Towards a Prototype Tool Leveraging Design Patterns to Support Design of Games for Brain Injury Therapy

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Abstract
In this paper, we discuss our user-centered approach in creating a game design tool prototype, GaPBIT (**Ga**me Design **P**atterns for **B**rain **I**njury **T**herapy). GaPBIT leveraged game design patterns to support designer-therapist collaboration when ideating games for brain injury therapy. In user studies, professional game designers expressed enthusiasm about the patterns and the GaPBIT prototype, indicating that conceptual and information tools like GaPBIT would be well received by design practitioners and help them in their work. We argue that tools like GaPBIT are promising facilitators for promoting design of games for health and could potentially be used for educating designers interested in serious games.

Author Keywords
Game design tool; game design patterns; serious game design; brain injury; rehabilitation; games for health.

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 [13]. Depending on the causes and nature, a BI can result in impairments affecting both physical and cognitive abilities, which in turn, leads to diverse recovery paths. It can be challenging to motivate patients with a BI to engage in repetitive activities needed for rehabilitation [2,8]. As a result, many therapists include games in their therapy sessions [14,15]. However, currently available games have many limitations for this population [4,5,11,16]. Designing effective, appropriate, and engaging games for BI therapy is thus a challenging and important area.

In previous work involving interviews with game designers focused on games for health (i.e. serious games embedded with health-related goals), we identified that many designers found it difficult to collaborate with the subject matter experts (e.g. therapists in this context), who usually have different mindsets and motivations [6]. Specifically, subject matter experts tended to be narrowly focused on the purposeful goals of the game, while game designers often lacked knowledge about the context in which the game would be played. Our interviewees also voiced a need for conceptual and information tools to support ideation and communication of game design ideas [6].

To address these issues, we created a prototype game design tool, GaPBIT (**Ga**me Design **P**atterns for **BI T**herapy) that leveraged design patterns to support designer-therapist collaboration when ideating games for BI rehabilitation. Design patterns, originating from Christopher Alexander's work in architecture, document reusable design concepts that have successfully solved recurring problems in corresponding contexts [1]. Björk and Holopainen completed the most comprehensive work applying the framework of design patterns in game design [3]. In the context of serious games, game design patterns have especially been advocated as an effective tool to support collaboration in interdisciplinary development teams [9,10,12]. However, discussion about design patterns in BI therapy games is very limited in the literature. There is also little work focused on tools for BI therapy game design. This work addresses this gap.

Efficacy-Centered Patterns

Game Rules Patterns	Physical Mechanics
• 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
Theme Patterns	**Learn and Master Patterns**
• Age Appropriate Theme • Enabling Theme • Familiar Theme	• Adjustable Speed • Gentle Challenge Ramp • Minimized Distraction • Pick up and Play

Figure 1: Summary of BI therapy game design patterns

BI Therapy Game Design Patterns

In our previous work, we identified 25 BI therapy game design patterns based on data we collected from therapists' accounts about game use in more than 400 BI rehabilitation sessions [7]. We organized these patterns into two groups: (1) *efficacy-centered* patterns that focus on enforcing the effectiveness of games at addressing therapy goals and (2) *experience-centered* patterns that focus on fostering in-game experience for patients. Each group was further divided into several sub-categories; see Figure 1 for patterns we identified.

Each pattern 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 games demonstrating how the pattern is implemented, and (7) a list of related patterns. For details about efficacy-centered patterns, see [7]. The side bar provides an example experience-centered pattern, *Optional High-Level Challenge*.

Early User Feedback: Methods

We worked with 11 professional game designers who focused on games for health to collect feedback about a

Optional High-Level Challenge

***Category*:** Challenge pattern

***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 wide range of patients.

***Solution*:** Provide regular challenges throughout the play but occasionally give the player optional higher-level challenges (e.g. bonuses). The high-level challenges should NOT be associated with the progress of the game.

***Example game*:** *Wii Fit 'Penguin Slide'*. Players stand on a balance board 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 challenges.

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

sample of our patterns. The participants' professional experience varied between 3 and 23 years. All had worked on games for health projects for the past three years. One week before each study, we sent to our participants a document that included two game design pattern examples: (1) *Change Hands* (an efficacy-centered pattern focused on the bilateral hand use therapy goal) and (2) *Optional High-Level Challenge* (an experience-centered pattern described above).

We first asked participants to identify their familiarity with game design patterns; we provided a brief introduction if participants were not familiar with the concept. We then asked them to provide feedback that included two things they liked and two things they did not like about each example pattern. Lastly, we asked participants to describe their general impressions about game design patterns. User studies were audio-recorded and later fully transcribed. We inductively coded the transcripts to identify major themes.

Early User Feedback: Findings

Participants' experience with game design patterns varied. Three mentioned that they have used patterns in their work. Four were familiar with the concept but had never used patterns in practice. The remaining four designers were not familiar with design patterns prior to the study.

