Crafting a Design Concept Prototype for an Educational Game Design
A Case Study

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Abstract

This paper presents the importance of rigorous design research in the development of an educational board game. The project's goal was to create a board game to engage children, their friends and parents in the management requirements of diabetes, which are difficult to understand. Board games were perceived as the most appropriate delivery because of their capacity to simplify large concepts, making them appropriate for the experiential learning required to master complex information. Research and design process of this project involved collaborations with graduate student researchers, sponsor clients, subject experts, and faculty advisors. Designers developed an iterative research model encompassing several design research methods, including interviews, literature review, participatory research methods, generative tools, usability testing, and pilot testing. The paper summarizes the collaborative and rigorous research process used in the design development of an emotionally connective and engaging game that was fun, educational, and significant to the management of diabetes.

Key words: Design Methodology, Design Tools, Design Project Cases, Co-design/Co-creation/ participatory design

1. Introduction and Design Approach

The Central Ohio Diabetes Association (CODA) solicited the assistance of the Department of Design to create an emotionally connective and engaging board game that was fun, educational, and relevant to the personal health management of diabetes for children living with diabetes, as well as their friends and parents. CODA staff from management, social enterprise, and outreach worked with varying teams of and individual design graduate students and faculty in the development of a prototype game. Individual involvement varied as specific tasks and areas of research evolved, allowing a fluid exchange of ideas and diverse set of experiences.

Diabetes has complex self-management requirements, which are hard for people unfamiliar with the illness

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to understand and implement. In analyzing the problem, one must first consider why a board game is more appropriate than other forms of communication or education. Project sponsors and designers deduced that elements inherent to games make them appropriate for experiential learning, specifically the simplification of concepts and social interactivity, thereby enhancing the learning process. Games, by their very design, provide both clear goals and immediate feedback, allowing for a more holistic learning experience (Smith, M. W. & Wilhelm, J. D. 2002). If the game succeeds at being emotionally engaging in a fun way, players will be in the right frame of mind to allow the educational component to be absorbed, effectively using an emotionally engaging experience as a springboard for learning. This study presents a design development project demonstrating educational board games can be fun and designers can use an analytical process to ensure so. Ultimately, it will propose a research model to be used as reference for board game designers.

This paper outlines the development of the CODA board game as a case study for the development of the research model. It leverages generative tools, co-creation workshops, literature review and interviews, iterative design processes, usability testing, pilot testing, and evaluative workshops to determine and propose the appropriate steps in designing educational board games.

2. The Proposed Game Design Model

The model employed for researching and creating the final prototype of the game consisted of four phases: Data Gathering, Creative, Testing and Evaluation, and Prototype. Each phase utilized a set of processes employing different forms of design research and generation. The model should not be seen as a step-by-step process. The four phases of research making up the model fit within it fluidly and are intermeshed with one another, depending on the designer's context (Figure.1).

3. Data Gathering: Overview

Interviews, literature review, and generative research constituted the Data Gathering phase, which also overlapped the second phase, Creative. Researchers conducted background research, consisting of interviews and meetings with CODA staff, who served as content experts. A team of researchers performed a literature review, to familiarize the research team with the subject matter of diabetes to inform creative decisions. The team organized generative research workshops employing co-creation to generate artifacts to augment the creation process and allow multiple people to create, offer input, and participate in the design process. It analyzed all the data collected from this research and used it to conceptualize ideas to incorporate into the workable game concept.
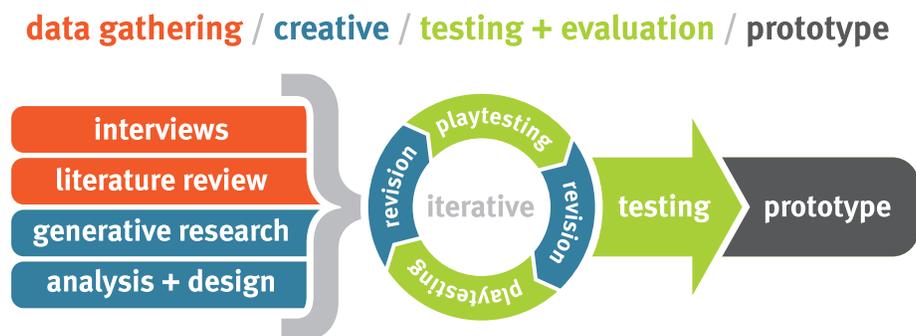

Figure.1 The game design research model for board game design

3.1 Data Gathering : Literature Review

The research team explored and learned about the subject matter and its complications and management by reading popular publications concerning diabetes and health management, as well as sponsor recommended literature. Researchers reviewed sample game concepts and analyzed the unique characteristics of other diabetes themed games. They also studied other established models of game design to gain insight on design language, processes, and strategic approaches.

