University of Cape Town

ParentCoach: Co-designing a Chatbot to Support First-Time Parents

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Declaration of Authorship

I, Leina Meoli, hereby declare that this is my own work, and no portion or the entirety of this work has been submitted for the conferral of a degree at this or any other university. Every contribution to and quotation from another person's work that is made in this dissertation has been acknowledged, cited, and referenced.

Signed:

Date: 15 November 2024

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Abstract

Recent advancements in chatbot technology have led to their widespread application across various sectors worldwide. Still, significant challenges remain in their effective design and implementation for healthcare in the diverse, multilingual socio-economic contexts in South Africa. These challenges include limited internet connectivity and the need for multilingual support.

This dissertation explores the co-design of a chatbot to support first-time parents' informational needs in an urban South African context by drawing on the perspectives of clinicians and parents using an exploratory and co-design approach. I conducted one-on-one interviews with five clinicians to understand their perspectives on parental support needs and exploratory workshops with ten parents to gather insights on their learning challenges and experiences and their informational needs. My analysis of findings emphasizes the importance of designing with empathy to support vulnerable parents, ensuring chatbots complement healthcare professionals, building clinician trust through credible sources and endorsement by reputable healthcare institutions, and enabling repeated access to information to aid parents' information retention.

I then conducted two sets of co-design workshops with 21 parents that gave insight into parents' preferences regarding chatbot design modalities and uncovered constraints for our design. These activities underscored the necessity of preparing communities to co-design unfamiliar technologies since most participants were engaging with chatbots for the first time. Despite this unfamiliarity, participants demonstrated an openness to adopt chatbots for parenting support.

Some key design contributions from co-design were to supplement multilingual support with English content and integrate simple language with medical terminology to enhance parents' understanding, enable user-initiated chatbot interactions, and offer customizable features for community inclusivity.

Though we set out to co-design a chatbot to support first-time parents, I did not end up building one due to various contextual constraints. The prototype is a "pseudo-chatbot", a question-and-answer informational resource presented in a chat-like user interface with search and menus for content exploration that we evaluated in a two-week pilot feasibility trial. The results of the trial demonstrated that familiar social messaging interfaces and robust menu designs enhance usability, even without fully interactive chatbot features, and highlighted the importance of aligning chatbot content with parents' priorities to promote engagement.

List of Publications

The following publications that I authored or co-authored contain work contributing to the overarching research study, ParentCoach to which this dissertation also contributes. The details of the ParentCoach study are provided in Chapter 3.

1. **Leina Meoli**, Francisco Nunes, Beatriz Félix, Joana Couto da Silva, Xolani Ntinga, and Melissa Densmore. 2024. A Not So Chatty "Chatbot": Co-designing to support First-Time Parents in South Africa and Portugal. In Proceedings of the 6th ACM Conference on Conversational User Interfaces (CUI '24). Association for Computing Machinery, New York, NY, USA, Article 30, 1–8. doi.org/10.1145/3640794.3665571 * Honorable Mention Short Paper

2. Beatriz Félix, Cristiana Braga, Xolani Ntinga, Sarina C Till, **Leina Meoli**, Alastair Van Heerden, Ricardo Melo, Nervo Verdezoto, Melissa Densmore, and Francisco Nunes. 2024. Understanding How Parents Deal With the Health Advice They Receive: A Qualitative Study and Implications for the Design of Message-based Health Dissemination Systems for Child Health. In Proceedings of the 2024 ACM Designing Interactive Systems Conference (DIS '24). Association for Computing Machinery, New York, NY, USA, 1319–1335. doi.org/10.1145/3643834.3661504

As such, within this dissertation, we shall, in some instances, reference and use aspects of these publications.

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Chapter 1

Introduction

1.1 Context and Aim

Traditional measures of economic performance, such as gross domestic product and household income, capture only a small part of what determines human well-being [78]. Healthcare is a key metric to assess the quality of people's lives and provide insight into the progress of societies, with maternal and child health being one of the key indicators of a nation's state of healthcare.

Goal 3 of the United Nations Sustainable Development Goals (SDGs) aims "to ensure healthy lives and promote well-being at all ages, which is essential to sustainable development". To achieve this goal, a particular focus needs to be placed on early childhood, a period crucial for children's development that has lifetime implications [78].

First-time parents face a unique set of challenges [53]. To adequately provide parental support during early childhood, first-time parents quickly need to acquire knowledge and skills to care for, nurture, and support their children. However, they often lack credible and context-appropriate information in a timely manner. In addition to issues around access to crucial information, another fundamental challenge parents face is difficulty in interrogating a source to ascertain the accuracy of information [64].

The world has been shifting in its use of technology to become more and more conversational. As of the third quarter of 2020, 93.2 percent of internet users in South Africa between the ages of 16 and 64 had used the WhatsApp messaging app in the past month. Meanwhile, Facebook Messenger has reached 6.15 million users in South Africa as of 2024 [48]. This technological use presents an opportunity

to use conversational agents such as chatbots for information delivery. Chatbots, simply defined, are programs that provide a reaction back to a user dependent on the offered text or speech input [65] often reside on several of these widely used messaging platforms, with many of them targeted at mobile users [36]. Worldwide – chatbots are also increasingly being used as a health information resource, with a recent example being the widely used WHO chatbot for COVID-19 to combat misinformation, which reached 12 million people on WhatsApp in its first month of operation [5]. While various parenting chatbots exist [5, 97], little is known about how chatbot design should vary across contexts. Merely transplanting a chatbot from another country for use in South Africa will face contextual and infrastructural challenges.