Participants generally expressed interest and satisfaction with our example patterns. The top elements about the design patterns associated with the positive comments included:

- The problem-solution structure of each pattern helps users understand the appropriate situations in which the patterns intended to be used. E.g., "*It's very good to state the problem – why would you even use this pattern – and then provide a solution exactly for that problem.*"
- The example games helps users better comprehend the core ideas of the patterns. E.g., "*It's good to have those examples so that you can actually understand what the description is intended to convey.*"
- The patterns are interconnected via categories and related patterns to potentially form a complex network. E.g., "*The related patterns are handy because that helps you with what is already there – saying 'maybe you need to consider these as well'.*"

Participants also voiced concerns associated with various areas of our design patterns. The most prominent concerns were about the game examples that represented the patterns. First, participants wanted to see more example games to better understand different ways in which patterns can be used. Second, participants desired more visuals (e.g. screenshots of example games) to better grasp how the example games realized the pattern. Third, participants desired more information about game consoles and controls; they considered such information as helpful for discussing with stakeholders who were not familiar with gaming. We refined all patterns in the library based on participants' feedback.

In support of our concept, participants also indicated a desire to have similar game design patterns in their focus health area. They discussed potential benefits of using the framework of game design patterns; we categorized their discussion into three areas:

(1) Seven participants mentioned that game design patterns could help them sharpen focus during game ideation. E.g., "*The big thing that I get from those patterns is sort of a clearer idea of what is most likely to work.*"

(2) Five participants considered game design patterns to be helpful for them to explore the problem space and understand the domain. E.g., "*I think mostly what those patterns do is opening up possibilities, possibilities for what you could accomplish with games in that domain.*"

(3) Three participants mentioned that the patterns could help them communicate with other stakeholders, including subject matter experts. E.g., "*I think those can really illustrate things so that both the game developer and the expert content providers can ultimately sit down and say 'Yeah, this is a right kind of thing for this particular area.'*"

Building the GaPBIT prototype

To afford the use of the BI therapy pattern library, we created the GaPBIT prototype. While the primary user focus for GaPBIT was game designers, we intended that the tool would support designer-therapist collaboration when ideating games for BI therapy. As such, GaPBIT, empowered by the underlying patterns, is aimed at providing a common language and useful contextual information for both designers and therapists.

Based on the structure of the BI therapy pattern library, 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 structured and visual information for users to understand the patterns. In the following sections, we describe our user-centered process and the current interaction design of GaPBIT.

Figure 2: Enhancing navigation

User Study Methods

We conducted user studies to iterate the GaPBIT interface with six professional game designers who were involved in the initial design pattern feedback. During the studies, we 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. These modifications included:

(1) *Enhancing Navigation Among Interconnected Patterns*. We improved navigation among interconnected patterns by including links that allow users to navigate to (a) patterns addressing the same therapy goals (for efficacy-centered patterns); (b) patterns of the same category; and (c) related patterns; see Figure 2.

(2) *Modifying the Background Information Structure*. We elevated the background information about game design for BI therapy to the homepage (this info was in

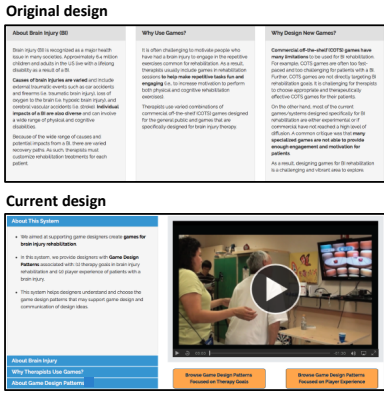

Figure 3: Revised background information structure

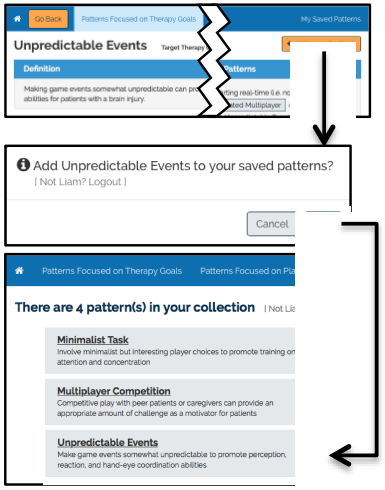

Figure 4: "My Saved Patterns" function

a separate page in initial design). We also organized it into collapsible sections and added a narrated video to provide an introduction; see Figure 3.

(3) *Adding "My Saved Patterns" Function*. Participants expressed a need to "mix and match" design concepts. In response, we added the "My Saved Patterns" function that allows users to create and login to their account and save particular patterns to their personalized collection for future use; see Figure 4.

All participants expressed excitement about the tool concept. For example, a designer focused on creating 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 games addressing young adults' health issues mentioned, "*I think the potentials 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 homepage 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) save patterns to a personalized library and retrieve the saved patterns. For each pattern browsing function, the system provides different views that organize the patterns according to their name, therapy goal (for efficacy-centered patterns), category, and interrelations.

