

The Prepared Partner: Can a Video Game Teach Labor and Childbirth Support Techniques?

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Abstract. The experience of childbirth is highly individualized. Proper preparation and support before, during, and after the onset of labor is key to shortening labor, decreasing the need for interventions during labor, and ultimately increasing maternal happiness. This paper reports the evaluation of The Prepared Partner, a simple game with goals to introduce natural ways to help a woman in labor, and their effects on labor; to introduce the mechanics of labor and childbirth; to practice interacting with a woman in labor; and to simulate the stages of labor. The user evaluation of The Prepared Partner showed an overwhelming majority of positive responses to the subjective portion of the study, and showed participants performed significantly better on a post-test about labor and childbirth than on a pre-test ($p < 0.01$). Furthermore, labor support was a major theme in a write-in question about childbirth, thus highlighting the effectiveness of The Prepared Partner in introducing the profound need for supporting a woman throughout birth.

Keywords: games for health, childbirth, user study.

1 Motivation and Background

Childbirth is a subjective and multidimensional experience. No single specific technique or combination of interventions can help all women, or even the same woman throughout the entire labor experience [5]. Therefore, it can be difficult to learn all of these techniques through reading books and watching videos alone. Face-to-face childbirth preparation sessions can provide a more thorough education to help future parents increase their confidence and learn strategies to reduce stress and anxiety and to manage pain during the childbirth event [6]. However, at least 15% of parents do not attend these classes, and are at an increased risk for having a more complicated labor and delivery [16,23].

The experience of childbirth is affected by a woman's emotional, motivational, cognitive, social, and cultural circumstance [1]. Maternal anxiety is associated with a less positive childbirth experience, whereas maternal comfort and preparedness can lead to a positive experience [29]. One source of anxiety is that parents are often forced to make uninformed or poorly-informed decisions at critical times (e.g., method of labor induction, whether to perform a C-section,

epidural administration) without understanding the risks and benefits of the various options. This is particularly dangerous when stress and pain can impede decision making ability. Unfortunately, inappropriate decisions, made by the parents or by medical personnel, can lead to issues as mild as frustration and discomfort and as severe as short- and long-term morbidity or even mortality for the mother and the baby [24]. Proper preparation and support before, during, and after the onset of labor is key to increasing the chance of a spontaneous labor [16], shortening the length of labor, decreasing the need for interventions during labor, and ultimately increasing maternal happiness [21].

To address the issue of the preparedness of first time parents, we developed The Prepared Partner, an educational video game about labor and childbirth.

Because The Prepared Partner is an online video game, it can be distributed to a much larger area and thereby can minimize the cost of sending human trainers, or the cost that the parents incur from paying for and traveling to conventional preparation classes. Additionally, the system is available 24 hours a day and thus allows single parents and parents with irregular work schedules to access the information at any time.

This paper presents The Prepared Partner, an educational video game about labor and childbirth. We evaluate results of a study assessing whether the system supports learning. Because literature suggests that fathers and birth partners need more support in labor and childbirth than was previously assumed [13], we target anyone with an interest in childbirth, including future mothers and birth partners.

We started The Prepared Partner with five main goals for the system. They are as follows [18,17].

1. To introduce natural coping mechanisms and their effects on labor,
2. To introduce the mechanics of labor and childbirth,
3. To train birth partners to help women in childbirth,
4. To practice interacting with a woman in labor, and
5. To simulate the stages of labor.

The focus of The Prepared Partner is not to advocate for natural childbirth. Instead, we only wish to prepare mothers and birth partners by providing a set of techniques that can be used during childbirth to help the mother through any pain and discomfort. Childbirth is a pivotal moment in many women's lives; women value a positive experience. Because women tend to feel more satisfied after a spontaneous, drug-free delivery [7], we aim to provide information about different natural techniques to help a woman in labor.

Childbirth is a sequence of unpredictable natural events, it is impossible to determine in advance how to help a woman in labor. Unlike reading a book or attending a childbirth class, The Prepared Partner rapidly exposes the player to an evolving, replayable simulation of the experience of labor and many different coping techniques. More scenarios are experienced in a dynamic way through The Prepared Partner gameplay than through reading books, watching videos, or attending childbirth class.

To assess the success of The Prepared Partner in achieving its intended goal, we performed a preliminary pilot study followed by a full study to measure whether players learned several key things about labor and childbirth and about natural coping mechanisms. Data were collected through an online survey. Closed- and open-ended questions were asked before and after the participants used the designed system. Due to the positive response of the pilot study, a full study of the learning assessment of the system was conducted.

The overwhelming majority of positive survey responses speaks to the success of The Prepared Partner as an enjoyable learning aid. We attribute its success to the close ties we had to both the childbirth professionals and the usability and game design experts during all stages of design and development of The Prepared Partner.

Several types of system evaluations were performed to assess the design of the system as well as the effectiveness of the system in informing the participants about natural coping mechanisms.