The ParentCoach study worked with communities in Porto, Portugal, Sweetwaters, Kwa-Zulu Natal in South Africa, and Cape Town, South Africa, engaging in the participatory design of chatbots for parent education to support first-time parents during the critical early childhood period by providing them greater access to curated Maternal and Child Health (MCH) and Early Childhood Development (ECD) information. This dissertation focuses on the work based in Cape Town that includes interviews, exploratory participatory workshops, and participatory co-design workshops with parents. Ethically, researchers need to take a participatory approach to first understand the perceptions around chatbots within the participating community before implementing any such intervention [21].

To ensure community priorities were centered in any resulting interventions, the study worked directly with clinicians and parents in middle and low-income communities in Cape Town who would be interested in participating in this study. Though the target users of the intervention were first-time parents, involving a wider variety of stakeholders in research activities is seen to be vital for successfully co-designing an information system [15] and is found to stimulate reflection and a commitment to action within a community [15].

We[1] sought to leverage the participating communities' existing local knowledge and experiences to understand the appropriateness of different chatbot design features, given that unique regional and cultural characteristics can play a significant role in determining a project's success [13]. By focusing on the empowerment and inclusion of communities inexperienced in design work, a collaborative or co-design approach makes the design more accessible to create more sustainable and context-appropriate innovations [15]. This approach was also vital in managing and establishing common expectations of the resulting intervention, which affects users' overall satisfaction [77].

[1]The term "We" refers to the ParentCoach consortium and gatekeepers for collaborative decisions and activities as described in Chapter 3.

The ParentCoach study aimed to address knowledge gaps in parents by democratizing neonatal care knowledge using a conversational interface (chatbot) in South Africa and Portugal. It contributes to understanding attitudes, perspectives, and values of middle and low-income communities in South Africa regarding chatbot systems, offers key considerations for different chatbot design modalities when designing for middle to low-income parents, and presents a chatbot prototype on which a sustainable real-world solution could be based.

1.2 ParentCoach Study

This dissertation presents a subset of work I conducted in the ParentCoach study in my capacity as a researcher on the study. The ParentCoach study was carried out by the ParentCoach consortium, which is made up of organizations in Portugal and South Africa. Fraunhofer Portugal AICOS led the consortium and has three partners: Aurora Tech AI, the Human Sciences Research Council (HSRC), and the University of Cape Town (UCT). The research study was funded by Fundação para a Ciência e Tecnologia and the Aga Khan Development Network.

The ParentCoach study aimed to address the knowledge gaps of first-time parents and families by democratizing neonatal care knowledge. To this end, the study investigated the design of chatbots to support first-time parents, providing them with greater access to curated maternal and child health (MCH) and Early Childhood Development (ECD) information. Partner organizations in Portugal and KwaZulu-Natal also carried out the same research activities in parallel. The study partners jointly analyzed the data collected to identify common themes and key differences across the different contexts. However, this dissertation focuses on research activities carried out in Cape Town by UCT, highlighting the other research contexts where it is relevant and necessary.

The ParentCoach project leveraged prior work by partner organization Aurora Tech AI, which developed Aurora, a Facebook Messenger chatbot launched in 2018 designed to support new parents from pregnancy until the child's 6th birthday. At the time of its shutdown, Aurora had 8000 users in Portugal and featured modules dedicated to children's sleep and breastfeeding. The Aurora chatbot focused on providing guidance and information on parents' day-to-day experiences and referred them for professional medical advice on any clinical issues. I used a subset of the previous Aurora chatbot's corpus as the corpus for the resulting chatbot prototype we trialed in phase 5 of this study.

1.3 Research Objectives

I set out with the following research objectives:

RO1: To investigate the implications of clinicians' perspectives and parents' information needs and learning patterns on the design of a parenting advice chatbot.

I conducted exploratory workshops with parents to understand the challenges they faced in caring for their children, their learning experiences, and their preferred sources of information. I also conducted interviews with clinicians who work with first-time parents. These activities offered insight into clinicians' teaching practices, the learning habits of parents they observed, and guidelines on the roles a chatbot could play for these parents.

RO2: To explore and understand the existing perceptions of chatbots within the participating communities.

It is documented that a significant population has not yet interacted with chatbots or is unaware of them [44]. We took a participatory approach, working with parents and clinicians to better understand what they think chatbots are and what they believe chatbots can or should offer them.

RO3: To identify key design considerations regarding different chatbot design modalities from the perspective of parents in middle- to low-income communities.

There are various established chatbot design choices that are outlined in Chapter 2. For the ParentCoach study, the key design choices to be evaluated were – support for multiple languages, information delivery mediums for low literacy users, input processing and response generation mechanisms, chatbot dialogue proactivity, and chatbot language tone and complexity.