3.2 Data Gathering : Generative Data Gathering

A research session with the project sponsors organized by researchers sought to identify their hopes and dreams for the game. The team developed a miniature toolkit consisting of an open storybook, and asked participants to craft stories describing their vision of the product. Stories contained many specific game ideas, with the concepts of " balance" and "fun" dominating. Sponsors were particularly interested in a product that was fun for players, since this elusive element was missing from previous attempts for a game. A particularly interesting observation emerged from this workshop. CODA participants were very verbal in their storytelling, using only text with no illustrations, while design researchers were very visual, using combinations of text and image, mind maps, and collage.

3.3 Data Gathering: Generative Workshop #1

The research team conducted a participatory workshop session with CODA to explore ideas for possible game concepts. A MakeTools approach provided workshop participants an expressive, creative, and emotionally engaging method for developing game concepts. The MakeTools toolkit consisted of a series of words describing different aspects of prospective games, many small toys, colorful paper shapes, and Velcro construction pieces used in other toolkits (Figure.2). Participants formed three teams, each with a combination of CODA participants and Design researchers. The teams selected words to use as starting points for their game concepts and produced thoroughly realized game concepts (Figure.3), each focusing on the concept of balance and exploring ideas of what constitutes "fun." Teams presented game concepts, after which the entire group discussed in greater depth. The researchers took notes, videotaped the event for further analysis, and collected all game models.

3.4 Data Gathering: Internal Data Analysis

Analysis of Generative Workshop data followed with researchers reviewing process notes, discussing design options, and evaluating preliminary game concepts. Two prominent ideas emerged identified:

Figure.2 Samples of Velcro modeling, toy, and word selection objects included in the toolkit during Generative Workshop #1

Figure.3 The three game concept artifacts generated in the workshop

customizable game pieces and the mechanics of the game in relationship to balancing the various aspects of diabetes. The team focused on these ideas for developing the central components of the game. It developed two full game concepts, one based on the children's game of "Capture the Flag," a schoolyard game where children compete to steal a flag or other token from their opponents' base, and the other based on a concept of power-ups and collecting items. The team decided to combine the most effective elements of both concepts into a concept prototype.

4. Creative: Overview

Some of the research team members began to take on the role of designers at this stage, assuming more creative responsibilities in addition to continuing research. It developed a concept prototype in paper and gatorboard (Figure.4), keeping design elements simple to encourage continued input from any and all participants. Time was spent determining the intricacies of the game's rules, and establishing and editing its relationship to the management of diabetes.

4.1 Creative: Design Development of Concept Prototype

Researchers deliberately chose not to worry about the visual appearance of the concept prototype, feeling users would more likely participate in the game's creation if it had a "rough" appearance. If the concept prototype appeared too finalized, it was possible users could feel their input would only complicate ongoing production of the final game. The end result was a prototype clear enough for users to understand, but loose enough that there was no particular visual style applied to anything, and lots of elements remained hand-made (Figure.5). It was rough, but ideal for the process. The paper prototype was pre-tested with a group of

Figure.4 Researchers building the Concept Prototype, Figure.5 The final Concept Prototype

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graduate students with backgrounds ranging from engineering to product design, and graphic design. It was revised as necessary to allow for the smoothest experience possible before the Playtesting Workshop.

4.2 Creative: Generative Playtesting Workshop

CODA scheduled a workshop session to test concept prototype usability with its target audience of children aged 7–12. It designed the workshop to encourage participating children, their parents, and the design team members to test and revise the existing game. Users were comfortable enough with the prototype to offer suggestions, critiques, and write out scenario cards, game cards presenting players with real-world scenarios that must be acted on in order to continue gameplay. The outcome of this workshop provided offered insightful information for the next stages of development. The concept prototype connected emotionally with the players, who expressed excitement over building their own characters and finding the flag. Participating children played the game again, impromptu, at the conclusion of the workshop, and asked researchers if they could keep the game.

