

Human-Centered Design Method for Serious Games: A Bridge Across Disciplines

ABSTRACT

Human-centered design (HCD) is often considered a central, largely unquestioned, tenet of good practice for product design. However, while various manuscripts had been published on HCD methods for generic interactive systems, few discuss HCD method for interdisciplinary projects; specifically, serious games (designed for a primary purpose other than pure entertainment). Applying HCD to the design of a video game, we soon found that there were missing links in the reviewed methods. Through the development of our serious game, an educational computer game to prepare first time parents for childbirth and labor, we propose a new HCD method. We show how iterative design, evaluation, and testing must take into account the interdisciplinary requirements of creating serious games. It is necessary to receive inputs from all of the different fields of experts before initiating the design stages: the thematic experts as well as the game design experts and learning experts.

Author Keywords

method, design, serious games

ACM Classification Keywords

H.5.2 Information Interfaces and Presentation: Miscellaneous—*Optional sub-category*

INTRODUCTION

Human-centered design (HCD) and its variations, such as participatory design, reflective design, and cooperative design, is an approach to design that attempts to actively involve the end users in the design process to help ensure that the product designed meets their needs and is usable. Although the practice varies slightly depending on the method chosen, the approach usually entails users participating during several stages of an innovation process: they participate during the initial exploration and problem definition both to help define the problem and to focus ideas for solution; during development, they help evaluate proposed solutions. HCD, more specifically participatory design, also has the notion that users are experts in their own domains. A continu-

ous stream of publications reported the success of products designed using user-centered design (UCD) method, resulting in greater buy-in from their target users, making HCD a central, largely unquestioned, tenet of good practice for product design.

While various published manuscripts had provided tremendous help for practitioners that plan to adopt the HCD method when designing traditional computer applications, few reports discussed UCD for non-standard computer applications such as serious games. Serious games are defined as games designed for a primary purpose other than pure entertainment, although to be faithful to the idea of games, they still have to be entertaining, engaging, and fun while serving their primary purpose (e.g., education, persuasion, and rehabilitation). Because of the nature of serious games, they generally encompass several domains. Generally, the science of game design is one of the necessary domains, and makes up the game rules, win conditions, core mechanics, and game affordances (what the player is allowed to do). The theme (or themes) of the game compose the bulk of the game's contents and these can be from very diverse domains such as health, education or psychology. The interdisciplinary nature of serious games can be suspected as the main cause of the lack of proposed UCD method for their system design.

In this paper, we present published manuscripts on HCDs for general product design as well as for video games. We reviewed and attempted to apply various HCDs and when we developed our serious game, an educational game for first time parents to prepare them for childbirth and labor [6], and realized that there were missing links in each of the methods we tried. Throughout the development process of our serious game, we discovered these missing links and narrowed down the stages of the development that worked best in our serious game project. We present our proposed development method, with several characteristics that are different from other methods we reviewed. The most distinctive difference is that the stages of conceptual design and implementation are not discrete.

RELEVANT WORK: MODELS OF SYSTEM DESIGN

Since the introduction of ISO 13407 standard for the human-centered design process [7], various other methods had been proposed. The following sections describe various HCD methods that informed our work.

Human-Centered Design

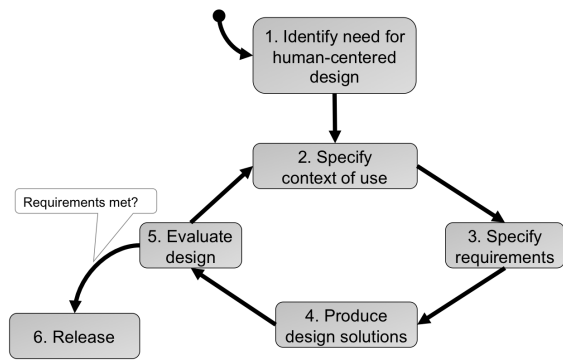


Figure 1. The ISO 13407 standard for human-centered design

The ISO 13407 standard for the human-centered design process defines five stages (see Figure 1) [7].

1. Identify need for human centered design;
2. Specify context of use;
3. Specify requirements;
4. Produce design solutions;
5. Evaluate designs; and finally, depending on the result of evaluation,
6. The system satisfies specified requirements, indicating that the design and implementation process is over and the product can be released.

The phases are meant to be completed in this order. If the evaluation finds an error in the system or a need for further development, the designer proceeds back to step 2, specifying again the context of use. This very generic approach is a starting point for many projects in computing; however, it has been shown that engineers do not work in this manner. Designers analyze the design much more often than is suggested by the ISO standard, and move in unpredictable ways around the graph [5].

Star Life Cycle

The star life cycle [5] is a well-established HCD design principle for interactive systems. Figure 2 shows the stages in the star method. The phases are as follows.