We sought to answer RQ3 through an iterative co-design process in two workshops to understand what parents prefer and what they use in practice. I presented various chatbot design modalities to the parents in two co-design workshops. The ParentCoach consortium team then jointly analyzed their feedback to design a prototype intervention. This prototype was evaluated with parents in interviews following their participation in a two-week feasibility pilot trial.

1.4 Research Methodology Overview

This study employed a mixed-methods approach to co-design, develop, and evaluate a chatbot intervention (ParentCoach) to support first-time parents in Portugal and South Africa. A participatory methodology was adopted to ensure the solution was community-driven, involving the key stakeholders throughout the research process. This approach is grounded in principles of participatory design that seek to empower marginalized communities by involving them directly in decisions that affect their lives. The study was conducted in five distinct phases:

- Phase 1: Interviews with clinicians to understand their perspectives on parental support needs and chatbots (Chapter 4).
- Phase 2: Exploratory participatory workshops with parents to gather insights on their learning challenges, experiences, and informational needs (Chapter 5).
- Phase 3: Co-design workshops with parents to understand their perspectives on various chatbot design approaches and adapt a chatbot for their context-specific needs (Chapter 7).
- Phase 4: Chatbot implementation to develop a prototype for user trials (Chapter 8).
- Phase 5: Pilot feasibility trial with ParentCoach App Prototype to evaluate its accessibility, usability, and impact (Chapter 9).

We recruited participants through established community organizations: the Bhabhisana Baby Project, Mowbray Maternity Hospital, and Black Equations. These gatekeepers were vital in facilitating access to participants, ensuring trust and cultural sensitivity in the research process. Data analysis followed an inductive thematic approach, with each research team independently coding transcripts and collaboratively refining themes through affinity mapping. This iterative process informed the chatbot's design, emphasizing empathy, accessibility, and user trust. Chapter 3 details this process further.

1.5 Dissertation Layout

The content of this dissertation consists of the background, methods, findings, and discussions that emerged from each of the above phases.

Chapter 1 outlines the motivation for the work, the research objectives this dissertation attempts to address, and the research methodology.

Chapter 2 provides background and related work for this research, looking at literature for digital MCH and chatbots. This chapter also provides an overview of the multi-institutional ParentCoach study that this research contributed to.

Chapter 3 details the research design and participant recruitment. It also describes the study context and outlines the data analysis techniques. This chapter provides a comprehensive view of how the study was structured and conducted.

Chapter 4 presents the methods for and findings from interviews with clinicians in Phase 1. It explores their perspectives on parents' information-seeking habits, teaching priorities, preferred information sources, clinicians' views on chatbot use, and their trust in digital resources.

Chapter 5 presents the methods for and the findings from workshops with parents in Phase 2. The chapter highlights teenage parents' challenges, common information sources parents use, and preferences for digital interventions. It also discusses methodological challenges such as group dynamics and participant influence, providing insight into the limitations of the exploratory approach used.

Chapter 6 presents a joint discussion of the findings from both Phases 1 and 2, including clinician interviews and parent workshops, focusing on emergent design considerations for the chatbot. It emphasizes the need for empathy in chatbot design, the importance of chatbots complementing clinicians, and the role of chatbots in providing easily accessible, trusted information for parents.

Chapter 7 focuses on the co-design phase, Phase 3, where parents were actively involved in designing the chatbot. It discusses the methodology behind the co-design workshops and the findings of co-design workshops with parents. The chapter then discusses these findings, presenting key design considerations and insights gained in a second prototyping workshop that we used to refine the prototype design.

Chapter 8 covers Phase 4, the implementation phase, discussing the contextual constraints and design decisions made to build the prototype and its development. It serves as a sample implementation to illustrate the considerations in Chapters 6 and 7.

Chapter 9 reports on the feasibility pilot trial (Phase 5) of the prototype, presenting findings on user interaction patterns, chatbot structure, and chatbot personality. It discusses further design considerations based on the trial's findings, such as content organization, user trust, and the need for empathy in the chatbot's responses. The chapter concludes by assessing the trial's limitations and providing suggestions for future research.

Chapter 10 collates and summarizes the contributions of the research, offering rec-

ommendations for future work and highlighting the potential of digital interventions in healthcare and parenting support.

Chapter 2

Background and Literature Review

2.1 Introduction

This chapter reviews the literature and background foundational to the ParentCoach study. It begins with an overview of the study's goals, emphasizing the role of parent education in improving maternal and child health (MCH) outcomes. The chapter then examines the context of digital interventions in MCH, with a focus on low-resource settings and the various categories they fall under.

The discussion includes perceptions of digital healthcare interventions, highlighting their potential benefits and limitations. An exploration of chatbots follows, outlining their applications in healthcare and MCH. I introduce key chatbot design choices identified through a review of the literature, including user input processing, dialogue initiation, human involvement, trust, language, and content delivery methods.

By synthesizing prior research, this chapter situates the ParentCoach study by identifying critical gaps and opportunities to be addressed and providing the necessary context for the findings and discussions presented in subsequent chapters.