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 5, from the detailed pattern information page users are able to navigate to the connected patterns and save patterns to their personalized library.

Discussion

In this paper, we described our user-centered methods towards creating and evaluating BI therapy game design patterns and a corresponding tool, GaPBIT that focused on supporting designer-therapist collaboration when ideating games for therapy. In our user studies, professional game designers expressed enthusiasm for the patterns and the GaPBIT prototype.

This work promotes game design for BI therapy. Providing game designers and therapists with easy access to information about the common considerations in rehabilitation games will greatly encourage design work in this area; i.e., this will help generate a more diverse set of rehabilitation games designed for a wider population of BI patients. Further, we argue that the

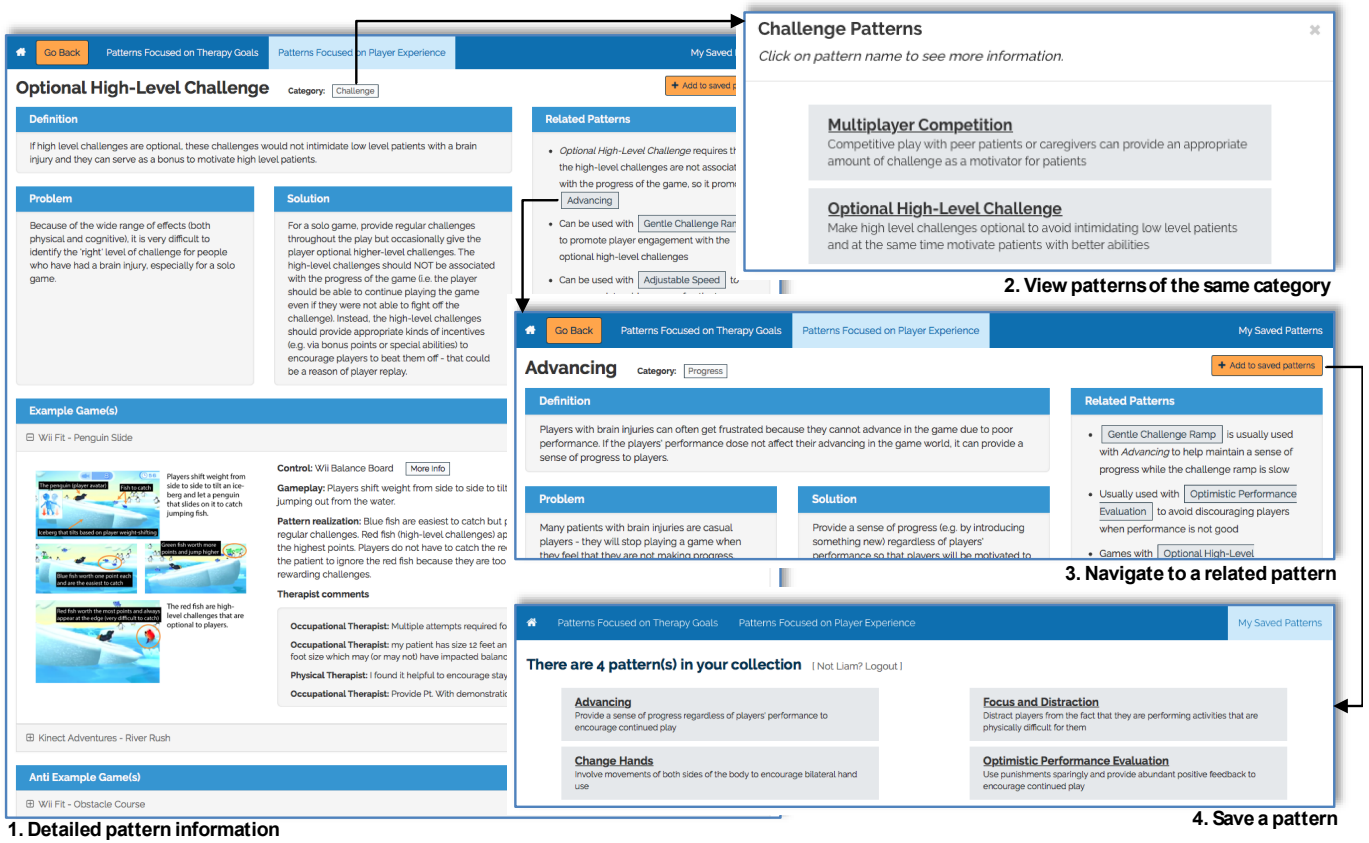

Figure 5: Example user interaction paths in the detailed pattern information page

game design patterns and the GaPBIT prototype has potential for use as an education tool to support learning serious game design; i.e., help in the development of higher education programs and/or in industry training programs for therapists and game designers to establish a better mutual understanding.

To further understand how the BI therapy patterns and the GaPBIT prototype support ideation and designer-therapist collaboration in realistic design situations, we are conducting game design workshops that involve both designers and therapists. Future work also includes exploration of similar tools in other games for health areas.

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