2 Relevant Work

Although a myriad of books is available on labor and childbirth [9,11,12,30], and childbirth preparation classes exist to educate and inform expectant parents and birth partners, childbirth-themed interactive media is limited in diversity and scope. Books have the advantage of being complete references, but they lack sensory immersion. With a book, the reader must split her mental efforts between learning the content and imagining the described scenario. In a video game, the scenario is described; the player no longer needs to imagine the scenario and is free to concentrate on the necessary action [10]. Furthermore, books, videos, and childbirth preparation classes are linear references. They show the same information each time the material is experienced; each time a book is re-read or a video is re-watched, the same information is presented in the same order. The Prepared Partner provides a different simulated childbirth experience and presentation of information with each invocation of the system.

Childbirth preparation classes are commonly used by expectant parents; however, parents under 25 years of age, parents who have not completed secondary education, single parents, parents coming from low income families and with no health insurance, parents living in rural areas, and public hospital clinic patients [23] are less likely to attend childbirth preparation classes and yet are at an increased risk for having a more complicated labor and delivery. Childbirth classes differ by instructor, setting, and method (e.g., Lamaze [22], Bradley [4], and Mongan methods [26]). Classes can be inaccessible for parents due to work schedule, travel, and finance reasons [16]; yet the Internet is one of the most influential resources for expectant parents [15]. For these reasons, we chose to deploy The Prepared Partner on the Internet.

Before designing and developing The Prepared Partner, we conducted thorough domain background research – an integral part of usability engineering as research must be completed before prototyping [19]. We read accounts of childbirth, or birth stories, in popular books suggested to expectant parents, and

paid particular attention to information about the stages of labor, relaxation to reduce anxiety, natural techniques to deal with pain and discomfort associated with childbirth, and information about pharmacological options available to mothers in a hospital or birth center [9,11,12,30]. We attended a class for training doulas for their work in continuous support of women throughout labor, birth, and breastfeeding initiation. This class was a thorough introduction to the mechanics of labor, the emotional implications and effects on the woman in labor and her partner, the options available to the parents, and involved hands-on practice of dozens of natural coping mechanisms. We experienced childbirth first-hand and assisted one other woman in the birth of her child, and used these experiences to fuel our research.

Video games aimed at health-related change have produced desirable outcomes in players, from knowledge increase to behavior change [2], yet they should augment, not replace, clinical oversight [20]. Moreover, electronic games for health education produce positive results, including results related to health education [28]. Although books and other static media have the advantage of being complete references, they lack sensory immersion. With a book, the reader must split her mental efforts between learning the content and imagining the described scenario. In an electronic game, the scenario is described; the player no longer needs to imagine the scenario and is free to concentrate on the necessary action [10]. Furthermore, books, videos, and childbirth preparation classes are linear references. They show the same information each time the material is experienced; each time a book is re-read or a video is re-watched, the same information is presented in the same order. Serious games, which are video games with a specific purpose: to educate, train, inform [25], or persuade the player, on the other hand, provide a different simulated childbirth experience and presentation of information with each invocation of the system.

The constructivist view of player learning in games, which is frequently adopted by serious-games' designers and evaluators, postulates that games teach ideas rather than particular behaviors, and rules of play rather than principles [3]. Therefore, we believe that presenting an educational intervention about childbirth and labor through a video game, which teaches the rules and mechanics of the game's purpose (namely, childbirth mechanics and support), can result in desirable outcomes regarding the preparedness of mothers and their partners. Those playing the game can learn, as a result of interacting with the game mechanics, the progression of labor, the meaning of contractions, and the simple things one can do to support a woman in labor.

3 Game Mechanics

The game, shown in Figure 1, depicts Amanda in labor. The stages of labor progress in unpredictable ways and are generated procedurally, by a simple mathematical formula tying Amanda's overall well-being to her cervical dilation and other factors [18,17]. As the labor progresses, Amanda's overall well-being decreases at a rate proportional to her energy, physical support, cognitive support, and other internal factors. The player must keep her well-being level high

by showing her coping mechanisms, altering her environment, and making educated choices about medical pain relief. The player is shown three action cards at a time. Each action card has a chance to increase or decrease the character's sense of emotional support, physical support, cognitive support, and the strength of her contractions; and these four attributes determine the character's hit-points, which are steadily decreasing. If the hit-points reach zero, the character is taken by the doctor and the player's role in supporting the mother is terminated. Otherwise, if the character passes through the pushing stage of labor successfully, she delivers her baby normally. The player's score increases with the character's dilation and with the help he or she offers her. There is a score bonus for delivering the baby normally.