1. Requirements specification
2. Evaluation
3. Conceptual design and formal design
4. Prototyping
5. Implementation
6. Task analysis and functional analysis

The phases are not meant to be visited in any particular order. The designer starts at any node and passes through evaluation on the way to any other node. For example, after gathering requirements, the designer evaluates the requirements

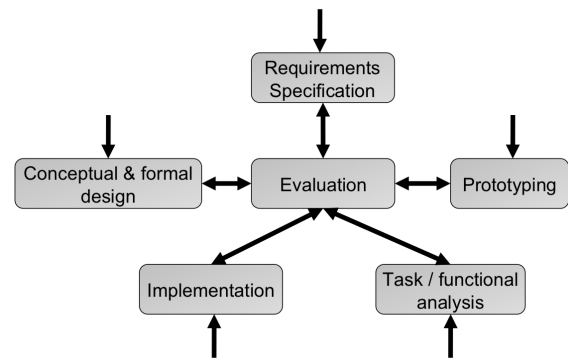


Figure 2. The star method of design, with evaluation being the key central component

prior to generating a formal design. Next, the designer evaluates the formal design and generates a prototype.

The star life cycle has two drawbacks for our project in serious games. First, it does not provide the designer with a clear starting point. On the contrary, it suggests that the designer start with whichever outside node is most appropriate, with little guidance of what constitutes an appropriate stage. Although some designers start with task diagrams, other designers may prefer to start with a conceptual design; still others prefer gathering requirements. This creates a problem for the designer without sufficient information about the domain of the system, as in the case of serious game. It leaves two questions: Is implementation a valid starting node? Can prototyping be a first step along the design cycle? Probably not, as the designer typically does preliminary research, draws concept art, or defines requirements prior to implementing anything. Second, the star life cycle is a generalized design-development paradigm for the human-computer interface. We soon found that for the design of our serious game, the model lacks the ability to embed interdisciplinary and team work effort.

Fullerton's Method

Fullerton, et al. [3] extend the user-centered system design to video games, and suggest three phases of design and development:

1. Conceptualization;
2. Prototyping; and
3. Play-testing.

The phases are to be completed in this order, but the phases generate a cycle, with conceptualization following play-testing. Conceptualization refers to the overall design of the game and its mechanics. Prototyping involves making low- or high-fidelity versions of the game and its implementation-level details. Prototype versions are typically progressively more detailed versions of the game, incrementally incorporating features, aesthetic elements (such as graphics and sound), and game complexity with each version. Finally, play-testing refers to user interaction with the game. Users play the game

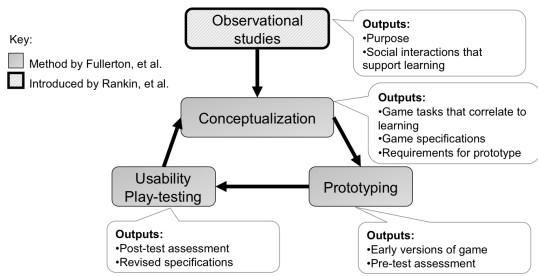


Figure 3. The method of video game design presented by Fullerton, et al., and modified by Rankin, et al.

and rate it based on several metrics, including but not limited to playability, enjoyment, engagement, ease of learning (for a game with a learning component), and so on. Because user-centered game design requires frequent interaction with users, the three phases are often revisited, and hence, the procedure becomes iterative. Feedback from the users is incorporated into the next prototype.

Rankin's Method

Rankin, et al. propose a modified-Fullerton framework for serious games, as social interactions, learning, and play are all involved [10]. The diagram is shown in Figure 3, overlaid with Fullerton's proposed method of game design. A first phase, called observational studies, is added before conceptualization can commence. The four phases according to Rankin are

1. Observational studies;
2. Conceptualization;
3. Prototyping; and
4. Play-testing.

In the observational studies stage, the game designer defines a purpose for the game and observes the social situations in which learning occurs. During conceptualization, the designer formulates the game's overall mechanic and aesthetic. The results of prototyping give an early version of the game and allow the designer to quickly collect a range of user and expert feedback about the game. The designer can also administer a pre-test during this phase of design [3, 11]. Finally, user feedback is collected during play-testing. The designer administers the post-test, and based on the results, modifies the specifications for the game in preparation for returning to the conceptualization phase of design.

Components of Video Game Design for Learning

A design method for video games should be mindful of the elements of video game design. Dondlinger reports the key elements for an educational game to be as follows [2].