2.2 Parent Education

Neonatal and Early Childhood Development knowledge is integral to better care for children in this critical period and has been seen to shape key aspects of parenting, such as appropriate and timely care seeking for their children [23]. In turn, proper health care-seeking behaviors are seen to prevent or reduce the magnitude of child

mortality resulting from childhood illnesses [101]. Well-informed patients are empowered to participate in making decisions on their clinical care in dialog with their healthcare providers [47]. Early childhood parenting information can be passed to parents through parent education interventions, "a range of teaching and support programs for parents to communicate knowledge about child development and teach new skills" [10].

Especially for first-time parents, caring for infants can often lead to parental anxiety and psychological distress, which studies have demonstrated may have long-lasting effects on the child's emotional, behavioral, and cognitive development [63]. Parent education has been seen to enhance the sense of competence as parents and is associated with significant reductions in parental depression and stress [46] with interventions aimed at parent education not only benefiting the children being parented but contributing to the wellness of the parents themselves and their families [10]. In as much as information around early childhood parenting is useful, first-time parents may find that the wide variety of information on parenting approaches considered best practice can also make it harder to accomplish everything they are supposed to do [53].

2.3 Chatbot Overview

A chatbot is a computer program capable of simulating human conversation with a human user [67]. The program is able to understand human speech or text and then generate a response or perform an action based on it. Chatbots are typically used to provide users with access to information and services and can be used to offer both proactive and reactive support [66]. Chatbots have significantly gained popularity in recent years, residing on social media platforms and mobile or web applications [36]. Across Africa, chatbots have begun to be used as tools for health information education [71]. These include MamaSupport in Kenya [11], AskNivi in Kenya [35], Big Sis in South Africa [38], Tina in Nigeria and Uganda [73] and ParentText [50]. However, most of these require internet access to operate, excluding a significant population in low-resource settings where access to the internet is constrained [13].

2.4 Study Context

The study was conducted in rural South Africa (Sweetwaters, KwaZulu-Natal, South Africa), urban South Africa (OceanView, Cape Town, South Africa), and urban Portugal (Porto). Across these diverse contexts, we set out to understand the information needs of parents, understand their experiences, and investigate their preferences regarding chatbots through co-design. My dissertation will primarily present and

discuss the findings of the research I carried out in Cape Town as part of the ParentCoach study.

2.5 Digital Interventions in Healthcare

2.5.1 Perceptions of Digital MCH Interventions In Low-Resource Settings

The term "low-resource settings" in healthcare refers to the lack of or limited availability of resources required to provide the necessary healthcare services within a specific geographic location [19]. An array of persisting issues in maternal and child healthcare in South Africa has motivated the development of numerous digital health interventions aimed at addressing them, with the number continuing to grow steadily with the proliferation of mobile technology.

A 2021 study found that women in low-resource settings are aware of digital interventions for self-management and are open to using these technologies. Participating mothers believed mHealth could benefit during pregnancy by providing useful tips and information on normal and abnormal pregnancy signs and saving them the cost of hospital visits[19].

There are a significant number of digital interventions available to parents globally and within South Africa. Table 2.1 shows some of the chatbots and message-based systems we used to identify the gap our intervention could possibly address. Many of these have been implemented as mobile phone apps requiring internet access or as SMS and USSD services that can run on various mobile devices. Each of these two approaches bring various advantages and disadvantages in the South African context, where the cost of mobile data is high and conectivity is limited in certain geographical areas [13] which makes USSD/SMS unreliable in these cases.

2.5.2 Genres of digital interventions in healthcare

The WHO provides a classification of digital health interventions based on the clients the interventions serve. This classification comprises Targeted Client Communication interventions, Untargeted Client communication interventions, Client-to-Client communication interventions such as peer support groups, personal health tracking interventions, citizen-based reporting interventions, and On-Demand Information services [98]. These different types of interventions are seen to be suited to certain use cases more than others, showing the need to carefully select the intervention based on what problem we are setting out to solve and where. We shall look at a broad classification overview of digital Maternal and Child Health interventions.

Table 2.1: Overview of message-based systems for maternal and child health [30].

Technology name [ref]	**Year**	**Information topic(s)**	**Tech**	**Users**	**Message targeting**	**Comm. mode**	**State**
- [75]	2010	Maternal care	App, SMS	ASHAs	None	2-way	P
Text4baby [95]	2012	MCH	SMS	Mothers	TCC	1-way	D
- [70]	2015	Appointments	SMS	Pregnant	TCC	2-way^{h}	P
MomConnect [81]	2018	MCH	SMS	Mothers	TCC	1-way	D
XhosaBot [62]	2019	Child health	Chatbot	Mothers	None	2-way	P
Smart-bot [64]	2019	Maternal care	Chatbot	Pregnant	None	2-way	P
Feedpal [99]	2019	Breastfeeding	Chatbot	Mothers	None	2-way	WoO
- [9]	2020	Appointments	SMS	Mothers	TCC	1-way	P
ALTCAI [25]	2021	MCH	Chatbot	Mothers	None	2-way	WoO
GISSA [6]	2021	Child health	Chatbot	Mothers	CA	2-way	P
- [74]	2022	Appointments	Chatbot	Mothers	None	2-way^{h}	P
Lhia [17]	2023	Breastfeeding	Chatbot	Mothers	None	2-way	P
- [45]	2023	MCH	SMS	Mothers	None	2-way^{h}	P
Rosie [55]	2023	Child health	Chatbot	Parents	TCC	2-way	P

Information topic(s): MCH - Maternal and child health, Appointments - appointment information and reminders.
Users: ASHA - Accredited Social Health Activist. ***Message Targeting***: TCC (Targeted Client Communivations)
Comm. mode: ^{h} - human-assisted responses. ***State***: P - Prototype, D - Deployed, WoO - Wizard-of-Oz study.

