

# 3, 2, 1 Start with Breastfeeding: Supporting Partner Involvement in Breastfeeding Education Through a Gamified Mobile App

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## ABSTRACT

Interactive technology offers a unique opportunity to supplement breastfeeding education, engaging expecting parents in reflection on breastfeeding. Yet, interventions typically target mothers, and although partner support is an important predictor of breastfeeding success, it is rarely addressed in interventions. We present 3, 2, 1 Start with Breastfeeding, a gamified mobile app that allows users to take care of a virtual baby alone or with their partner while engaging with educational content. The app was designed off an existing breastfeeding intervention, and leverages Self-Determination Theory to address parents and their partners. An evaluation with twelve parents show that the app engaged parents and their partners, and successfully communicated the lived experience of early-stage breastfeeding. However, our results also suggest that involving partners needs to be done with nuance to emphasise autonomy. We discuss these findings to derive considerations for the design of interactive interventions to support breastfeeding.

## CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**.

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MuC '23, September 03–06, 2023, Rapperswil, Switzerland

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ACM ISBN 979-8-4007-0771-1/23/09...\$15.00

<https://doi.org/10.1145/3603555.3603557>

## KEYWORDS

Breastfeeding, Partner, Gamification, Mobile App

### ACM Reference Format:

Kymeng Tang, Kathrin Gerling, Marnix Lijnen, Marten Geets, Luc Geurts, Maria Aufheimer, and Joke Muyldermans. 2023. 3, 2, 1 Start with Breastfeeding: Supporting Partner Involvement in Breastfeeding Education Through a Gamified Mobile App. In *Mensch und Computer 2023 (MuC '23)*, September 03–06, 2023, Rapperswil, Switzerland. ACM, New York, NY, USA, 11 pages. <https://doi.org/10.1145/3603555.3603557>

## 1 INTRODUCTION

Breastfeeding brings health benefits for parents and children [32, 33, 65] but the process is challenging. There are many factors dictating parents' infant feeding practices: birth complications, medical conditions of mothers and infants, and socio-economic status all can have a negative impact on breastfeeding [4, 39, 43, 53]. Other factors are often addressed through interventions, for instance, self-efficacy, breastfeeding knowledge and skills, understanding of milk supply [6, 8, 26, 37, 42, 43, 45]. Likewise, a positive breastfeeding attitude, acknowledgement of benefits of breastfeeding, and the perception of being supported contribute to parents' intention to breastfeed [43, 50]. Partners have a vital role in providing emotional and pragmatic support, which helps mothers carry through the breastfeeding journey [21, 46, 47, 55, 62]. However, partners often report feeling excluded and unsure how they can support breastfeeding mothers [57].

Antenatal education can prepare parents-to-be for their breastfeeding journey [72]. It touches upon topics such as techniques to breastfeed, and introduction of the benefits of breastfeeding [14, 73]. However, many partners find that antenatal classes do not meet their needs and report feeling uncertain about what to expect during the early days of parenthood [38]. Further, it is known that

involving partners in antenatal education can be challenging due to connotations associated with maternity [17]. This poses barriers to helping partners acknowledge their roles in supporting breastfeeding mothers and understanding the feeding process. As such, our work aims to explore strategies to involve parents(-to-be) together with their partners in antenatal education.

We took inspiration from Tang et al. [59] and Gerling et al. [27] and developed a gamified mobile app that illustrates the early breastfeeding journey. Our work was done in consultation with an antenatal education provider, and we drew from the Self-Determination Theory [3, 51] as a theoretical framework to guide the design of game elements. The resulting app allows users to explore the first few days and weeks of breastfeeding; users move along a timeline of initial baby development milestones, are invited to interact with and feed a virtual baby, and engage with educational materials. Partner involvement is conveyed through a cooperative mode of play, which centres on partners playing with the baby, bottle-feeding with expressed breast milk and responding to quizzes. Through this work, we seek to address the following research questions:

**RQ1:** How do parents perceive a gamified application to support antenatal education?

**RQ2:** Can gamified breastfeeding education engage partners in considerations regarding breastfeeding?

Our work makes the following core contributions: (1) We offer insights into the potential of gamified mobile applications to support breastfeeding education by offering an engaging experience, and provide an example of the challenges and opportunities when involving partners in such interventions. (2) We demonstrate how Self-Determination Theory [3, 51] can be leveraged to inform the design of a breastfeeding intervention, and to understand shortcomings in its design, supporting theory-driven intervention design. (3) We provide general points for attention for researchers and designers wishing to develop playful interventions to support the transition to parenthood that extrapolate beyond mobile apps.

## 2 BACKGROUND

Here, we give an overview of technology interventions designed to support breastfeeding along with a reflection on gamification as a strategy to enhance engagement. Additionally, we summarise aspects of Self-Determination Theory that form the theoretical foundation for our work.