1. Edutainment vs. educational games
2. Motivation
3. Narrative context

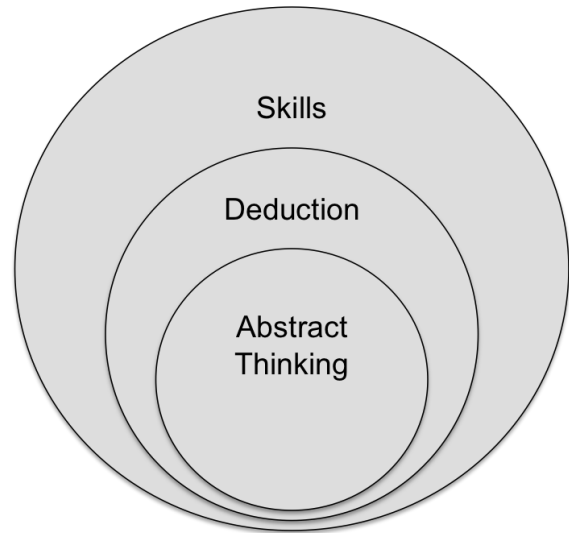


Figure 4. Learning hierarchies

4. Goals and rules
5. Interactivity and multisensory cues

The main difference between edutainment and an educational game is the where the game's mechanics lie on the repetition—abstraction continuum. Games in the edutainment category stress memorization and repetition. Educational games allow the player some free will and choice; they encourage thought, and hope to engage players on a deeper level of learning. Further, Dondlinger reports that there are three hierarchies for learning: skills, deduction, and abstract thinking. These are shown graphically in Figure 4. Skills can be learned by rote memorization, and regurgitated upon request. An example is the multiplication table or state capitals. Deduction and hypothesis testing is a learning outcome in which players can form hypotheses as a result of playing the game. More complicated game-play is required, as players must be given the ability both to make decisions and to make mistakes. For example, a game that teaches electromagnetism through simulation may teach players about electromagnetism in a physics class. Finally, the deepest level is abstract thinking. In this learning outcome, the player can apply skills and methods learned in-game to situations outside of the game.

Next, the designer must consider the motivation for play. What will keep the player interested in playing? The player must be given just enough praise to be interested in playing further, but not too much to make the game seem to easy. In other words, the challenge level of the game must be appropriate to the audience, and the feedback appropriate to the challenge level.

The narrative context refers to the story. What is the setting of the game? What is its history? The game should be telling a tale to entertain and engage the player, as if it were an interactive book, complete with details about the environment.

The goals and rules of the game include the game's affordances (what the player is allowed to do in the game world) as well as game rules, scoring, win and loss conditions, and other game mechanics elements.

Finally, interactivity and multisensory cues refers to interface design and player feedback. The game designer considers the input and output devices as well as the sensory stimuli both to the game and to the player.

APPLICATION OF RANKIN'S METHOD

In making a serious game to teach women and their partners about the stages of labor, the physiological changes of cervical dilation, and different ways to help a woman in labor, originally we applied Rankin's model to our design and development cycle.

Observational Studies

According to Rankin, observational studies is a phase of the design cycle in which the designer conducts background work prior to formulating a game concept. The designer observes people playing video games and the social interactions that emerge. During this stage, it is crucial to take note of the social aspects of playing video games as well as the methods of learning.

Because The Prepared Partner, a birth partner training game, was very specialized, it was difficult to find people playing such a game to observe. We had to replace observational studies by thoroughly researching the subject area of labor and childbirth. More specifically, we extracted themes from texts designed to prepare expectant parents for labor and childbirth. These themes included, but were not limited to, the progression of labor (stages of labor), ways to induce relaxation during labor, reducing anxiety and fear, and other natural ways to handle the discomfort and pain associated with labor

In addition, to gain an insight into preparation methods for childbirth and to gauge interest in a childbirth video game, we had to conduct an online survey. A convenience sample of 120 participants, both male and female, was used. Participants had given birth to at least one baby, or had participated as a support person in their partner's birth experience. We found that 4% of participants claim to have prepared for childbirth by playing video games. However, we know that no video game preparation methods were in existence at the time of the survey; hence, we conclude that results from these preparations were negligible. We found that 5% of participants would have liked to prepare for childbirth by playing a video game, and would do so if they could go back in time and prepare for their first child again. Only 3% of participants would recommend such a method of preparation to their friends. The results of the survey suggested that a niche market could develop for a childbirth-themed video game focused on educating the birth partner.

As between 50% and 80% of expectant parents attend childbirth preparation classes [9, 1] we attended such a class at the local birth center to better understand how parents pre-



Figure 5. Mothers and their partners attending a childbirth preparation class



Figure 6. Doulas-in-training attending classes

pare in real life, such as getting into and out of certain positions during different stages of labor, learning ways to deal with the minor discomfort of squeezing a handful of ice, and attending the birth center tour. Figure 5 shows a photograph of expectant mothers and their birth partners attending an organized childbirth preparation class in a hospital ¹

Next, we realized that we needed to understand childbirth preparation from a health professional point of view. For this, we attended a class for women as professional birth partners, called doulas. This class aims to prepare women for their new role as doula, and covered information such as different ways to support the woman and her partner and helping the new mother initiate breastfeeding. Figure 6 shows a photograph of birth doulas in training.

Finally, our hands-on background domain research culminated with the firsthand experience of labor and childbirth. Additionally, we assisted another woman in the delivery of her child in the role of birth doula. We used many of the natural comfort techniques and non-pharmacological pain relief options that we studied. Figure 7 shows a doula helping the mother through a contraction [8].

After this background research, we felt comfortable begin-

¹Photograph courtesy of Milford Regional Medical Center. Accessed September 24, 2010.



Figure 7. A birth doula helps a mother and her partner deliver a child.

ning to conceptualize the video game, and felt confident in our knowledge of the most common techniques that expectant parents should know prior to labor.

Conceptualization

Both Fullerton and Rankin agree: conceptualization drives the design-development cycle. The conceptualization phase creates outputs of game tasks that the designer can correlate to learning outcomes during analysis; a rough idea of the game mechanics or specifications; and the set of requirements for the next prototype game or game version.