Targeted Client Communications (TCCs)

TCC health campaigns, especially in low- and middle-income countries, "recruit recipients on-demand and gather only a few background characteristics"; this makes it difficult to deliver individualized and time-appropriate information to recipients [9]. MomConnect [81] is an example of a TCC in South Africa. Pregnant women can register and receive targeted SMS messages based on their stage of pregnancy and the needs of their child up to when the child is two years old.

Chatbots can either be targeted or untargeted, depending on the clients they serve. In the case of the ParentCoach study, the targeted clients were first-time parents. A major motivation for the use of exploratory participatory workshops and contextual interviews prior to the design of the chatbot intervention was to ensure that the chatbot content was aligned with the needs of first-time parents in the participating

communities.

Individualized messaging can be achieved by linking TCCs to electronic health registries containing information on clients [9]. Unfortunately, in many low-resource settings, such as our study context in South Africa, this may pose a challenge due to varying levels of consolidation of health record systems. However, the two-way communication of chatbots can allow user input to provide useful context and enable more specific information to be relayed back to the end user in subsequent interactions.

On-demand Information Services

These services make health information accessible when triggered by the client to do so [98] in contrast to TCCs that are largely system-initiated in their interactions.

On-demand information services play a crucial and unique role in providing reactive support to clients through information, emotional support, and advice at the time of a challenge or crisis. These information and support services are made available through a variety of mediums such as websites, helplines, USSD and SMS menus, or mobile applications [98]. GISSA [6] is one such on-demand information service that mothers used to access information such as breastfeeding, feeding introduction, immunization, and growth and development milestones according to their interest and need.

Telephone helplines are a tried and tested resource for information and service delivery on demand. In the health and welfare sector, helpline services have become an increasingly popular mode of providing community access to information and expert information and advice [86].

Reactive telephone helplines enable the provision of real-time professional support to mothers when they are most vulnerable [86]. These calls are reported to provide reassurance and alleviate emotional stress [85].

Human-operator live chats are typically computer-based services accessed through websites or mobile applications where users can remotely chat in real-time with a human operator on the other side. Similarly to telephone helplines, they can be used to support parents.

However, on-demand information services such as telephone helplines and human-operator live chats can be costly for the endorsers to operate due to scaling up human capacity to meet demand [49] or zero-rating calls and messages for customers; or costly for the users who need to use their airtime or mobile data to call and chat with human operators.

2.5.3 Chatbots in Healthcare and MCH

In health care, chatbots are seen to have the potential to provide patients with access to immediate medical information or connect them with appropriate health care providers across their communities [67]. In mental health, users perceive chatbots as useful for learning and preparing for future interactions with their healthcare providers [2]. Further, they show great promise in improving healthcare accessibility, especially for groups considered marginalized and under-served [51].

2.6 Key chatbot design choices

Chatbot systems come in a wide range of implementations and can be classified using different parameters such as their user input processing and response generation method, the level of human involvement, chatbot proactivity, chatbot content form, and chatbot anthropomorphism (humanness) [3]. The different permutations of these parameters present unique opportunities and challenges depending on the context in which they are deployed. The following are key design choices we identified through a review of existing literature.

2.6.1 User Input processing and Response generation methods

Retrieval based chatbots

Retrieval-based agents check for keywords inside the information expression and recover relevant answers dependent on the query string and its similarity to the text and the retrieved from the knowledge base [65].

Rule-based chatbots

These chatbots are scripted in their interactions. They rely on conditional logic with a set of possible inputs being mapped to predefined responses and actions based on some rules. The knowledge used in the chatbot is humanly hand-coded and is organized and presented with conversational patterns [76]. Rule-based and retrieval-based chatbots are highly dependent and limited by the correctness and form of user input to provide meaningful responses. They are not typically robust to the human error commonly occurring during natural communication.

Rule-based chatbots do have their advantages. They provide a more predictable and consistent experience to the user. It is also easier to structure the flow of conversation for task-oriented chatbots where a user wants to perform a certain set of actions toward their goal conveniently.

In addition, rule-based chatbots have greater transparency regarding their capabilities and what they can and cannot do, ensuring the user has realistic expectations. When users hold realistic expectations regarding chatbots' capabilities and their interactions match those expectations, they tend to be more satisfied [77].

ML based chatbots

Certain chatbots can understand natural human language in the form of speech or text through Natural Language Processing (NLP), which is a set of Artificial Intelligence techniques used to process text and speech. Users can communicate with these conversational chatbots almost as if they are speaking to another real person.

There has been notable advancement in chatbots by integrating generative AI and large language models (LLMs) in systems such as ChatGPT. LLMs represent a class of AI-based models trained on massive amounts of data to analyze language and generate natural language text responses to free-text inputs without receiving input-specific training [102].