### 2.1 Technology Designed to Support Breastfeeding

There is a wealth of technology interventions that support breastfeeding but many of them focused on digitising educational materials [5, 59]. There are efforts to support antenatal education with interactive systems, for example, through a quest game [29] that requires users to complete learning tasks (e.g., looking up information on the internet, watching videos on how to latch a newborn baby). However, the evaluation did not examine user perceptions of the system, and outcomes with respect to changes in breastfeeding intention were limited. Researchers also explored other means of promoting breastfeeding, e.g., via social media [31, 74]. Other systems support breastfeeding pragmatically, e.g., geo-social network that allows parents to find and review public breastfeeding

spaces [7, 13, 66], milk donation platforms [19, 67] and communication systems that connect parents to peers and/or professionals [20, 25, 28, 36, 49, 58, 71]. There are only three technology interventions [1, 2, 40, 54, 69–71] that specifically target partners, and they focus on engaging partners in online discussions about breastfeeding [54, 69–71], providing information about maternity [40] and breastfeeding [1, 2]. Strikingly, no systems has explored how partners can be involved in antenatal education. Here, playful-interactive technology (e.g., simulations) offers a novel way of engaging partners in learning about breastfeeding [27]. In this work, we sought to design a playful-interactive simulation to convey the lived experience of breastfeeding parents, enabling parents(-to-be) and their partners to get a glimpse at the lived experience of breastfeeding parents already in the antenatal stage while engaging with education contents.

### 2.2 Gamification: Overview and Considerations for Implementation

Gamification is a widely leveraged technique to increase enjoyment of an activity. Within the literature, there are several definitions of the practice (e.g., [23, 34, 56, 56, 68]) but the frequently referred description being “*the use of game design elements in non-game contexts*” by Deterding et al. [23]. Gamification imitates games and engage users by introducing game mechanics that drive challenge, curiosity and fantasy [41], for example, task performance and progress indicators, rewards and easter-eggs, stories and narration, social connectivity and audiovisual effects. Owing to its potential, the technique has been broadly applied in many health and education settings with success [18, 30, 35]. This makes gamification particularly an appealing approach for our work that seeks to address partners, an arguably difficult to reach stakeholder in breastfeeding context.

The effectiveness of gamification, however, depends on a number of factors, e.g., context and audience’s demographic (see [22, 30, 56]). Even so, researchers outlined considerations for applying gamification. Notably, Deterding [22] provided six critical points of reflection that help designers reconsider the relevance and limitations of gamification for an application, so that it can be deployed in a *good way*, i.e., one that does no harm and supports people in the achievement of a good life that allows them to flourish (also see [22] for a more detailed discussion). Likewise, Seaborn and Fels [56] proposed in their systematic review of gamification a theory-grounded or user-centred design approach to gamification as an effort to mitigate the potential negative outcomes resulting from improper implementations. Motivated by these approaches, we framed the design of our app around the Self-Determination Theory [3, 51] and followed the user-centred design methodology, in which we involved parents and breastfeeding educator.

### 2.3 Self-Determination Theory

Self-Determination Theory (SDT) [3, 51] is a macro-theory focusing on different aspects of human motivation, functioning and well-being. Two of its mini theories, Cognitive Evaluation Theory (CET) and Basic Psychological Needs Theory (BPNT) in particular, are widely adopted in HCI and games research in efforts concerning the understanding of player experience and expedient game design

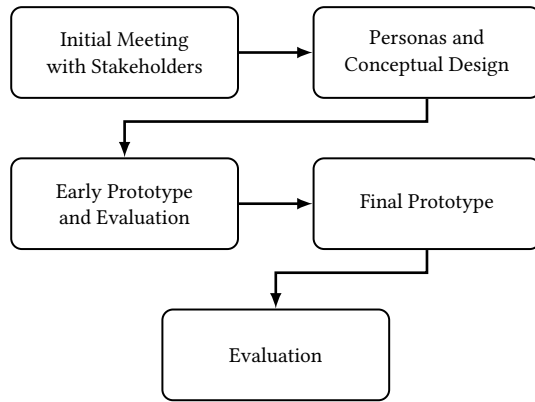


Figure 1: App design and development process.

[63]. BPNT identifies competence, autonomy, and relatedness as the key psychological needs to human motivation and well-being [3]. BPNT suggests that human are motivated when they feel that they can excel at something (competence), have the ability to freely take actions that reflect their value (autonomy), and feel connected to others (relatedness). CET addresses intrinsic motivation, the motive to do something for the satisfaction of doing it [3, 51]. This theory is specifically concerned with the effect of external events and social contexts on motivation, and highlights the importance of fulfilling the psychological needs for autonomy and competence in these contexts. Other mini theories, Organismic Integration Theory (OIT) and Relationships Motivation Theory (RMT) are also relevant for game research. OIT [3, 51] emphasises the importance of autonomy and relatedness as critical factors to internalisation, which is associated with positive outcomes such as wellness, engagement, and behaviour adherence. RMT [3, 51] outlines the interactions coming with interpersonal relationships as essential for a person's adjustment and well-being. However, the theory also emphasises that the satisfaction of all three basic needs through mutual support constitutes the highest quality personal relationships. In line with prior work [52, 75] that studied gamification through the lens of the SDT, we employ SDT, specifically BPNT, as theoretical support for the development of game mechanics that engage players in performing in-game actions. We further facilitate this through engagement with the theoretical lenses given by CET, OIT, and RMT in an effort to systematically draw from theory in the design of our app.