When we reached the conceptualization phase, we found that something was lacking: feedback from domain professionals. We contacted midwives and childbirth educators for their comments on the general idea of *The Prepared Partner* before design and implementation of the project began. These childbirth experts expressed excitement about such a product, but also concern about the sensitivity of the topic. This concern drove our decision to use abstract forms rather than realistic graphics in our game.

We applied Dondlinger’s list of design elements in creating video games [2]. Making sure we were staying in the educational games domain, we created an abstract concept (that is, the narrative context): the player was to simulate a birth partner, applying natural ways to help a woman in labor through the pain and discomfort associated with contractions. The motivational elements were the same as the goals of the game; namely, the woman’s well-being, player’s score, and whether the woman ultimately delivered naturally or assisted by a doctor (i.e., by Caesarean section). The interaction modes were the various elements in the room (such as the light, the window, the bath tub), and by interacting with them, change the environment for the woman and suggest natural coping mechanisms for her. At the time of initial design, multisensory cues were not designed nor developed, although multimedia sensory stimuli were added later as a result of user testing and feedback.

Prototyping

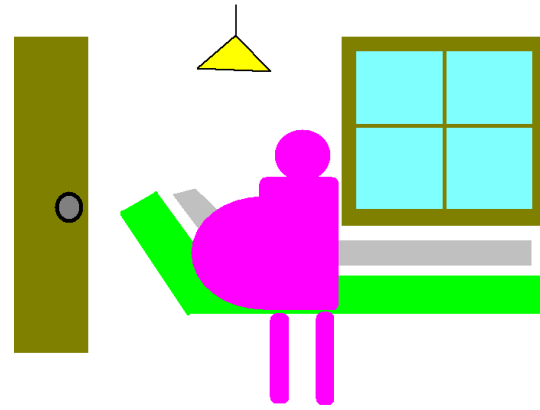


Figure 8. The concept for *The Prepared Partner*: a birth partner training game. This was later changed drastically.

The next phase of design and development is prototyping. However, on our first pass through the design-development cycle, we were not prepared for prototyping directly after conceptualization. The transition did not work because again we required more feedback prior to implementing our designs, more specifically from game players. We presented the concept, along with a mock-up of the game’s interface, to a panel of nationally-ranked competitive video game players. The feedback we received made us re-visit our entire design and change the fundamental structure driving our design.

After prototyping, we evaluated the system, and progressed back to conceptualization without play-testing, indicating that the transition suggested by Rankin did not work with our system. In this instance, we removed the environmental elements in the hospital room, and changed the presentation of the suggestions for the laboring woman.

We created four major prototypes, explained in detail in another paper [6]. For reference, Figure 8 shows a snapshot of our first design mock-up; results of iterative prototyping are shown in Figures 9–11; and Figure 12 shows the final version of our system. In Figure 12, the laboring character, named Amanda, is eating a sandwich in active labor. Her energy level is increasing dramatically as she eats. Other options available to the player are visualization, still touch, and get in large tub — that is, the player can help Amanda with visualization; the player can place hands on Amanda in a reassuring way; and the player can help Amanda get in a large tub. The actions are not guaranteed to have a positive effect: effect rates were gleaned from medical literature and incorporated as a random error.

Usability Play-Testing

The phase of usability play-testing is an evaluation phase involving users — players of the game. In a typical usability play-test, participants are recruited to play the game, most likely in a laboratory environment, and assess the interface. For a serious game, the participants look for ways in which the interface succeeds or fails to deliver affordances to the