Generative AI chatbots have the capability to take users' natural language input and generate human-like responses, enabling more natural and informative interactions. These chatbots can be used for various tasks such as answering questions, writing essays, poetry, or music, and composing emails and computer code. However, generative AI chatbots often lack consistency in their output and come with the risk of misinformation and errors, which is particularly concerning in healthcare, where the accuracy of information is critical [51].

Outside of generative AI, there are still other chatbot systems that use other machine learning techniques for various tasks, such as intent recognition. One such intervention is a chatbot by Jacaranda Health in Kenya that allows users to ask questions through SMS messaging and provides appointment reminders and nutritional information [11]. This system uses Machine learning techniques to classify and prioritize incoming messages, flagging critical messages from mothers to be handled by human operators at a health desk. In this way, machine learning techniques can be useful in ensuring the most efficient and appropriate use of human capacity where it is limited. There also exist an entire class of retrieval-based chatbots that use machine learning to retrieve the most appropriate response from a predefined set, based on similarity between the user input and the stored queries or responses while taking into context provided [68]. More recently, there have been advances in a combination of retrieval-based and generative AI chatbots called Retrieval Augmented Generation (RAG) chatbots. In RAG chatbots the text generation task is supported by controlled knowledge injected into the prompts to increase reliability

[33].

2.6.2 Proactivity and initiation of chatbot dialogue

Reactive support is defined as "support which provides information, emotional support, and advice at the time of a challenge or crisis, while proactive support aims to provide knowledge and resilience prior to the encounter" [87].

A key aspect of digital interventions is the locus of initiation of dialogue between the user and the system. In this regard, there are two types of chatbots those that offer proactive chatbots, which are designed to initiate and engage in dialogue with the user, and reactive chatbots, which respond to the user and assist them with their specific requests [66].

For the previous Aurora chatbot, the initiation of dialogue was seen to have a significant impact on the adoption and use of the chatbot, as well as the resulting impact it achieved. Parents are more likely to engage with the chatbot when prompted and guided through their interactions. They found that when the conversation was wide open, users often did not start it.

2.6.3 Human involvement in Chatbots

Globally, chatbots have greatly gained popularity in the last ten years [36]. Despite this, there remain concerns about the ability of chatbots to perform meaningful tasks in healthcare, as many chatbots using automated techniques still struggle to serve user requests well. Human involvement in chatbot systems, of varying levels and nature, has emerged as a powerful approach to address the challenges posed by automated chatbot approaches [49].

Chatbot systems can either take a human-aided approach or be fully automated. Those systems that utilize human computation in at least one component are referred to as human-aided. Grudin and Jacques posit that for the foreseeable future, nontrivial task-focused chatbots might focus on handling simpler queries and hand off more complex queries to human partners [36] Further, for practical application in high-stakes domains such as healthcare, human involvement may be necessary to provide a "safety net" within the chatbot system.

While human computation provides more flexibility and robustness to a chatbot system, introducing a human component poses challenges in providing timely real-time support responses and scalability as the number of chatbot users grows [49].

Chatbot systems and digital interventions at large could still be used to amplify the limited human capacity available [90] and serve more people than would be possible

in the absence of technology. They can also reduce the burden on medical experts for general queries by providing responses to common queries [99].

It is likely that successful chatbot interventions for Maternal and Child Health (MCH), especially those that use AI models, would require a degree of human involvement to ensure quality and safety. For these reasons, it is a priority to investigate the roles stakeholders perceive a digital resource such as a chatbot could play; the roles they perceive human health agents should provide toward exploring how human operators and chatbot systems can be optimally designed to work together to ensure robust, timely, and scalable interventions.

2.6.4 Human Attributes, Trust and Expectations of Chatbots

Anthropomorphism refers to the attribution of human characteristics or behaviour to inanimate entities. There are three major cues that can be used to humanize a chatbot: visual cues using a human avatar can increase perceived homophily with the chatbot, which is the tendency for people to bond with others who are similar to them; identity cues by using human names and communication characteristics and contingent/variable responses within message interaction; and conversational cues by using a high level of message interactivity where responses are contingent upon the preceding message as well those preceding it. [34]

The "humanness" of chatbots poses a unique dilemma regarding user satisfaction in chatbot design. Humanizing a chatbot can cause the expectations of an agent's capability to be gauged on the expectations of a human agent. Certain attributes, such as humor, have been seen to create unrealistic expectations of other human-like qualities that the intelligent assistants cannot deliver [36].

It has been found that users' expectations of a chatbot affect their perceptions of it during interaction, influencing their overall satisfaction. Including the potential user within the community in co-design will be key in managing and establishing common expectations of the intervention. Users holding realistic expectations appear to value the help this technology can provide. Interstingly, where expectations are undefined, users seem to compare chatbots with alternative technology services they have interacted with for accomplishing similar tasks, such as search engines [77].