### 3 PHASE I: APP DESIGN AND DEVELOPMENT

In the first phase of our work, we followed an user-centred design process [44] (see Figure 1) in which we involved Care4Education in the design and prototyping process of our app. We then created a design concept, and developed an early paper prototype that enabled a formative usability test with parents and a parent-to-be. Then, the concept was developed into an Android app that allows users to take care of a virtual baby alone or with a partner while engaging with educational content about breastfeeding.

#### 3.1 Initial Meeting with Breastfeeding Education Provider

We carried out a 1-hour meeting with Care4Education to understand the *3, 2, 1 Start with Breastfeeding* breastfeeding education package. The meeting covered discussions about the story of Care4Education, the target audience of their antenatal education workshop, the profile of attendees, the organisation of their workshop, as well as the description and a demonstration of the use of the educational package.

*3, 2, 1 Start with Breastfeeding* is a breastfeeding educational package developed by Care4Education, a breastfeeding education provider in Belgium. The package is used for guiding a two-hour antenatal education workshop in Dutch ran by breastfeeding educators or lactation consultants. The kit consists of a game-of-geese-like board (see Figure 2) that guides parents(-to-be) through maternal stages and introduces discussion topics through flashcards. The guiding board gives an overview of maternity milestones, starting from pregnancy and leading up to the second birthday of the child. Each milestone is associated with a discussion topic which comes in form of a scenario or a multiple-choice quiz presented on a flashcard. These discussion topics encourage parents to share their thoughts with other workshop participants, resolve misconceptions, and help parents reflect on their expectation of breastfeeding.

#### 3.2 Conceptual Design and Prototyping

On the basis of the initial meeting, we drew from our meeting notes, breastfeeding literature, and SDT's BPNT mini-theory, and drafted design ideas within the research team in a brainstorming session, resulting in a conceptual model (see Figure 3) focusing on four elements:

1) **Simulation of newborns' needs** is a strategy to convey the lived experience of breastfeeding parents as inspired by Tang et al. [61]. Here, we set out to present the users with the irregular demands of a baby in the early postnatal period with respect to feeds [16] and other practical scenarios. More concretely, we provided (a) a simulated agent in the form of a *virtual baby* in combination with (b) a *timeline with levels representing milestones* of the virtual baby development. Throughout engagement with our system, users alternate between the two elements: tending to the virtual baby's needs, and engaging with milestones and educational materials.

2) **Reward on achievement**: we provide users with an item associated with children (e.g., a teddy bear), coupled with sound and particle effects every time a level is completed. The collected rewards can then be placed next to the virtual baby to create a more personal scenery. We introduce this mechanism to further enhance the sense of competence, relating to the theory of BPNT and CET.

3) **Cooperative play** offers an opportunity to invite a partner into the app. This feature enables users to take care of the virtual baby together with their partner. We engage parents in a cooperative play environment by requiring them to finish the levels on the timeline. Features focus on functionality that encourages the players to assist each other. For example, we designed a mechanic in which one player can express and store milk, which is typically done so that the non-breastfeeding partner can provide the baby with milk in their absence. In a second step of this mechanic, the partner