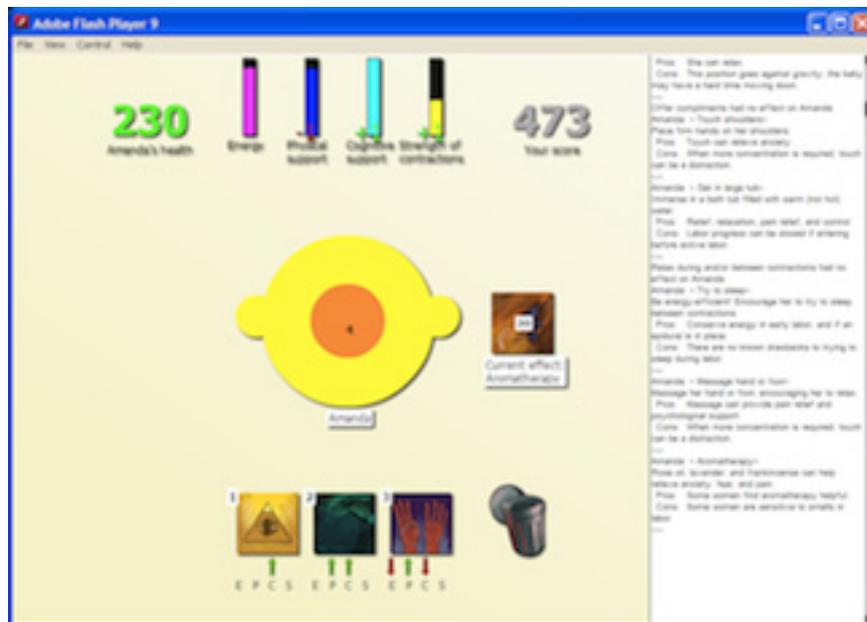


Fig. 1. Amanda is using aromatherapy in active labor as a natural pain relief measure. Available actions are visualization, stroking, and counting breaths.

4 Heuristic Evaluation

To receive early feedback about the system design, we conducted heuristics evaluation with five independent expert evaluators. We used an early version of the system for the heuristic evaluation, and modified the system in response to the evaluation results. A set of heuristics specifically designed for games and their playability was used [8]. The categories under evaluation were game play, game story, mechanics, and usability. Severity ratings were used as in Nielsen's

heuristics method [27]. The minimum rating was 0, and the maximum rating was 4. The heuristic evaluation found a total of 73 issues; these are summarized in Table 1 and the highest scoring (worst) issues are reported below.

Table 1. Issues found by category and severity through five independent heuristic evaluations

Severity rating	Game play	Game story	Mechanics	Usability	Total
(1) Cosmetic, trivial	11 (40.74%)	5 (35.71%)	4 (44.44%)	10 (43.48%)	30 (41.10%)
(2) Minor	11 (40.74%)	6 (42.86%)	5 (55.56%)	6 (26.09%)	28 (38.36%)
(3) Major	2 (7.41%)	2 (14.29%)	0 (0.00%)	4 (17.39%)	8 (10.96%)
(4) Critical	3 (11.11%)	1 (7.14%)	0 (0.00%)	3 (13.04%)	7 (9.59%)
Total	27 (100%)	14 (100%)	9 (100%)	23 (100%)	73 (100%)

Game play. Game play heuristics include issues such as scoring, winning conditions, goals of the game, out-of-the-box experience, and challenges.

The game should give rewards that immerse the player more deeply in the game by increasing their capabilities (power-up), and expanding their ability to customize: (Score: 1.75) Evaluators were concerned that there were no power-ups in the game, nor any ability to customize. Mini-achievements were proposed but not implemented in the interests of time.

Pace the game to apply pressure but not frustrate the player. Vary the difficulty level so that the player has greater challenge as they develop mastery. Easy to learn, hard to master: (Score: 1.60) Evaluator concerns were that the game was easy to learn, but also too easy to master. This issue was resolved by tuning the game variables to quicken game play later in the game, yet leave the slow pace earlier in the game.

Player is taught skills early that you expect the players to use later, or right before the new skill is needed: (Score: 1.50) Evaluators agreed that the tutorial was effective in teaching the skills, but argued that skills did not provide enough information in how to accomplish the skills in real life.

Game story. The game story category assesses the player’s mental and emotional involvement in the game.

The game transports the player into a level of personal involvement emotionally (e.g., scare, threat, thrill, reward, punishment) and viscerally (e.g., sounds of environment). (Score: 1.40) Comments from the evaluators listed an threat-to-reward imbalance, and a lack of immersion. To address this, we added a congratulatory reward screen at the end of the game which listed the player’s accomplishments, score, and in-game statistics. We also added sounds — the name of the action is read aloud, and when the action is applied, the character in labor vocalizes a response to the action — and visual effects, such as bath tub water.

The Player has a sense of control over their character and is able to use tactics and strategies: (Score: 1.25) Comments from the evaluators listed an threat-to-reward imbalance, and a lack of immersion. Two of the five evaluators were concerned about the sense of strategy component of this heuristic. Initially, the player must experiment with the actions until the corresponding game mechanic is understood. We did not address this issue because we felt it to be more realistic. When helping a woman in labor, it is difficult to know in advance which actions will have a positive effect. We wanted to mimic this uncertainty in the game.

Player is interested in the characters because (1) they are like me; (2) they are interesting to me, (3) the characters develop as action occurs: (Score: 1.25) Two of the five evaluators felt no connection to the character in the game. Players of the game should have some interest in childbirth to really connect with the character.

Mechanics. The set of mechanics heuristics refers to the controls for the game, the learning curve, and underlying mechanics including score reporting.

Game should react in a consistent, challenging, and exciting way to the player's actions (e.g., appropriate music with the action). (Score: 1.20) As with the corresponding Game Story heuristic, sound was added to the game. Mousing-over the actions caused the action name to be read, and applying the action to the character caused the character to respond vocally (e.g., the *sing* action caused the character to sing). Visual assets were added where appropriate (e.g., *take a bath* filled the screen with water for the duration of the action; *dim lights* darkened the screen's background).

