G*

At the beginning of the *Exploration Phase*, both participants read the design requirements; the designer took notes about the target player and therapy goals. Then the designer asked about the therapist's typical practice if he was working with a patient like the target player. The therapist brought up several high-level issues very early in the exploration phase; e.g., "*We need to keep it simple, and also being able to customize without taking too much time.*"

After discussing these issues, they used GaPBIT to explore the resolutions. They browsed, discussed, and saved 11 game design patterns in GaPBIT. During this process, they were mostly focused on pattern descriptions and related patterns and did not explore the example games. Based on these patterns, the therapist suggested using the mini-game format to support adjustable features: "*Maybe for our game, we can have two pathways: standing only and arm use only. Then the therapist can decide which one is more appropriate. If there is a set of mini-games, then we can divide them up into different games.*" The participants then agreed upon the platform, the main theme, and the core mechanics of the game: a Wii game that includes activities happening in national parks.

In the *Elaboration Phase*, they first used GaPBIT to explore several example games in the patterns they saved. Based on this exploration, they discussed and settled on six mini-games within the national parks theme. They elaborated each mini-game to include different difficulty modes and other adjustable features. During this process, they revisited the design patterns they saved in GaPBIT to get clarifications and inspiration; they also extensively explored the example games associated to their saved patterns for ideation of game mechanics. The designer took extensive notes to record the ideas emerged during the discussion.

During the *Finalization Phase*, the participants focused primarily on typing and editing the game design pitch. They occasionally discussed to clarify or confirm the ideas they previously generated.

Findings 5: Workshop Participants' Feedback

During debrief, participants in all conditions stated that they were satisfied with their game ideation process. However, the reasons for satisfaction varied. In *Condition DT*, participants valued the interaction with someone from an unfamiliar field to bring in different perspectives. For example, the therapist from *Case PD+T* mentioned, "*It's nice to talk to someone in a completely different field because you can bounce ideas off of each other and get a different point of view.*"

In *Condition DG*, the designers felt that GaPBIT was useful at helping them explore game design ideas and understand the needs in BI therapy. For example, the professional designer in *Case PD+G* mentioned, "*I came with the idea very early on and I think from the tool I got just enough support without being overwhelmed.*" The student designer in *Case SD+G* also said, "*When making games I don't often think about players who have a disability. So the tool did help me single out the things I am looking to the needs of this particular group.*"

In *Condition DTG*, participants commented on the common language GaPBIT provided to support collaboration. For example, the therapist from *Case SD+T+G* said: "*I think the tool did open up that communication where you have two experts in very different areas trying to come up with something that they have to work together on. It captured a lot of the terms we use and the goals that we have. So I think it helped the game designer talk in our terms.*" The designer from *Case PD+T+G* mentioned: "*The tool acts as a checklist. So it helps to have someone else view it and also to hear their understanding of how each thing could be addressed.*"

DISCUSSION AND CONCLUSION

In this paper, we explored how GaPBIT, a tool incorporating game design patterns supported conceptual design of games for BI therapy and facilitated collaboration among designers and subject matter experts. We frame our discussion in the next sections by reflecting on our three hypotheses. We conclude with additional implications of our study and discuss limitations and future work.

GaPBIT Supported Ideation and Collaboration

There is rich evidence to support Hypothesis 1, that GaPBIT facilitates collaboration among designers and therapists. We found that GaPBIT facilitated the game ideation process and helped to support an efficient discussion among the workshop participants. Our results indicated that GaPBIT was able to help establish an early mutual understanding that resulted in fewer conflicts and disputes between our designer and therapist participants. Participants also employed the pattern language embedded in GaPBIT when discussing their game design ideas. Further, in debrief interviews participants indicated that they appreciated the communication scaffolding provided by GaPBIT.

Tools Could Not Substitute Collaboration

Hypothesis 2, that GaPBIT will lead to game concepts that are better perceived by both designers and therapist, was only partially supported. The most highly rated games by therapists were those that included GaPBIT, a designer and a therapist, indicating that the use of GaPBIT led to games with more predicted therapeutic value. However, there were no salient patterns among the designer evaluators. Particularly, there was a substantial discrepancy between therapist and designer evaluators on *Concept SD+G*, designed without the input from a therapist. These results suggested that information tools like GaPBIT should only be considered as a supportive channel and should not substitute collaboration with subject matter experts.

Characteristics of the six game concepts also indicated that the therapists provided valuable information about the needs in BI therapy during the game ideation process. While the two concepts designed without a therapist (*Condition DG*) embodied a more artistic quality, the concepts designed with a therapist (*Conditions DT* and *DTG*) integrated more challenging physical and cognitive activities. Further, allowing players and/or therapists to adjust game features was commonly desired by therapists [5,42]. GaPBIT was able to communicate this need through certain patterns (e.g. *Optional High-Level Challenge*); however, the adjustable features were more emphasized and contained more details with therapists' input.

Novice Designers May Need More Scaffolding

Hypothesis 3, that the GaPBIT prototype is especially helpful for novice designers, was also partially supported. On one hand, when used with a therapist, GaPBIT helped student designers achieve considerably higher scores from both designer and therapist evaluators; for experienced designers however, the scores for *Concepts PD+T* and *PD+T+D* are similar. On the other hand, novice designers exhibited difficulty in absorbing the complexity of information provided by the therapists, resulting in games that had less coherent themes and gameplay. Notably, both game concepts designed by student designers working with a therapist (*Game Concepts SD+T* and *SD+T+G*) adopted a mini-game structure; *Concept SD+T* exhibits considerable incoherence. The student designer from *Case SD+T* mentioned in debrief, "*At first we wanted to focus on one game. But it's hard to do too much in one activity. ... [The therapist] just prodded a lot of different considerations you have to worry about.*" These results indicated that while GaPBIT and the design patterns were helpful for novice designers who have less established ideation methods, more scaffolding is needed for students to consider coherent design concepts in extremely complex contexts, such as the context of games for BI therapy.

Conclusion: Game Design as a Reflective Process

The results of this study supported previous findings that games-for-health designers tend to explore both the problem and the solution spaces somewhat equally [17]. Particularly, participants spent much of the *Exploration* phase to examine the current BI therapy practice and the target player's attributes. Further, the participants' approach echoed Schön's concept of "reflection-in-action" [45]; i.e., designers constantly engage in critical, reflective thinking to adjust and refine their design concepts in an unfolding situation. Even with the limited time provided in the ideation workshops, participants still performed multiple mini-iterations through the three design phases. Reflective thinking and adjustment manifested as a major activity in the *Exploration* and *Elaboration* phases; and in the *Finalization* phase, participants still refined their design when new information and/or clarification emerged.

In this study, we demonstrated that tools incorporating game design patterns are promising techniques to support reflective design process of BI therapy games. These techniques are critical for domains in which there are collaboration challenges among designers and subject matter experts. As such, we argue that our research methodology used in this study generalizes to other domains to support design in interdisciplinary teams; e.g. other types of games for health such as games aimed at ameliorating challenges for children with autism.

Limitations and Future Work

While the small sample size of the ideation workshop sessions afforded detailed exploration, conducting a larger-scale study might support quantitative analysis of our three hypotheses. Further, although somewhat realistic, our ideation workshops did not duplicate real-world game design situations that involve more complex issues, such as budget, time, and market constraints. Additionally, this study focused solely on the creation of initial game concepts. Further research exploring how patterns and tools could support evolvement of fully developed games in real-world game design contexts would be valuable.

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