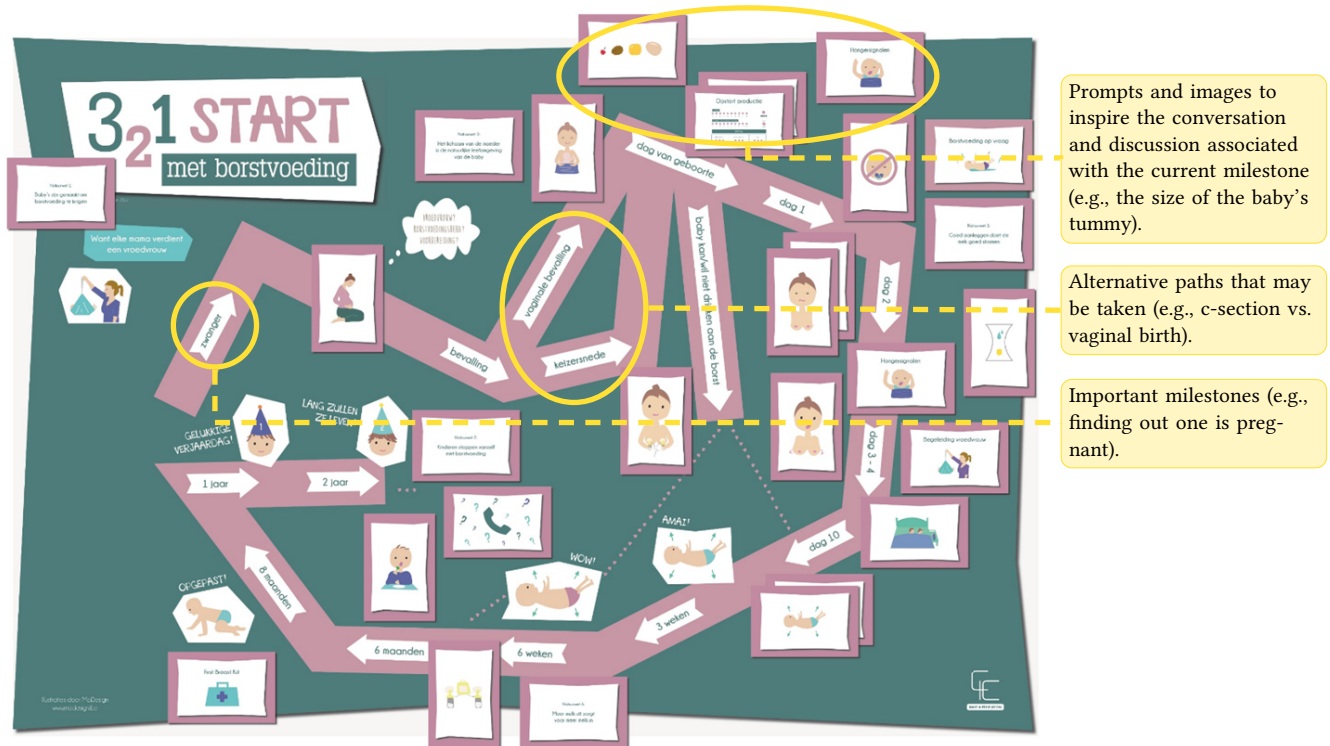


Figure 2: Overview of the “3, 2, 1 Start met borstvoeding” (3, 2, 1 Start with Breastfeeding) educational package: A game-of-geese-like board that guides parents(-to-be) through maternal stages and introduces discussion topics.

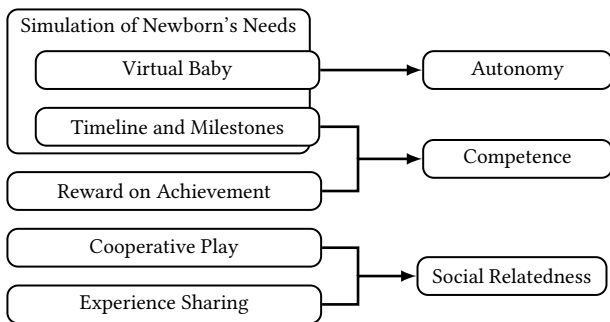


Figure 3: Conceptual model guided by Self-Determination Theory.

can then use this expressed milk to bottle-feed the baby. This element is further conceptualised in line with the basic psychological need for social relatedness as outlined by the SDT mini-theories BPNT, OIT, and RMT. In the context of breastfeeding, this is highly relevant as one of the most important predictors for continued breastfeeding is adequate partner support also with respect to the feeding process.

4) **Experience sharing:** In line with prior breastfeeding literature [11, 12, 48, 61], we integrate an online forum where users can share their personal breastfeeding experiences. This feature is

designed to address the need for social relatedness, drawing from BPNT, OIT, and RMT.

### 3.3 Early Prototype and Evaluation

The conceptual model was developed into a paper prototype, which was used to obtain initial user feedback. Here, we recruited six parents and one parent-to-be (four women and three men; one in 26-30 age group and six in 31-35 age group) to take part in pilot evaluation in which we prompted for their perspectives towards the prototype.

The initial evaluation revealed that participants generally appreciated the app and its user interface design, and highlighted two points for reflection with respect to features. First, almost all participants were put off by the forum feature as they expressed concerns that it might deter expecting parents from breastfeeding in case of emotionally challenging content. Second, participants were intrigued and viewed the rewarding mechanism in a playful way, however, they found the mechanism trivial as they could not use the rewards in other functions of the app. There were a few usability concerns, for example, the amount of textual information, and the lack of affordances of buttons.

### 3.4 Final Prototype

Taking into account the results of the initial evaluation, the concept was developed into an Android app using React Native, with Firebase being the backend database. The resulting app is called “3,

2, 1 Start with Breastfeeding” (see Figure 4 for screenshots) named after the breastfeeding education package. The app allows users to raise a virtual baby alone or with their partner by completing levels positioned on a timeline that starts right before the baby’s birth and runs until the baby becomes two years old. On the timeline, babies’ development milestones are represented as levels that need to be completed.

Each level is associated with a multiple-choice quiz to debunk misconceptions, or to share a piece of reading material, both of which are derived from the 3, 2, 1 Start with Breastfeeding workshop material. Upon the completion of each level, the users will receive a reward that can be used to cheer up the virtual baby. Starting from level 4 (lesson about hunger cues), users are required to feed the baby on demand for 24 hours. We push notifications to inform the users about the baby’s demand on a timely basis with a small random delay between notifications. Users can also check if the virtual baby exhibits hunger cues.

We allow the user to add a partner so that they can take care of the baby and complete the levels together, each using their own phone. In the cooperative play mode, the levels become more competitive as both players can now also see a shared progress. They can also take turns feeding their baby as the breastfeeding parent can pump milk bottles for the non-breastfeeding partner to feed the baby.

## 4 PHASE II: USER STUDY

In the second phase, We leveraged semi-structured interviews to evaluate the app with respect to our research questions.