High anthropomorphism may not be suitable for limited chatbots with regard to interaction and knowledge base. Where chatbots use highly anthropomorphic cues, revealing the identity of the chatbot as a machine can result in more reasonable user expectations and lead to more satisfactory interactions with chatbots [34]

2.6.5 Chatbot Language

Participants in the study conducted in a low-resource setting in Nigeria expressed that they prefer interventions to help them identify signs and symptoms during pregnancy using a language they are familiar with because some of the women did not understand English sufficiently [19]. Bilingual parents have been seen to prefer accessing health information in English as well as their native languages to improve their medical vocabulary and understanding, thus empowering them in future health worker interactions to engage in their infants' health care and decision-making [56]. Though it is clear that local language use is an important priority for low-resource communities, it is not sufficiently discussed in existing literature, exposing a gap for the ParentCoach study to investigate among parents across to sites.

2.6.6 Content delivery medium

Chatbot content mediums include text, video, images, and audio (voice). It is necessary to select the appropriate information mediums for the chatbot intervention within the participating community. We sought to establish this through participatory research with the community members.

Text-based interventions using alternative message delivery channels such as Unstructured Supplementary Service Data (USSD) or Short Message Service (SMS) are seen to improve platforms' ability to deliver messages but may not be appropriate for low literacy users [52]. A study using individualized TCC found that expressing necessary and personalized information clearly and understandably within the limitations of SMS messages is challenging. These limitations include the text-only format, phone screen size, and the increase in cost by the cost of a complete SMS for each additional character over the allowed character limit. It is also suggested to provide voice content to cater to more mothers [19]. Combining text-based interfaces with buttons and media is suggested to create a more engaging experience [44].

Seeing as the majority of chatbot interventions that have emerged in the "chatbot tsunami" of the last decade are text-based [36] and require internet access, it was vital for us to investigate how chatbots can be adapted to serve low literacy users in LMIC contexts despite the various technological constraints they face.

2.7 Chapter Summary

This chapter situates the ParentCoach study in existing literature, providing and identifying the knowledge gaps it seeks to address. I began by introducing the study's objectives, emphasizing the critical role of parent education in improving

maternal and child health (MCH) outcomes, particularly in low-resource settings. I then examined digital healthcare interventions, exploring existing perceptions of them.

A review of chatbot literature highlighted their applications in healthcare and MCH. This review also identified and discussed key chatbot design choices to be investigated in the study, including input processing, dialogue proactivity, human involvement, trust-building attributes, language, and content delivery.

This chapter provides a literature-based overview that informs the methodological and design discussions in the following chapters.

Chapter 3

Methods

3.1 Introduction

In the previous chapter, I reviewed relevant literature to contextualize this research within Human-Computer Interaction (HCI) and maternal and child health (MCH). In this chapter, I detail the methodological approach used to address the research objectives of this study. The chapter begins with a description of the recruitment process outlining the inclusion criteria and the participants involved, including first-time parents, clinicians, and community members from three research sites: the Bhabhisana Baby Project (BBP), Mowbray Maternity Hospital (MMH), and Black Equations in Ocean View (OV).

I then describe the data analysis methods employed to interpret qualitative data collected through interviews, workshops, and co-design activities. Ethical considerations and data management strategies are also detailed, ensuring participant confidentiality and adherence to research standards. This chapter lays the groundwork for understanding how the findings presented in later chapters were generated and validated.

My research consisted of a mixed methods study to adapt, develop, and evaluate a chatbot for first-time parents in Portugal and South Africa. The study assumed a participatory approach to crafting an intervention for the participating communities. Participatory processes seek to involve economically and socially marginalized people meaningfully in the decisions that affect their lives to address the shortcomings of top-down development approaches [15]. I conducted one-on-one interviews with clinicians and exploratory and participatory design workshops with parents. Parents then evaluated the resulting intervention prototype in a two-week feasibility pilot.

This dissertation presents a subset of my work on the ParentCoach Study described in Chapter 2. The study design described here was developed jointly by the ParentCoach consortium. For this reason, I use the term "We" throughout this document to refer to the ParentCoach consortium whenever decisions and research activities were collaborative.

The study took a phased approach as outlined below and illustrated in Figure 3.1:

- Phase 1: Interviews with clinicians to understand their perspectives on parental support needs and chatbots. (**November - December 2022**)
- Phase 2: Exploratory participatory workshops with parents to gather insights on their learning challenges, experiences, and informational needs. - (**March 2023**)
- Phase 3: Co-design workshops with parents to understand their perspectives on various chatbot design approaches and adapt a chatbot for context-specific needs. (**March 2023**)
- Phase 4: Chatbot Implementation to develop a prototype for user trials. (**August - December 2023**)
- Phase 5: Pilot feasibility trial with ParentCoach App Prototype to evaluate its accessibility, usability, and impact. (**February - March 2024**)