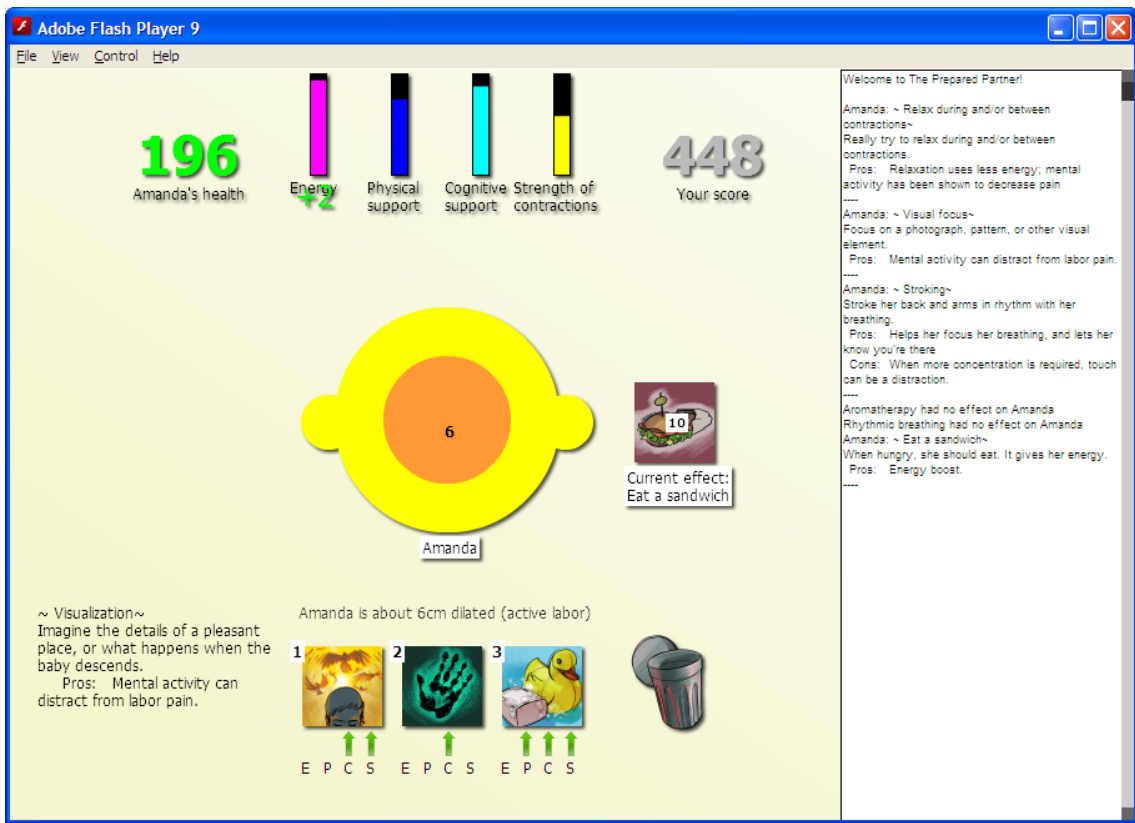


Figure 12. The final version of The Prepared Partner

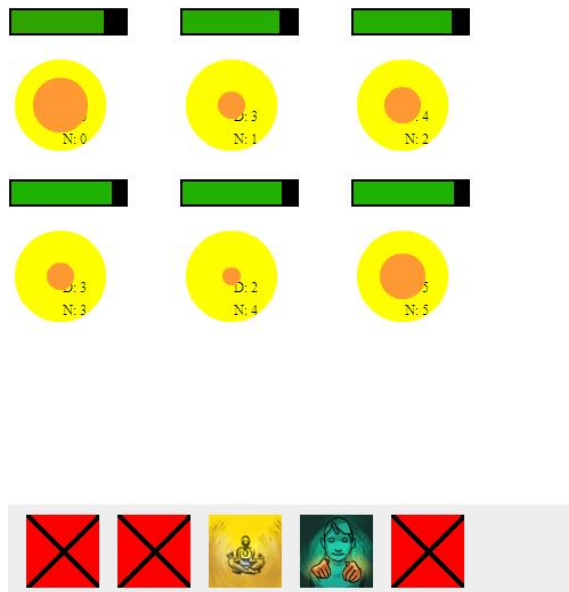


Figure 9. The Prepared Partner: First working prototype of the game

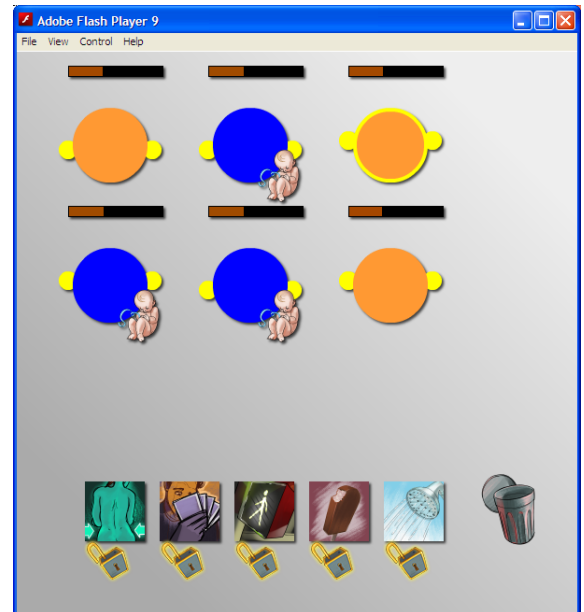


Figure 10. The Prepared Partner: Second prototype of the game

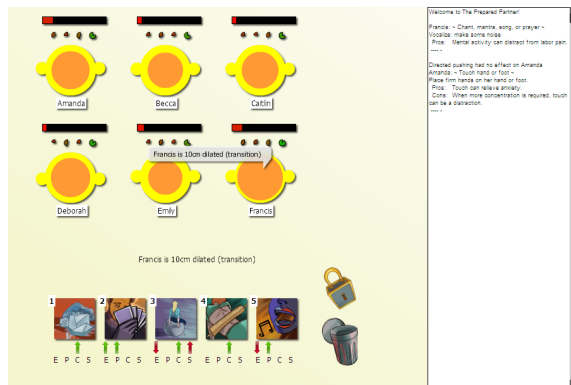


Figure 11. The Prepared Partner: Third prototype of the game

player in a timely and intuitive manner. The goal of usability play-testing is to gather information about how to make the game interface better. It is also helpful in pinpointing failures in the game mechanic, and hinting towards solutions.