### 4.1 Method

We explored parents’ perspective through a post-play semi-structured interview about their thoughts and experience using the app in an antenatal education context. Sample questions include “*What is your first impression of the app? Are there any positive and negative elements that stand out?*”, “*What do you think about the parenthood experience we presented in the app?*”, and “*How does it compare with your lived/anticipated parenthood experience?*”. We opted for a semi-structured interview to engage in open-ended exploration of player perspectives on the system, addressing elements of player experience, but also expanding into the lived experience of early parenthood.

### 4.2 Participants and Procedure

Given that breastfeeding is a sensitive and personal topic, we opted to work with parents (rather than parents-to-be) to screen for the appropriateness of the app before presenting it to parents-to-be whose intention to breastfeed is yet to be determined (also see [60] for an example of previous work taking a similar approach). Twelve participants (six female; three in 26-30 age group, eight in 31-35 age group and one in 36-40 age group) were recruited through a snowball sampling method via social media and through word-of-mouth. Five participants were breastfeeding mothers and they breastfed for one week, 7 weeks, 11 months, 11.5 months, and three years. One participant bottle-fed their child and six other participants are partners. Participants have two children (4) and one child (8); among them, two participants are expecting another child.

All participants resided and grew up in Belgium. Ten participants took part with their partner and two took part individually.

At the start of each online session, we supplied participants with information about the research, obtained consent, and helped them install the app on their phone. Participants were instructed to complete six tasks covering all features of the app (e.g., feeding the baby, completing levels). For the task that in principle requires participants to feed the virtual baby on demand for 24 hours, we followed the Wizard-of-Oz method [15] which involves manipulating the baby’s state on the backend real-time storage (Firebase web console) to trigger emotional states and to enable the participants to complete the level within the period of the study. Afterwards, we gave participants the opportunity to explore the app freely. We then invited the participants to respond to a semi-structured interview.

Study sessions were conducted in Dutch and lasted about 90 minutes. Each session was video-recorded, reviewed and translated to English by the third and fourth author (fluent Dutch speakers). The research protocol was approved by the institutional ethics board.

### 4.3 Data Analysis

We examined the transcripts obtained from the semi-structured interviews about parents’ view on the developed app. Following thematic analysis outlined by Braun and Clark [10], the transcripts were coded and aggregated into initial themes in line with the research questions and the core functionalities of the app by the third and fourth author. The initial themes and data points were then reviewed within the research team, and finally three main themes were crafted from the data. In total, nine final codes were assigned across transcripts, and 88 data points were coded.

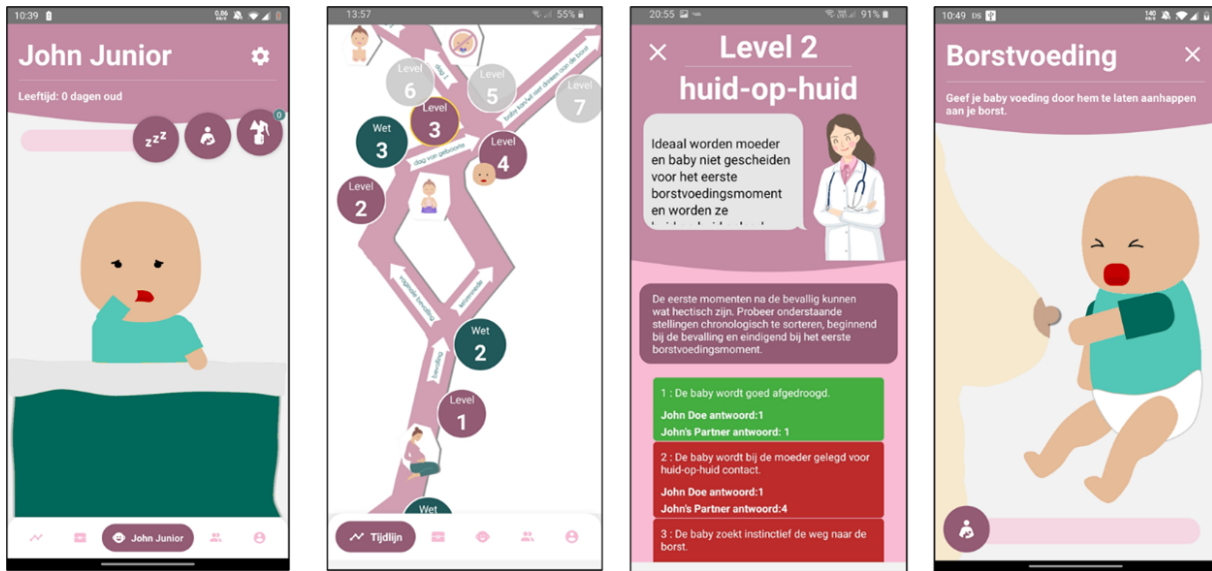
### 4.4 Authors’ Positionality

The analytical approach taken by our work is inherently interpretive, therefore, acknowledging authors’ positionality is essential in interpreting the work. The main author is a male researcher trained in computer science, and has worked extensively in technology and parenthood, but is not yet a parent themselves. The other authors are researchers, software developers and midwife, and they have a background in electrical and electronics engineering, computer science, media studies and midwifery. Two female members of the research team have personal breastfeeding experience that was neither overly negative nor positive, one male member was a partner of a breastfeeding parent, and the other three members have neither the experience of breastfeeding or being a parent. There is a general consensus among with the research team that breastfeeding is beneficial for health but the process can be challenging, and that the individual should choose the mode of infant feeding that best suits them.