Usability. The usability heuristics refer to the non-game aspects of the player experience, including menus, manuals and help, feedback, art, and generally how easy it is to understand and interact with the game.

The Player can easily turn the game off and on, and be able to save games in different states. (Score: 2.60) Evaluators were concerned that there was no way to pause; the only way to turn the game off was to close the browser or Flash Player window; the only way to turn the game on was to reload the browser window or reload the Flash file. In response, we implemented a replay option after the game is over. We did not add pausing capabilities.

Players should be given context sensitive help while playing so that they do not get stuck or have to rely on a manual. (Score: 1.60) Although help was available on the action cards (including the pro and con of applying each action and its effect on each of the character's stats), evaluators were concerned that it was not clear how to help the woman, and certain game assets (such as the trash can) were not explained. We added the unexplained items to the tutorial.

Make the menu layers well-organized and minimalist to the extent the menu options are intuitive. (Score: 1.60) Initially, there was no menu option; we added a menu with a large *Play* button to make the only option very clear.

5 Learning Assessment

To test the efficacy of the system in teaching about ways to support a woman in childbirth, as well as whether the player learned some key facts about the mechanics of labor and birth, we recruited participants for a remote play-test of the system. We used a standard pre-test—intervention—post-test format for the assessment, and included a survey to gauge the player’s playing and learning experience in interacting with *The Prepared Partner*.

Although we did not state any age restriction, if participants were under age 18, their data were deleted (as our Human Subjects approval did not cover those under 18 years old). We purposely did not limit the age as the study had a drawing for a US\$25 gift card, and we did not want participants to lie about their age for the purpose of participating in the drawing.

5.1 Pilot Study Summary

We recruited seven participants for a pilot study of the system. The participants were recruited from a liberal arts college. All participants were females between the ages of 19 and 26 years old.

The pilot study was conducted over the Internet. In this study, the participants first answered a demographics survey, followed by a survey about video game habits and preferences. They then took a brief pre-test about labor and childbirth (for all the subsequent analysis, this test is referred to as pre-test). Next, the participants played *The Prepared Partner* at least twice. At the conclusion of the play, the participants took a brief post-test, where questions were either identical to the pre-test with answer choices randomized, or of similar difficulty and subject matter to pre-test questions. Finally, participants answered exit survey questions. The study took between 30 to 45 minutes.

One of the reasons for the pilot study was to determine the effectiveness of the test questions in gauging learning. Each portion of the test (pre and post) was split into three parts: multiple-choice questions about the mechanics of labor, a short-answer question asking for five ways to help a woman in labor without using drugs, and long-answer questions tying the game mechanic to natural support methods.

Pilot study results indicated that the second part of the test (the short-answer question) failed to measure learning. However, the test as a whole, as well as the first and third parts individually, did show a difference that we considered would be statistically significant given a large enough sample set. Hence, for the full study, we modified the second portion of the test.

Due to the positive results in the pilot study, we conducted a full study to assess *The Prepared Partner* as an enjoyable learning experience. The following sections describe the full study.

5.2 Participants

Participants were recruited for the study by e-mail announcement, through social networking sites, with online communication aids, and through a video game online community called Quarter To Three forums¹.

Though 90 participants began the survey (including completing the pre-test), 24 did not complete The Prepared Partner playthrough. Of these 66, 15 did not complete the post-test. Hence, only 51 participants completed all portions of the study, including the pre-test, the game, and the post-test and survey.

Ages ranged from 19 to 43 years with a mean age of 30. More than half (54%) of the participants identified as being married and/or a member of an unmarried couple. The remaining 46% were single, separated, or divorced. The median education level among participants was four-year college graduate (43% of participants). Less than a quarter (23%) of participants had either given birth, or helped wife or partner give birth. About half (47%) of participants stated no prior experience with childbirth. Finally, more than half (51%) of the participants marked that they play video games daily with the most common duration of gameplay between one and three hours.

Because of the nature of the advertisement for the study, 80% (N=36) of the participants were male, 25% (N=13) were female, and two participants declined to state their gender.

The large sample of male participants is not a problem because The Prepared Partner aims to reach future birth partners; in today's birthing climate, most birth partners are the expectant fathers and hence the large sample of male participants captures the target audience. However, more participants in this study have a four-year college degree than the average American. According to the US Census data from 2009, only 27.7% of people in the US attaining a Bachelor's degree. Hence, our sample set was not representative of the general population.

5.3 Stimulus and Procedure

The stimulus was The Prepared Partner: a game in Macromedia Flash and requiring Macromedia Flash Player 9 or higher. The learning assessment was conducted remotely. Estimated time from beginning to end of the study was 30 to 45 minutes.

Participants first answered a demographic survey, followed by a survey about video game habits and preferences. Participants took a brief pre-test about labor and childbirth. The pre-test consisted of multiple-choice questions, a long-answer question, and a series of short-answer questions tying the game mechanic to the player's understanding of labor support. Next, participants were instructed to play The Prepared Partner at least twice. Participants took another brief test (post-test) about labor and childbirth. Questions were either identical to the pre-test with answer choices randomized, or of similar difficulty and subject matter

¹ Quarter To Three: <http://quartertothree.com>

to pre-test questions. Finally, participants answered exit survey questions about their learning and playing experience.