Because our project goal was the learning assessment, the usability play-testing phase did not account for the majority of our system evaluations. We obtained feedback about our system’s design decisions, implementation details, research focus, and general playability of the game through more informal means. We demonstrated storyboards, concept art, and early prototypes several times to game design experts, casual video gamers, new mothers, HCI experts, and a learning assessment specialist, both formally in a lecture setting and informally mid-implementation. These methods of evaluation, which were not strictly play-testing, were of utmost importance to us in generating the final system.

Throughout the design-development cycle, we revisited and tuned the mechanics of the labor process. We ran simulations of the game and checked its accuracy in terms of the durations of each stage of labor, the relative contraction strength of the character in labor, and the effectiveness of relative power of each of the actions. Actions were added and deleted as ideas were presented or gleaned from various sources. Our main sources for actions were Simkin’s works, detailing natural coping mechanisms and their effects on labor [12, 13, 14], though we also collaborated with childbirth professionals and members of the local childbirth community, including doulas, midwives, and certified childbirth educators.

For example, in early prototypes of The Prepared Partner, we included a “send home” action. Using this action indicated to the character that she should go home and wait for labor to become more intense. Doctors advise their patients to labor at home until 4-1-1: contractions at least four minutes apart, each contraction at least one minute in duration, and this pattern to be repeated for at least one hour. If a woman arrives at the hospital or birth center and she is not in active labor, it is possible for her to be sent home. In fact, early arrival at the hospital is correlated with an increased risk of interventions during labor. We included the “send home” action to teach the player that going home is not only acceptable, it is

sometimes appropriate. Childbirth professionals applauded the inclusion of the “send home” action. However, in later iterations of the game, we removed the action because feedback from both games experts and pilot participants showed it interrupted game flow and contributed to player confusion.

We also found a missing link: in later iterations of our design, we implemented and verified incremental changes without passing back through conceptualization. Especially when fine-tuning the mechanics of the speed of labor and the player’s effect on the woman’s cervical dilation, we made several iterations of tweaks, sought feedback, and made more tweaks. We did not have to re-conceptualize the design on these occasions.

THE STAR METHOD FOR SERIOUS GAMES

When we applied Rankin’s method to our serious game, we found several inconsistencies with our procedure.

1. The observational studies node should encompass other forms of research, including literature search, interview, and other methods. It should be re-entrant — that is, the designer must be allowed to perform more research even after design and development are under way.
2. There is a missing link between conceptualization and the evaluation node noted above. The concept should be evaluated by domain experts. The evaluation does not need to be thorough, but some evaluation as far as scope and subject matter is beneficial to the project.
3. Usability play-testing does not encompass different feedback methods. It should be more generic to allow for formal and informal feedback and evaluation with users and experts.
4. There is a missing link between usability play-testing and prototyping.

We propose a modification of Rankin’s method which takes into account the need for constant collaboration across different fields, common in the design of serious games. In the following subsections, we describe each of the stages or phases of the collaborative method we propose. The phases in our model are as follows, and are shown in Figure 13.

- Research
- Validation
- Design
- Implementation

In the following sections, we discuss each phase in greater detail.

Research

Research is the entry point for designing a serious game. No design can occur before preliminary research has been conducted. The amount of background research depends on the designer’s familiarity with the game’s subject matter. Designers that have extensive experience with the domain of