## 5 RESULTS

Here, we summarise our interview findings crafted into three themes:

*Theme 1: Motivational Pull of Gamification in Antenatal Education.* This theme summarises parents’ perspective toward the application of gamification in the context of antenatal education and describes how gamification engages parents in breastfeeding education. Our data suggests that participants were generally intrigued about the



**Figure 4: Final prototype (from left to right): simulated virtual baby, timeline and levels, an example multiple choice quiz, and simulation of breastfeeding the virtual baby.**

gamified breastfeeding app, stating that they wished to use the app before their first child (P8, P3, P5) and would recommend the app to other parents-to-be (P11, P6, P5). In addition, participants described their experience with the app as “very interesting” (P1), “fun to try” (P3), “useful for first time parents” (P12), and “more fun to play than have to read a book” (P5). Here, participants suggested that they were engaged with the educational content through the gamification elements that provide explicit feedback about their progress on a timeline and milestones/levels, and pieces of educational information presented in the form of quizzes or short messages. Participants commented that the presentation of reading materials in this manner (i.e., presenting only a small chunk of information in the form of short messages or quizzes throughout levels) makes the reading material more engaging and less overwhelming (P1, P5, P6, P10, P11). For instance, they noted that “the game felt manageable, each level was a bite sized chunk, allowing you to process the information easily at our own pace” (P12), “the game kept my attention, completing levels never took too long” (P10), and “the amount of information and reading was definitely not too much” (P3). Furthermore, there are instances in which participants expressed their enthusiasm towards the timeline and levels with statements such as “I was excited to know what the next level brings, will I be having to change diapers, let my baby burp” (P12) and “I’m excited to know what else would be in the game” (P1), suggesting that gamification elements such as progress indicators and levels can encourage curiosity about other aspects of parenthood beyond infant feeding. In addition, the rewards unlocked after the completion of each level can also contribute to engagement, as one participant commented that the rewarding animation and sound effect “were very fun and everything looked very cute... kept me very interested” (P12). With respect to the simulation of newborn baby’s demands, participants were fond of the virtual baby and stated “I like the idea of having to take care of a virtual baby and respond to its demands; for an expecting parent,

it is hard to comprehend how much your baby asks” (P1) and “I have to check my phone occasionally to take care of the baby. This gives me a feeling of responsibility” (P10), indicating that mobile apps can be leveraged to convey the temporal needs of a baby.

*Theme 2: Digital Parental Experience - Challenges in Experience Conveyance.* Our data shows that the conveyance of parenthood experience requires a careful balancing act between the level of realism and playful elements to maintain user engagement. For instance, partners suggested that “in real life, taking care of a baby requires longer time than a button press, but I wouldn’t like to play this game if I have to take care of the virtual baby this long” (P2) and similarly, “If I have to feed my virtual baby for half an hour or even three minutes, I would definitely not play the game” (P4). Likewise, there are instances in which partners expressed their lack of interest in taking care of the virtual baby but are more engaged by the information from the educational package. Here, partners stated “I was rather playing the game to complete the levels and get the information than to take care of the virtual baby” (P2) and “I like the information the most, but I think my partner would be more interested in the baby feeding” (P6). Moreover, one partner commented on the simulation of the baby’s demands via push notification and suggested “it would be daunting to expecting parents to experience how much your baby asks via all those notifications. It is good that it only takes one day to complete the level” (P9).

Our data also reveals limitations of mobile apps as a medium in conveying the lived experience. Participants noted that the app lacks aspects of parenthood beyond breastfeeding, namely a bottle-feeding feature (i.e., bottle feed with pumped milk or formula) for the breastfeeding parent (P1, P8) and intimate interactions with the virtual baby (P2, P9). Participants commented that “there is of course more to a baby than just feeding” (P3, P6) and that “the nicest part of being a parent is being able to interact with your baby and this is hard

to grasp in the app” (P2), however, participants also acknowledged the limitations of mobile apps and stated that “I like that the app is more focused on the feeding process because of course, when taking care of a baby, there is so much you have to learn and do, and an app can never properly convey all of these” (P8). Here, participants elaborated that “it would have been nice thought to be able to do more with the virtual baby than just stroke and move toys” (P2).