Long-answer survey questions provided qualitative results. Quantitative performance measurements included each player's game score, number of successful and failed actions, and amount of time spent in each stage of labor, as reported by The Prepared Partner. Survey responses were on a 5-point Likert scale. Quantitative measures were linked to qualitative measures by a unique invitation code identifier.

5.4 Hypothesis

We state the hypothesis for the study below.

H1/0 There is no difference in aggregate pre-test and post-test scores.

H1 Aggregate post-test scores are different than the pre-test scores.

5.5 Test Scoring

The pre- and post-tests were scored both human and machine-scored. Multiple-choice answers were machine-scored and write-in answers were human-scored by a professional birth doula who has extensive domain knowledge, having undergone approved childbirth education and specific workshops dedicated to labor support. Write-in answers were scored liberally, with almost any answer accepted. Answers which expressed not understanding the question or not knowing the answer (such as "I don't know") were not accepted. Each correct answer was awarded one point.

For the long answer question, *How can you help a woman in labor without using drugs? Name as many ways as you can. Please separate each answer with a comma (,) a computer counted the number of distinct answers separated by commas and awarded the number of points equal to the number of answers.* This is because one could argue that nearly anything can be helpful, given the appropriate circumstance.

For the short answer questions, the scoring was as follows.

What is one thing you can do as birth partner to speed up labor, or increase the strength of labor contractions? Almost any answer was accepted, including clearly correct answers such as "walk around," "change position," and "have sex with your partner." Questionable answers such as "tickling" and "tell her to push" were accepted as well. Clearly incorrect answers such as "scare her witless" and "You can't do anything to speed up labor" were not accepted.

What is one thing you can do as a birth partner to help a woman in labor gain energy? Clearly correct answers included "feed her," "Make sure she is eating and drinking, allowing her to rest and sleep as much as possible," and "hold her up." All answers were accepted; there were no clearly incorrect answers.

What is one thing you can do as a birth partner to help a woman in labor feel more physically supported? Any answer was accepted, including clearly correct answers such as "hold her hand," "push on her back during contractions," "sit

behind her,” and answers such as “make sure she has clean sheets.” Only one person answered, on the post-test, “give her pain killers.” This answer was accepted, though it was contrary to the goal of the exercise, which was to name natural support methods.

What is one thing you can do as a birth partner to help a woman in labor feel mentally, or cognitively, supported? Any answer was accepted, including clearly correct answers such as “talk to her,” “encourage her,” and “meditation or hypnosis.”

6 Results and Discussion

The following sections describe the result of the learning assessment of The Prepared Partner, and the discussion surrounding the data.

Learning outcomes. The Prepared Partner was formally evaluated by the 51 participants who participated in the study in its entirety: a combination of mothers, birth partners, and those that have never had children. The average score on the pre-test was 7.49 ($s = 7.13$), while the mean score on the post-test was 11.08 ($s = 7.50$). That is, participants had an average of 3.59 more correct answers to the questions on the post-test compared to the pre-test. Paired-samples t-test showed that the difference between the pre-and post-scores was significant ($t = 3.622$, $df = 50$, $p = 0.001$, two-tailed), and this result is depicted graphically in Figure 2. This significant difference indicates rejection of the null hypothesis $H_1/0$, indicating that the increase in test scores is not due to chance variation, but can be attributed to playing The Prepared Partner.

Pre-test scores were normally distributed but skewed towards lower scores. Post-test scores were close to bimodal with modes at around 5 and 17. A difference of 3.59 correct answers gives an effect size of about 0.5, which is considered a large difference effect.

Interestingly, there was a difference in pre-test score by gender, with women outperforming men ($t = -2.185$, $df = 16.276$, $p = 0.044$, two-tailed). In fact, women scored 5.7 points higher than men on the pre-test, with a large difference effect (0.6). For the post-test, although women’s scores were higher than men’s, here was no significant difference. The reader is encouraged to study Figure 3.

Players of The Prepared Partner answered with more breadth and confidence in the short-answer portion of the test. When asked how to speed up labor naturally, participants answered with more concrete actions such as “intimacy,” “take a bath,” “apply pressure to the lower back,” and “acupressure.” On the pre-test answers were generally more vague and several participants included question marks in their answers, indicating uncertainty. When asked how to help a mother re-energize in labor, on the post-test, most participants answered with a variation of “feed her” and far fewer respondents left the question blank. Finally, participants answered with a broader range of cognitive support methods on the post-test than the pre-test, most of which were presented in the game.