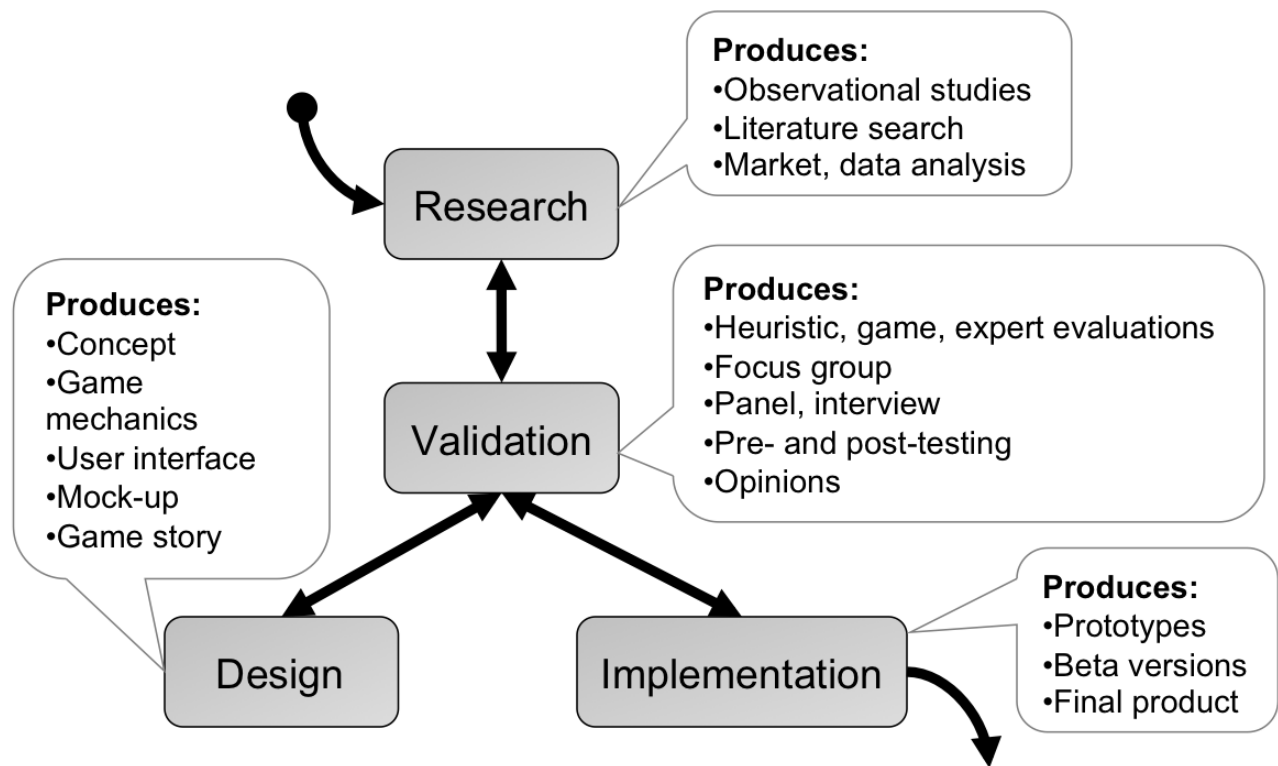


Figure 13. The validation phase is crucial in moving between research, design, and implementation.

the game need not pore over texts for inspiration and initial game concepts. On the other hand, limited exposure to the subject material may be an indication that more research is needed before a concept is presented to a panel or focus group for feedback and evaluation.

In the research phase of the design-development cycle, the designer performs ethnographic or observational studies, as Rankin suggests [10]. The designer observes people performing a task, and looks for ways to make the task easier, better, more fun, more efficient, or more educational. Next, the designer conducts a literature search, noting other technologies and research similar to the one under design or scrutiny. Market research is conducted for a comparative analysis of other games with similar features. These features can and should be used in the design of the serious game, as repeating current trends in games makes them easier for players to learn. Research conducted must be wide in variety and diverse in scope. The idea of the serious game takes shape, or becomes better defined as a result of the research. After initial research has been conducted, the designer should proceed to the general feedback phase, and seek advice from experts in the domain or domains of the game.

Domain, game-related, and education-related research must be conducted both prior to undertaking the project and along the way to completion of the project. When the phase is

entered at a subsequent time in the design-implementation cycle, we call this continuing research. Continuing research includes further literature search, domain research, and observations, and also data analysis from the evaluation and feedback phase. Continuing research on the part of the game designer as a result of user and expert feedback strengthens the game's credentials as a learning aid, can add to the believability or immersion of the game, and can affect the learning or persuasion outcomes of the game.

Validation

Validation is the core component of the design process. The purpose of the validation phase is for the designer to verify the game design, including its concept, mechanics, user interface, story, and other game-specific, domain-specific, education-specific, and interface-specific functions. Types of evaluation that can be performed on a system range from quick thought experiments, surveys, focus groups, panels, interviews, demonstrations, and studies involving pre-test and post-test data, commonly used to measure learning in a game. Heuristic evaluations are inexpensive ways to simulate player interaction with the system. Each method has pros and cons, and has particular applicability at certain stage of the design process. Experts in either the domain or domains of the game, as well as experts in the field of game design, education, and learning assessment, if applicable, are invaluable in making the game successful. Success can be measured in terms of matching the game concepts and me-

chanics to the real world, introducing enjoyable game play to keep players motivated to continue playing, and noting whether learning is occurring during game-play. Rankin, et al., and Fullerton, et al., name this stage *usability play-testing*, which we feel does not take into account the different ways in which the designer can receive feedback about the system and its design. Hence, we named this phase *validation*, because users, both casual and expert, do more than simply play the game.

Design

The purpose of the design phase is for the game designer to generate requirements. The designer can brainstorm the game elements such as motivation and concept; narrative context and story; the goals and rules of the game, including game mechanics; and the user interface, including the feedback and modes of interactivity. These design relics can be evaluated in the validation phase prior to implementation. Both Rankin, et al., and Fullerton, et al., call this stage *conceptualization*, because in this stage the game concept and surrounding implementation details emerges. However, we feel that conceptualization is a subset of design: that is, design embraces much more than just conceptualization.

Implementation

As a result of the expert and user feedback in the validation phase, the designer is well-positioned to implement all or some of the design, or to make incremental changes to the game with results of the domain research. In early stages of the project, the designer can produce a storyboard, mock-up, or another visual aid for use during validation. Low-fidelity prototypes in paper, low-fidelity prototypes in the medium of the game, game mock-ups, high-fidelity prototypes in the medium of the game, and implemented game features are frequently produced in this phase. The output of this phase is offered again for evaluation in the validation phase.

Non-discreteness

The phases of video game design mentioned above (research, validation, design, and implementation) are not discrete stages. They are not mutually exclusive: it is not only possible, but likely that a designer is simultaneously validating while implementing, designing and validating, or even researching, designing, and implementing — all while validating. We found that designers may be engaged in more than one phase at a time. For example, while considering the game mechanic, the designer may simultaneously validate the mechanic, by thought experiment and informal cognitive walk-through, making minor adjustments to the design. A little later, when the design has taken form, a prototype may be created, and again, the designer may evaluate his or her own design through several small changes or iterations before presenting it to someone else for validation.