**Theme 3: Cooperative Play - A Mechanic to Involve Partners in Breastfeeding Education.** This theme highlights the cooperative nature of breastfeeding through the perspective of partners. Participants generally expressed that their interest in the breastfeeding education app is boosted by the cooperative game mechanics. This was manifested through statements like “as a man, I would never just play this game on my own. If my partner would ask me to play with her though, I would” (P2). However, participants suggested that the cooperative play function can draw partners into breastfeeding education, underscoring the role of partners in supporting breastfeeding mothers. For example, one participant commented that “it was fine to play the app alone, but I think it would be more interesting to play with your partner if you’re thinking about children. This way you can divide tasks and think together about the levels.” (P10). Likewise, there are many statements suggesting that “The game would be most fun to play with your partner” (P11). These comments suggest that social elements of gamification offer an incentive for parents to team up and get involved with educational content about breastfeeding. While the cooperative play feature was generally well received among parents, there were instances in which participants argued that responsibilities for non-breastfeeding partners within the app are lacking and do not fully reflect the role of partners in supporting mother, for example, one participant noted that “In real life, the partner has a bigger function other than once in a while give bottle. ... the (virtual) baby (needs) to have more features so that you and your partner can work together more” (P3). Likewise, the lack of interactivity specifically for partners sparked tension as it resulted in a loss of autonomy, illustrated through comments like “I can’t do anything as long as my partner did not provide me with milk bottles” (P6), and suggesting a need for more comprehensive features to provide partners with engaging opportunities for play. Interestingly, one partner viewed this as an opportunity to reflect on the challenges of breastfeeding mothers and suggested that “I would like to be able to switch roles for a day so I also understand what difficulties I can come across when breastfeeding and having to provide bottle for my partner” (P11).

## 6 DISCUSSION

In our work, we explored perspectives of parents and partners on a gamified breastfeeding education app that allows users to take care of a virtual baby, while giving a dedicated role to partners. Here, we discuss our findings with respect to our initial research questions and implications for technology design that leverages gamification in the context of antenatal education.

### 6.1 RQ1: How do parents perceive a gamified application to support antenatal education?

Parents view gamification as an enjoyable and useful strategy to apply in the context of breastfeeding education, and are more willing

to engage in gamified breastfeeding technology than other forms of media (e.g., books and reading materials). We hypothesize that this is associated with the novelty of the approach, and the fact that traditional breastfeeding information is often presented in a dry fashion, whereas our app offers small chunks of information that can also be processed in the gaps of the day. Our data suggests that game elements like levels, cooperative play, and the simulation of a virtual baby can help parents gain insight into the lived experience of breastfeeding, which is otherwise difficult to grasp for expecting parents. However, our findings show that conveying the lived experience of breastfeeding is challenging and requires careful consideration when providing a simulation of the demand and the behavior of a newborn baby with respect to the level of realism and user interactions that it facilitates. Most importantly, we observed that parents (rightly) associate breastfeeding with other aspects of parenthood and anticipate such playful technology to have a broad scope beyond breastfeeding, which would also facilitate placing bigger emphasis on the role of partners. Interestingly, social connectedness in terms of experience sharing in the context of an online forum was not well received by participants during the evaluation of the early (paper) prototype. This contradicts prior literature which highlights its potential in fostering human connection within the context of breastfeeding [11, 12, 48] and its positive effect on intrinsic need satisfaction [75]. Here, our findings may be explained by additional work that suggests that perception of gamification elements hinges on situational factors [64], with breastfeeding being particularly sensitive and personal, and not everyone being comfortable in sharing related experiences with strangers. Generally, we argue that playful prenatal technology needs to be crafted in a way that it does not overburden users, so that the lived experience can be conveyed without discouraging breastfeeding. Moreover, technology that support antenatal education should be designed to encourage discovery of new information through interactivity rather than simply digitising learning materials.

### 6.2 RQ2: Can gamified breastfeeding education engage partners in considerations regarding breastfeeding?

Our findings suggest that gamification has potential to engage partners in antenatal education and that cooperative play offers partners an incentive to take part in breastfeeding education (with their partner) while other game elements such as levels and a timeline keep them engaged. In addition, we noticed that breastfeeding parents and partners were interested in different elements of the app. For example, partners are more enticed into elements that provide explicit feedback and factual information, such as quizzes in levels and progression on the timeline, rather than the part that conveys the nuanced lived experience. Reflecting on our research, there exists a risk of reinforcing the notion that non-breastfeeding parents are not able to help with parenting responsibilities (i.e., the app’s feature that supports partner involvement is shallow). Here, future systems need to address interactions that enable partner involvement more comprehensively. Nevertheless, this still highlights an opportunity for the design of playful elements around the lived experience that is in line with the role of different breastfeeding

stakeholders, i.e., designers need to consider different gamification strategies to better suit the role and the norm of each stakeholder.