5. Testing and Evaluation: Overview

The research team continued game development in an evaluative stage. Although the generative stages of the research process involved a certain amount of evaluative thinking during every step, this next stage was based on evaluation of the existing game concept and its revision into the final prototype. The game concept was already part of the way through an iterative process of playtesting and revision that was intended to help gather enough data to determine the best approach for designing a working, final prototype. It was additionally imperative to perform usability testing on various components; in this case, the game's instructions. It was impossible to maintain their fluidity and accessibility along with the game, as doing so would have impeded the game design process due to their nature as a somewhat separate system from the game itself. The concept prototype was then ready for pilot testing with a group of participants who would stand in for the participants at the final testing workshop.

5.1 Testing and Evaluation: Usability Testing

The researchers shifted focus to revising the physical game prototype and preparing for another level of iterative testing following the playtesting workshops. A major deficiency with the concept prototype was the lack of any detailed instructions, i.e., written, codified rules. As the game was constantly being revised due to the iterative process, the original rules quickly became obsolete. Also, as the revisions continued until the day of the Generative Playtesting Workshop with CODA participants, researchers had relied on communicating the game's rules verbally. The team realized it was important to develop a set of written instructions to codify

Figure.6 The visually-based instructions that underwent usability testing

the rules and assemble them into a tangible, written format. Two versions of instructions were produced: one relying mostly on visual aids, the other on written text.

The first version of the instructions given to subjects consisted mostly of visual aids, and fewer words (Figure.6). The subjects were attracted at first to the appearance of these instructions, and thought the visuals corresponded well to the game pieces in front of them. Their interest in learning the game was heightened based on the visual presentation and the attractive playing pieces. Players' reactions were mixed regarding the clarity of the setup details. They were unsure of the placement of certain game pieces and whether there was a suggested method for configuring the game board tiles. Subjects struggled to move forward with the game, and the decision was made to switch to the second instructional format without completing testing of the first format.

The second version of the instructions, which was a more verbal, format and much more text-based, was initially pleasing for the subjects, but that positive experience did not last. Players felt this set of instructions assumed they already knew the basics of gameplay and setup, that it was not clear at what point players should do certain things, and that key rules and gameplay elements were either left out or mentioned off-hand. One participant went so far as to say, "at this point, I would just make up rules." Subjects were also not seeing some of the information that was actually there, as their frustration had served to shut down their intuition. They also expressed a need to "get it right." Neither set of instructions addressed this issue. Ultimately, the game rules needed to be simplified much more. The visual instructions were preferred, but required more details from the written instructions in order to serve their appropriate function. The challenge remained to distill the complex instructions and present them in a clear and interesting way.

5.2 Testing and Evaluation: Pilot Testing
All parties involved in the development of the game recognized a prime situation for testing the playability and informative ability of the game; specifically, Camp Hamwi, CODA's summer camp for children with diabetes. Counseling staff volunteered to run the research sessions, which required training the counseling staff to act as researchers to ensure successful data collection. The counselors would teach the campers how to play the game and collect data while observing the gaming sessions. A set of training materials for the counselors was developed in addition to the game and its instructions. These included a session checklist, procedural description, and a set of guidelines for running this type of research session. Workbooks facilitated and directed the counselors' note taking, and stood in for a session recap.

6. Prototyping: Construction of Visual Design and Content Prototype
A final game prototype was constructed for the next stage of research following the usability testing of instructions. The number of participants possible for the planned research group was projected as large enough to require the creation of multiple copies of the prototype, to be kept at Camp Hamwi for the duration of their summer camp sessions for play on rainy days and during scheduled activity times. Researchers and designers decided that further, smaller tests could be implemented, and created two versions of the prototype with minor differences. They analyzed the elements of the game that players responded to positively and refined the aesthetic design of the characters and the playing pieces, which were taken in two different directions to reflect minor stylistic changes. Previous players' positive reactions to the customizable pieces informed the development of prototype version 1, and prototype version 2 focused on an idea suggested by participants in

Figure.7 The final Visual Design and Content Prototype (prototype version 2)

the pilot test session that each player would have a theme, consisting of a specific terrain and the control of corresponding pieces, using the themes of natural elements, such as ice, desert, grass, and water.