CONCLUSION

In this paper, we presented a schedule of thorough and interdisciplinary evaluation and feedback throughout the design and development cycle. In illustrating our contribution, we presented *The Prepared Partner*, a video game about childbirth. The game describes about 50 natural ways to help

a woman in labor, and allows the player to explore these different options by trying them on the simulated woman in labor. Designers of educational games should be aware that the design-development cycle needs to accommodate ample time and opportunity for interdisciplinary collaboration. Initial prototyping, refinement of the concept, continued prototyping, feature implementation, the final prototype, and the final system are outputs or products of the design-implementation process, but they are incomplete without intermediate feedback from all disciplines at all stages. Domain literature search, background research, and intermediate feedback, both formal and informal, are critical in making an educational game.

When designing serious games, it is imperative to iteratively re-evaluate, with experts and casual users from all fields, and re-design the system to suit demands.

We found that Rankin's model did not account for the interdisciplinary nature of designing serious games. Feedback from users, during the play-testing phase, is insufficient, as experts both from the game domain and from game design must be consulted throughout the process of creating a serious game. Rankin's method does not address the educational component in designing a game for learning. We proposed a modification of Rankin's iterative framework that takes into account the interdisciplinary requirements of creating serious games, and the need for small, incremental changes to system design verified against users, experts, or literature. Evaluation and feedback (formal or informal) is a key element between every point of the framework. We apply the framework to the iterative design, development, and testing of *The Prepared Partner: a childbirth training game*. This iterative process of feedback between the two fields of childbirth experts and video games experts was key in making the game successful as a learning tool. The phases in our model are as follows, and are shown in Figure 13.

- Research
- Validation
- Design
- Implementation

The core concepts are

- Validation is key in moving between research, design, and implementation, and
- The phases of the model are non-discrete.

In other words, both formal and informal evaluation and feedback from experts and users is mandatory for continuing design and development, and continuing research is essential as the general feedback and user evaluation phase generates questions for the designer. Each phase is meant to be re-entrant; that is, each phase can, and should, be entered more than once in the course of designing a serious game. A designer of the system may be taking inspiration from any of the phases of research, validation, design, and implementation simultaneously.

FUTURE WORK

Future work on The Prepared Partner includes further improving the game, adding levels, changing the game mechanics for better pace, and allowing the user an increased action selection ability. We plan to conduct another study with these changes. We are recruiting more men to play The Prepared Partner, as literature indicates that birth partners and expectant fathers require more support in labor and childbirth than was previously assumed [4]. Finally, we plan on applying our method to other serious games.

REFERENCES

1. E. Declercq, C. Sakala, M. Corry, and S. Applebaum. Listening to mothers II: Report of the second national US survey of women's childbearing experiences. *Journal of Perinatal Education*, 16(4):9–14, 2007.
2. M. Dondlinger and D. Student. Educational video game design: A review of the literature. *Journal of Applied Educational Technology*, 4(1):21–31, 2007.
3. T. Fullerton, C. Swain, and S. Hoffman. *Game Design Workshop: Designing, prototyping, and playtesting games*. Focal Press, 2004.
4. A. Hallgren, M. Kilhgren, L. Forslin, and A. Norberg. Swedish fathers' involvement in and experiences of childbirth preparation and childbirth. *Midwifery*, 15(1):6–15, March 1999.
5. H. Hartson and D. Hix. Toward empirically derived methodologies and tools for human-computer interface development. *International Journal of Man-Machine Studies*, 31(4):477–494, 1989.
6. A. Holloway and S. Kurniawan. System Design Evolution of The Prepared Partner: How a Labor and Childbirth Game Came to Term. In *Meaningful Play*, 2010.
7. Human-centred design processes for interactive systems, 1999.
8. E. Jewett and H. Maybery. Special Deliveries: Hello mom, dad and Doula! *Sun Valley Magazine*, Summer 2008.
9. J. Lumley and S. Brown. Attenders and nonattenders at childbirth education classes in Australia: how do they and their births differ? *Birth*, 20(3):123–30, 1993.
10. Y. Rankin, M. McNeal, M. Shute, and B. Gooch. User centered game design: evaluating massive multiplayer online role playing games for second language acquisition. In *Proceedings of the 2008 ACM SIGGRAPH symposium on Video games*, pages 43–49. ACM, 2008.
11. K. Salen and E. Zimmerman. *Rules of play: Game design fundamentals*. MIT Press, 2003.
12. P. Simkin. *The birth partner, third edition: A complete guide to childbirth for dads, doulas, and all other labor companions*. Harvard Common Press, 2008.
13. P. Simkin and R. Ancheta. *The labor progress handbook: early interventions to prevent and treat dystocia*. Wiley-Blackwell, 2005.
14. P. Simkin and A. Bolding. Update on nonpharmacologic approaches to relieve labor pain and prevent suffering. *Journal of Midwifery And Women's Health*, 49:489–504, December 2004.