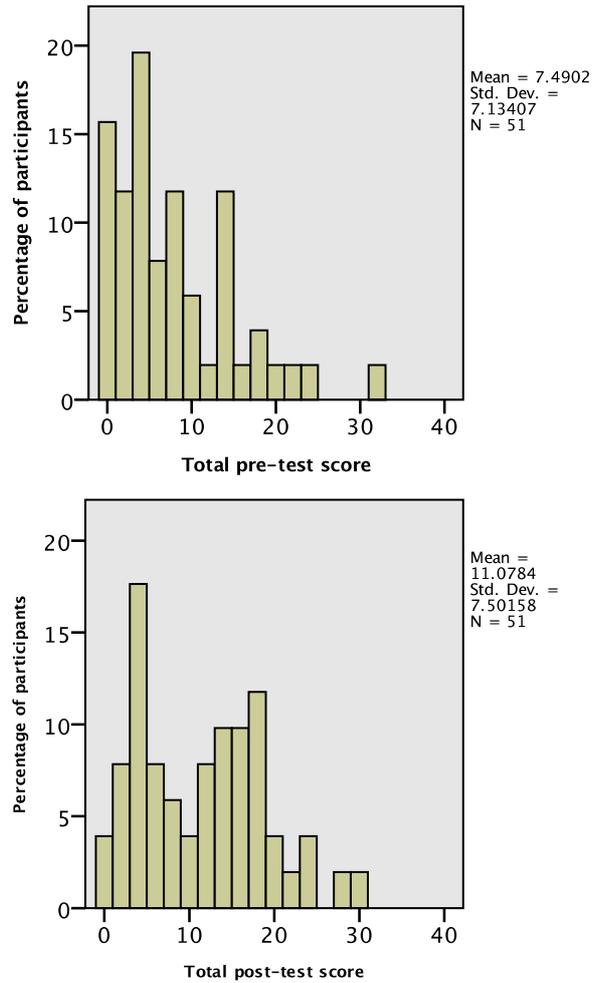


Fig. 2. Pre-test score and post-test score distributions: Difference in mean scores was 3.59 ($p < 0.01$) with a large difference effect. A score of zero implies either all incorrect answers, or all pre-test answers left blank.

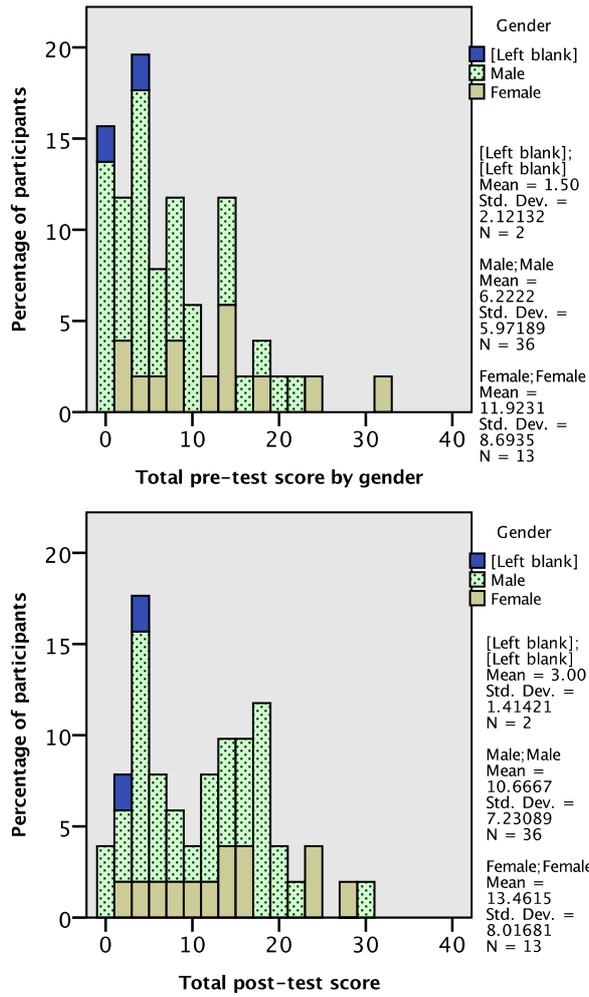


Fig. 3. Pre-test score distributions by gender. Two participants declined to state their gender. A score of zero implies either all incorrect answers, or all answers left blank.

Game results. Participants were instructed to play *The Prepared Partner* at least twice, thus leaving the total number of games played up to the individual participant. As the study was remote, it was impossible to control for the number of games played, though we did keep track of this number per participant. The 51 respondents that played and correctly completed the post-test played a grand total of 122 games; the mean number of games played was 2.08, with a minimum of 1 and maximum of 7 games.

Players used an average of 20 actions per game to help the character in labor, thus exploring 40% of the actions available to the player by the game mechanic, as the game afforded around 50 unique actions. Actions included massage, hydrotherapy (immersion in the tub or shower), distraction, visualization, and position change. In all but five of the 122 games' births, the player was present for the delivery of the baby. In the remaining five (less than 5% of all games), the mother was taken by the doctor and the game ended with a birth by C-section. As the average C-section rate in the US is over 30% [14], our game results may indicate one of the following. Either the game was perceived as too easy, and the game metrics need fine-tuning to increase the difficulty of delivering a baby normally (though this is contradicted in the survey responses), or the game shows that helping a woman through the stages of labor greatly decreases her risk of C-section. This is corroborated by research; Klaus, et al. found that having a doula, or a woman in a role of professional support for the woman in labor, can decrease the C-section rate by up to 50% [21].

Survey responses. We asked participants survey questions about their experience with *The Prepared Partner*. The survey questions were split into three sections: questions about the participant's learning experience, questions about the participant's playing experience, and questions about the player's view of the game mechanics in *The Prepared Partner*. Participants were asked to mark their level of agreement or disagreement on a five-point Likert scale to questions in each category (strongly disagree, disagree, neither agree nor disagree, agree, strongly agree).