The concept prototype's paper construction, although beneficial in the research process, would not logically hold up to repeated play sessions at a summer camp. The visual design and content prototype needed to have all the functionality of the previous one, but be designed to be much more durable to survive several weeks at Camp Hamwi. A production system involving laser-cut acrylic, applied decals, and acrylic-welded pieces was designed, as needed. The customizable playing pieces consisted of bodies with snap-on heads, bases on which to stand, and "backpack" units that were usually wings or additional arms for the characters. The game's scenario cards were typed up for increased legibility and applied as decals to water-resistant flashcards. Dies were constructed from wooden blocks with hand-written numbers. Instructions were extensively revised and re-formatted based on the results of the usability testing and printed as color booklets. Finally, the visual design and content prototypes were packaged into durable plastic tubs with handles, color-coded by version number. The game was branded "Balance of Power," to add authenticity for the players (Figure.7).

6.1 Prototyping: Playtesting of Visual Design and Content Prototypes

The training workshop for the counseling staff at Camp Hamwi was scheduled during their staff training days. The staff training was comprised of two full days of training for medical situations, emotional counseling training, and the nature of working with children in a scheduled environment. This created many obstacles to running this workshop, including lack of concentration from the participants, environmental conditions, information overload, and exhaustion. The staff was not fully engaged with the research method briefing prior to the playtesting session and wanted to quickly start playing to game. To accommodate, researchers hastened the verbal presentation on the game and the process, making sure to mention the major points, such as why counselors were needed, and the objectives of the game.

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The instructions remained the biggest stumbling block with the game. Some participants felt the instructions were too lengthy or complicated, while others felt they were too vague and simplified. One observation from this session was that adult players are the ones who have a harder time being patient with the game's strategic system. In the training session with the staff of Camp Hamwi, this may have been subdued by having additional facilitators to guide the staff as they learned to play the game. Adult players almost always think the game is going to be too hard, long, complicated, or intellectual for children to understand. The results from sessions with children in the target demographic seem to indicate almost the opposite. This indicates the importance of gaining insight from audiences of varying ages and backgrounds such as how children's interaction compares with parents and camp staff.

6.2 Prototyping: Results of the Visual Design and Content Prototype Testing

The results from the training workshop with counselors provided valuable input, allowing for revision and simplification of the game rules, which were sent back to the camp. The counseling staff played the game with campers during several key activity times and reported the children were fully engaged with the play process. The game was generally met with positive reactions, with several children expressing interest in purchasing it. Players expressed aspects of the game components and their uses could be further clarified. The campers were happy with the game as a whole, its focus on diabetes, the customizable pieces, and the capturing of the flag. They were concerned about structural details, such as the sliding game tiles and the physical process of searching for their opponent's flag.

7. Overall Research Findings and Analysis

Game design theorist Raph Koster argues that games are teachers, and that by absorbing the rules and systems of games, they engage the learning centers in our brains. Regardless of the subject matter of the game, its players are learning. By this rationale, all games are "edutainment [1]." The "fun" will follow if the system in place is functional. The CODA game left behind the archaic concepts of educational games based on "rote memorization and behaviorist conditioning," and followed a more streamlined, systematically-considered process of conceiving the game. The designers and researchers involved with the study learned if the game is functional and the educational component is ingrained in the game system, then the element of fun will follow. This is in line with Eric Zimmerman's proposal that the entertainment one gets from playing a game comes from the interaction between the player and the game's system of rules and fictions [4].

As each research and design stage concluded, it was apparent players understood what they were doing as they played. They understood the rules, and they understood how to work within the system and progress toward winning. The game succeeded in being fun, but also functions in an educational capacity, due to its rule system effectively representing the diabetic's need to stay "in balance." Its stand-alone playability has proven to be engaging, and the system in place has proven to be an effective, simplified simulation of the process of diabetes management and its emotional and physical ramifications.