### 6.3 Leveraging Gamification to Augment Technology to Support Antenatal Education

Gamification has the potential of engaging expecting parents and support antenatal education. Therefore, our work supports the notion that playful technology can support the transition to parenthood [27]. We drew from SDT and its mini theory (BPNT) [3, 51] as a theoretical framework to inform the design of gamification elements, suggesting that thereby it would be possible to improve player engagement. The results suggest that this is a promising approach. However, we also observed two key challenges for future work, which we further discuss here:

*Challenge 1: Tension Between Playfulness and Reality of Early Parenthood.* In our work, we observed instances in which gamification (and prioritising an engaging player experience) risks simplification of core experiences of early parenthood. For example, we decided to simulate the experience of attending to the virtual baby over a shortened, accelerated period of time, which is a strategy frequently employed in games to allow players to observe and engage with processes that are lengthier in reality. From the perspective of the SDT mini-theory BPNT, this would have contributed to player autonomy [3, 51], which is also reflected in participant feedback, suggesting that the task was manageable because it was not spread over a realistic timeframe. At the same time, loss of autonomy as a result of continuously having to attend to the newborn's needs is one of the key challenges experienced by new parents [61], broadly relating to BPNT [3, 51]. In this instance, by designing for a compelling player experience, we directly counteract the integration of features that would allow players to explore and reflect on the potential loss of autonomy. Therefore, one of the key issues that future work in this field needs to address in more detail lies in the resolution of tension between the creation of engaging playful experiences, while accurately reflecting the lived experience of early parenthood. Here, existing work on emotionally challenging play experiences [9] could provide first insights into how to integrate aspects that are not necessarily fun, but nevertheless meaningful for players.

*Challenge 2: Involving Partners in a Way That Facilitates Agency.* In line with prior work [17], findings from our work suggest that partners are less interested in learning about breastfeeding due to its feminine connotation. This can be explained by the Social Role Theory [24], which argues that gender stereotypes emerge from the distribution of men and women into social roles within their society. Our data shows that playful co-operative mechanics can motivate partners to initiate the gameplay while gamification can engage them with the learning materials. However, it is revealed that partners experienced a loss of agency as they have to be dependent on the other player to feed the virtual baby, i.e., the player with the breastfeeding role needs to provide breast milk so that the other player can feed the child. From the perspective of SDT, we hypothesise that the limited amount of options for partners to get involved negatively impacted their autonomy within the

app, and limited the ways in which they could experience competence, which aligns well with aspects covered by BPNT, CET, and RMT [3, 51]. Further, this inadvertently reinforces the notion that mothers play a central role in childcare and fathers are on the sideline [62]. Although this can be viewed as a limitation of our work, the tension mirrors the reality of parenthood experiences of many partners whom experience frustration for relying on mothers to feed their child with breast milk [61]. It can be argued that the tension can be resolved by introducing other modes of feeding, i.e., providing opportunities for one player to supplement the feeding with formula when breast milk is not provided by the other player. However, it is important to recognise that partner support can be nuanced and does not have to directly involve feeding the child [57], but can also extend to other acts of support, e.g., by providing the breastfeeding parent with drinks, creating a peaceful environment for them, or helping them feed at night [60], which again aligns well with the theoretical background of the RMT mini-theory [3]. Thus, one main challenge for future work lies in the design of learning experiences that inform partners about the importance of indirect support and their contribution to the success of breastfeeding by looking at early parenthood more holistically, encouraging partners to reflect on their opportunities for involvement and the benefits of their nuanced support on breastfeeding practice.

## 7 LIMITATIONS AND FUTURE WORK

There are a few limitations that need to be considered when interpreting our work. First, our research was conducted in Western Europe and findings may not translate to other cultures. Second, for this initial piece of work we worked with participants who were predominately parents who already had experience with different modes of infant feeding rather than parents-to-be whose intention to breastfeed is yet to be determined. While the research presented here has provided valuable first insights into parents' perspectives toward a gamified app to support antenatal education, we have not yet assessed longer-term use and effectiveness, which is an opportunity for future work. For example, investigating the impact of the app on breastfeeding determinants (e.g., knowledge or attitudes) should be carried out. Likewise, larger scale investigations of the effect of gamification elements in antenatal education could provide valuable insights to support researchers and designers wishing to develop playful interventions to supplement antenatal education. For example, in our work there was evidence of situations in which partners competed with each other, and future work should explore whether this is a desirable outcome or one that can threaten the shared experience and the emergence of relatedness. In this context, we also see potential in the development of features that enable partners to engage more deeply, e.g., adding functionality to the app that enables them to further support the breastfeeding partner, take care of the baby in additional ways, or better understand the changes that the birthing partner is experiencing throughout the early stages of parenthood. Finally, while we considered the SDT mini-theories BPNT, CET, OIT, and RMT as especially relevant in the background of our work, we focused on BPNT as an overarching theme in our development and evaluation. As such, our work would benefit from a yet more comprehensive perspective regarding the theoretical lens of SDT, deconstructing in more detail



how the elements integrated in our app affect need satisfaction and implications for breastfeeding parents and partners in the sensitive setting of breastfeeding.

## 8 CONCLUSION

Breastfeeding can be challenging, and partner support can contribute to the success of the feeding practice. However, strategies in involving partners in antenatal education remain patchy. Our work showcases the potential of gamification and simulation in engaging parents and partners in the process of learning about breastfeeding and associated challenges. The results of our work suggest that gamification is a promising approach in supporting antenatal education by mean of improving parents' and partners' engagement with breastfeeding education and facilitating the conveyance of early parenthood experiences. Through this work, we lay out considerations to be taken when leveraging gamification to convey the lived experience of breastfeeding parents, and challenges in the design of playful educational media to involve parents in antenatal education.

## ACKNOWLEDGMENTS

We would like to thank all study participants for their time and contribution to our work.

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