Ten participants left the survey blank altogether. The remaining 41 participants' answers are summarized in Figure 4, Figure 5, and Figure 6, for the learning, playing, and mechanics questions, respectively.

For the learning experience (Figure 4), 69% (N=35) participants agreed or strongly agreed that they learned about labor and childbirth by participating in this study, 61% (N=31) participants agreed or strongly agreed that they learned five natural ways to help a woman in labor, and a majority (53%, N=27) of participants agreed or strongly agreed that they felt more prepared for childbirth than before participating in the study. The positive replies corroborate the quantitative evidence of learning on the labor and childbirth test as well as the qualitative evidence given by the write-in questions. That the majority of respondents both felt that they learned something, and actually learned something as measured on a test, is encouraging for *The Prepared Partner*.

A low percentage (37% N=19) of participants agreed or strongly agreed that they understood the stages of labor. This may be explained by the large percentage (47%) of the participants claiming no prior experience with childbirth, and corroborated by the conflicting feelings in the describing birth portion of the survey (see below). Those that have not had any prior exposure to childbirth may have found the game educational yet insufficient to thoroughly prepare them for what they may know of childbirth from other sources.

Finally, 67% (N=34) of participants agreed or strongly agreed that they had a positive learning experience as a result of playing *The Prepared Partner*. One participant wrote:

My own childbirth experience involved induced labor, an epidural and a c-section, so I do feel like I learned about something that I know very little about (i.e. natural childbirth).

Another participant added, “I now know how very unprepared I am!”

For the playing experience (Figure 5), participants agreed or strongly agreed that *The Prepared Partner* was enjoyable and fun (63%, N=32), engaging (67%, N=34), interesting (64%, N=33), enjoyable to replay (55%, N=27), and 61% (N=31) of the participants would recommend *The Prepared Partner* to a friend. Most (62%, N=32) participants agreed or strongly agreed that they had a positive overall playing experience.

To gauge participant reactions to the game’s mechanics, we asked five questions about perceptions of the game (Figure 6). Unfortunately, only 30% of participants (N=15) felt some degree of connection to the character representing the woman in labor, whereas 25% of participants neither agreed nor disagreed with their sense of connection, and 22% disagreed or strongly disagreed about feeling connected. This result was expected based on earlier heuristic evaluation results and may be a consequence of the abstract, conceptual representation of the woman [17]. Next, 45% (N=23) of participants agreed or strongly agreed that there were multiple ways to win the game, which highlights the emergent, non-scripted gameplay experience. Regarding the pace of the game, 34% (N=18) disagreed or strongly disagreed that the game went too fast, and 43% (N=22) agreed or strongly agreed that the pace of the game was varied.

Describing birth. Finally, we asked participants, *How would you describe the process of labor and childbirth to a friend?* To explore the topic, two independent researchers extracted themes from the written answers. Common themes were labor support, with sub-themes methods of support and the mother’s need for support in labor; a description of the stages of labor, with sub-themes natural process and medical description of birth; and conflicting emotions as felt by the birth partner. Responses were evenly mixed between describing birth as a natural process and one that requires a doctor-led medical influence. An example of the *conflicting emotions* and *labor support* themes is found in the following response.

I would describe it as long, arduous, painful, possibly verging on torture for both mother and child. Also exciting. Also potentially wonderful. Also something for which the mother needs a great deal of support.