When combined with some form of educational guidance, such as annotated gameplay facilitation, discussion, or post-game reflection, the CODA game can be an impactful tool for promoting the understanding of how people with diabetes must live in order to manage their disease. The game would be most appropriately used with a parent, teacher, or care provider functioning as a facilitator who can ask questions or incorporate a

discussion at the game's conclusion to assess and assist the players' understanding of diabetes management. Researchers did not set out with the goal of teaching people what diabetes is, but rather, to educate and promote awareness of how it affects people. By Raph Koster's analysis of the brain's "chunking" of data, games are not intended to present facts and figures for people to know. They are designed as systems to be understood, so their delivery of information must be appropriate to this concept [1]. For this reason, it was more important to us that the players understand how diabetes affects people than to know facts about diabetes. Educational theorists Grant Wiggins and Jay McTighe propose that "understanding" is a lasting result, something that can be applied in a broader context [2]. Although people experienced with diabetes will likely not learn anything new about their own disease, this game is designed more for children who do not fully understand the system yet, as well as their friends and family members who may not understand it at all.

The CODA game is based on the idea of engaging players in a rule-based system in a social environment, which is what draws people to games in the first place. Diabetes management itself is based on a system of rules, and although those rules are different for different people, depending on type of diabetes, age, lifestyle, and many other variables, condensed into the idea of keeping the body in balance by adjusting diet, medication, and exercise. This system of rules became the central focus of the game's rule system. By playing on teams or independently against one another, players engage in a social situation, as well.

The game falls within the definition of endogenous games, as game design theorists Brian Winn and Carrie Heeter define them, incorporating the learning aspect into the actual mechanics of the game [3]. An altered form of the aforementioned "Capture the Flag" served as the basis for the game, primarily because it provided a means to deliver the learning content. This content consisted of presenting situations based on diabetes and its maintenance, and defining appropriate consequences. Players have the option to address each situation independently, with appropriate choices being rewarded and inappropriate choices resulting in repercussions.

The notions of community and personal choice affect all people involved in the situation in the game, despite its competitive strategy format. Good choices can promote forward movement and provide the player with the incentive to make bigger choices and attempt to reach more goals. This notion of interactivity is what makes games unique. The consequences players experience are bound by the idea of "feedback," which educational literacy researchers Michael Smith and Jeffery Wilhelm feel allows games to deserve future exploration as educational tools. These consequences define the players' experiences, and the players' experiences drive the narrative of the game, but the educational component is built into the structure of the game's rule system.

When considering why the educational games seen in the past have not been as successful as they could be, perhaps the answer is that they were not designed using a method that is appropriate to what they are. As "edutainment," they are meant to educate by stimulating their user in a way unseen in typical learning environments. Games, however, are inherently learning environments, as Koster points out. To play a game, one must learn a new system and engage with it, thus testing any newfound knowledge and allowing players to course-correct and fix errors in their judgment. The problem is most likely that designers of educational board games must keep in mind the limitations that games have, and understand where other educational

games fail. The learning and fun come hand-in-hand, as they are both part of the game's system of rules. If the educational component is a part of the game's rules, then the learning will come naturally, and the game will likely be classified as "fun." One can conclude that the success of educational games depends largely on what type of information is being disseminated through the game, and whether that information is appropriate to apply to the medium of games. If a subject is more appropriately disseminated through other media, there may not be any reason to design a game.

8. Conclusion

This study employed and leveraged several methods of design research to develop a methodology for designing educational board games. The results of this study can be broadly applied within the design field, and this could culminate in a more widely valued and accepted method for approaching educational tools. The experiences from the research and design process of this case study can be further used to inform the design of educational board games, but the same process could be adapted to fit the design process for other educational games, educational toys, or even more broadly, the way people conceive of education and curriculum development as a whole. As media evolves, our application of it must also evolve in order to maintain relevance, accessibility, and usability.

The research team concluded, following evaluation, that the game design achieved the original goals of the study by introducing and familiarizing players with the process of diabetes management and creating an engaging experience for the children playing it. Its educational component was subdued when played for fun, and forefront if used as part of a larger learning environment. The iterative process provided multiple stages for the evaluation, anaylsis and development of the design process of the board game, illustrating that to design a game, designers must constantly revise and evaluate until the final product functions effectively, a widely accepted notion in other areas of product design. The CODA game is a step forward in educational board game design, and provides an example of how analyzing the strengths and limitations of games can be utilized to create an engaging, fun product that is educational.

9. Citations

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