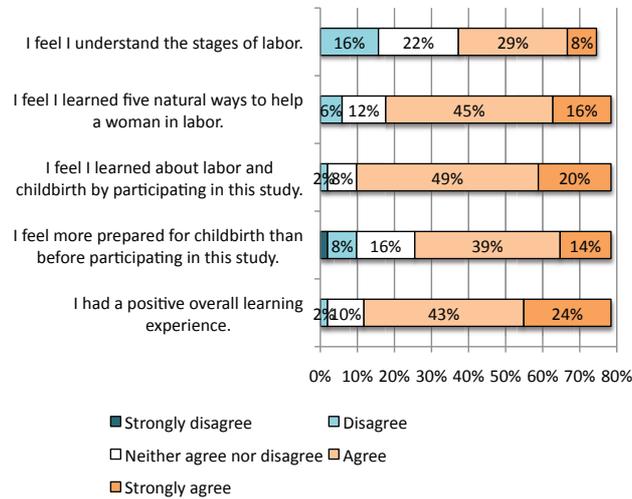


Fig. 4. Participants' answers for the learning experience portion of the survey

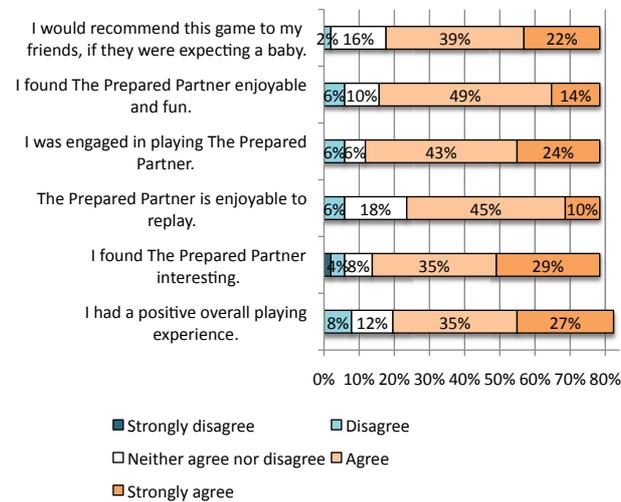


Fig. 5. Participants' answers for the playing experience portion of the survey

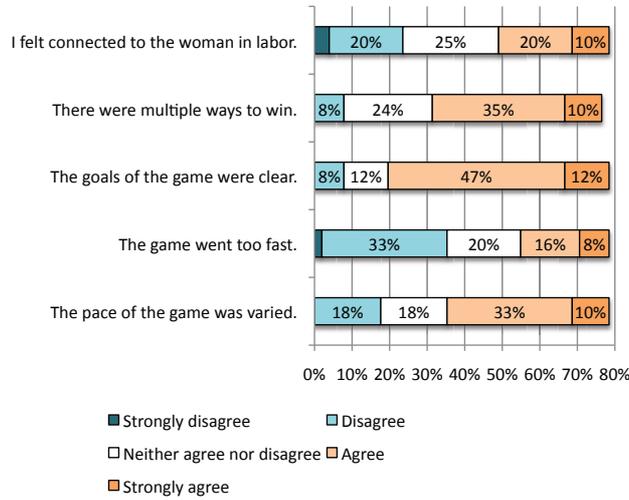


Fig. 6. Participants’ answers for the game mechanics portion of the survey

Thus, given the large number of respondents that mentioned labor support after playing The Prepared Partner (22 participants out of 51), the game was successful in highlighting the need for continuous support for a woman throughout labor and childbirth. Moreover, as 12 participants mentioned specific methods of supporting a mother throughout her birth experience, corroborating the results from the childbirth test as well as the survey results asking about participant learning.

7 Conclusion

We presented the evolution of the system design of The Prepared Partner, an educational video game about labor and childbirth. In the game, we implemented a novel approach to modeling a woman in labor, and a game model for actions taken to help her through her labor. The Prepared Partner is the first game of its kind. Although the models The Prepared Partner uses to simulate a woman through the stages of labor are simple, our learning assessment and other studies show the methods are effective in teaching players about the stages of labor and natural ways to help a woman in labor. The game presents 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.

We showed that The Prepared Partner teaches players about the importance of supporting a mother through labor as well as several techniques of natural support. Objective evidence from a childbirth test was paired with subjective Likert-scaled data on a survey as well as a long-answer question about childbirth; all three measures showed that participants both believed The Prepared Partner to be an effective and fun teaching aid and that The Prepared Partner was effective at teaching about labor support.

The overwhelming majority of positive survey responses spoke to the success of The Prepared Partner as an interesting, enjoyable, replayable, and fun learning aid. The game encourages learning through an engaging, interactive interface designed through tight, interdisciplinary collaboration. We attribute its success to the close ties we had to childbirth professionals and usability and game design experts during all stages of design and development of The Prepared Partner.

Our study showed that we met our goals of introducing natural coping mechanisms and their effects on labor, introducing the mechanics of labor and childbirth, training birth partners to help women in childbirth, allowing the player to practice interacting with a woman in labor, and simulating the stages of labor. The Prepared Partner is the first game of its kind, and uses a simple, novel approach to simulating a woman in labor.

8 Future Work

Work on The Prepared Partner can be further improved by exploiting different pedagogical strategies based on the on-line game functionalities. The game could be enhanced to be a game engine that can develop different scenarios and thus implement different pedagogical strategies. This can lead to further investigations on the effect of the pedagogical strategy adopted to the achievement of the anticipated learning outcomes.

Appendix A Test Questions

1. Which of the following are stages of labor?
 - (a) Latent phase, hyperactive labor, pushing, delivery
 - (b) First stage, second stage, third stage, fourth stage
 - (c) Early labor, active labor, transition, pushing
 - (d) Active labor, translational phase, pushing, delivery
 - (e) Other (please specify)
2. When is a woman considered to be in active labor?
 - (a) Between 1cm and 10cm dilation
 - (b) Between 3cm and 5cm dilation
 - (c) Between 4cm and 8cm dilation
 - (d) Between 7cm and 10cm dilation
 - (e) Above 10cm dilation
 - (f) Other (please specify)
3. Which cervical dilation is required in order to allow the baby to pass through the cervix?

(a) Less than 5cm dilation	(d) 10cm dilation
(b) Between 5cm and 8cm dilation	(e) Between 11cm and 12cm dilation
(c) 10cm dilation	
4. When is it most appropriate to do something distracting, like play a card game, with a woman in labor?

(a) Early labor	(d) Pushing
(b) Active labor	(e) All of the above
(c) Transition	(f) None of the above

5. Please name five ways you can help a woman in labor without using drugs.
6. What is one thing you can do as a birth partner to speed up labor, or increase the strength of labor contractions?
7. What is one thing you can do as a birth partner to help a woman in labor gain energy?
8. What is one thing you can do as a birth partner to help a woman in labor feel more physically supported?
9. What is one thing you can do as a birth partner to help a woman in labor feel mentally, or cognitively, supported?

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