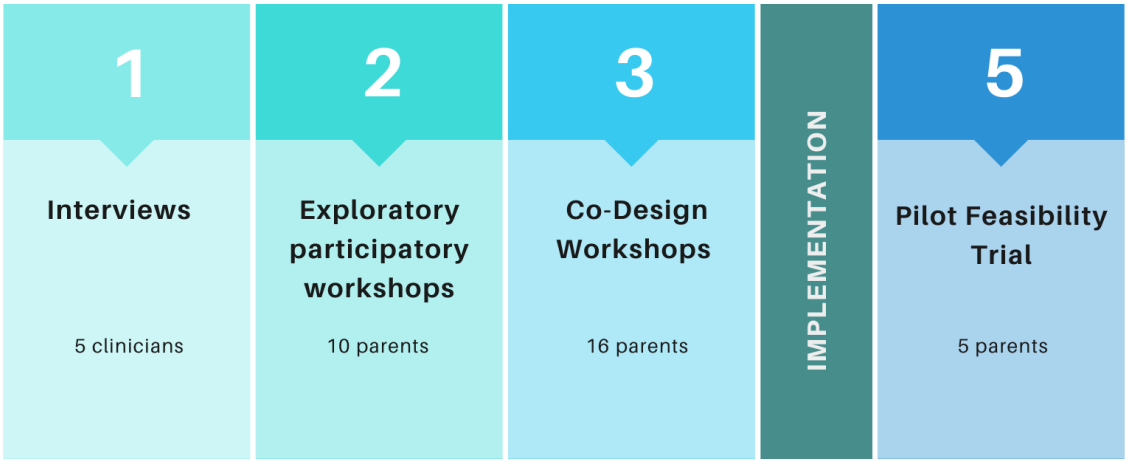

Figure 3.1: Study methodology phases

3.2 Recruitment and Participants

We recruited participants through gatekeeper organizations and their contacts by convenience sampling. For successful community participation, researchers need an understanding of the local culture, strong collaboration, and trust by the community that these gatekeepers provide [96, 57]. Conducting research activities in partnership with gatekeepers who are a part of the target community allows access to the broader community [57] that we would not otherwise have had to the communities.

These organizations were Bhabhisana Baby Project, Mowbray Maternity Hospital, and Black Equations. Below is a description of these three gatekeeper organizations, outlining their involvement in the research study.

3.2.1 Bhabhisana Baby Project (BBP)

The Bhabhisana Baby Project (BBP) is a non-governmental organization based in Athlone, Cape Town, that works with mothers and caregivers of babies with long-term functional abilities and babies born with disabilities or developmental problems. They provide physiotherapy, occupational therapy, and speech therapy for babies during the three-to-six-month wait for public health appointments before the families have been fully integrated into the government health system. It serves caregivers from a wide geographic area in Cape Town, mostly from low-middle-income communities.

We recruited three clinicians and five first-time parents at BBP. The participants recruited at BBP offered a unique perspective to the ParentCoach study since they were concerned with care for children with special needs. Including these participants who deal with children with developmental delays added an additional dimension to the richness of data collected during research activities to contribute towards more accessible and inclusive research.

3.2.2 Mowbray Maternity Hospital (MMH)

Mowbray Maternity Hospital (MMH) is a secondary-level referral hospital treating women with complicated pregnancies who are referred from the Midwife Obstetric Units (MOU) of False Bay, Retreat, Hanover Park, Gugulethu, and Mitchells Plain, which are low-income communities. The hospital runs daily antenatal clinics, which we found to be an excellent opportunity to recruit relevant participants for the study - mothers attending clinics and clinicians providing care. We recruited nine parents at Mowbray Maternity Hospital.

3.2.3 Black Equations - Ocean View (OV)

Black Equations is an NGO based in the Ocean View (OV) township in Cape Town. It operates the iNethi, a community wireless network and platform to support community-based services and content sharing. [28] Black Equations assisted in recruiting parents from the community interested in participating in developing a chatbot to support early childhood parenting.

Researchers from the Human-Computer Interaction lab at UCT have done extensive work within the Ocean View community over the past 6 years, conducting training and co-design workshops toward developing iNethi. Through this work, early childhood development and parent well-being emerged as challenges within the community, making them suitable issues to address in our study.

The socio-demographic make-up of the Ocean View community is low-to-middle income families primarily of colored ethnicity. We recruited six parents for the exploratory workshop, six for the co-design workshops, five for another co-design workshop (W3), and five for the feasibility pilot trial in phase 5.

3.2.4 Inclusion Criteria

Across the study phases, we only included participants willing to participate and give informed consent for their participation. Below is a more detailed breakdown of phase-specific inclusion criteria.

- Interviews – clinicians who interact with first-time parents in their day-to-day work.
- Exploratory participatory workshops – parents with a child below two years
- Co-design Workshops - parents with a child below two years
- Preliminary field trial with Aurora2 - Parents or caregivers who:
  - Have a child younger than 12 months
  - Are proficient in English, Portuguese, or isiZulu
  - Android phone and SIM card owner with previous Android phone use experience
  - WhatsApp user with internet access, even if intermittent, to be able to communicate with the project team,
  - available to meet with the research team at the end of the preliminary and feasibility trial and for a WhatsApp meeting in the middle of the

feasibility trial.

First-time parents were the intended end-users and primary beneficiaries of the intervention. However, we included even parents who had more than one child because of recruitment challenges and to get a richer perspective from their previous experiences. In phase 5, we opted to include only parents who had children due to the unique challenges they face in the new experience of parenthood. New parents, especially first-time mothers, typically face being saddled with too many new tasks and responsibilities, fatigue, exhaustion, and psychological distress as they transition into parenthood [37].

Our recruitment did not deliberately exclude fathers; however, the recruitment naturally skewed towards mothers due to a greater availability at the study sites. Since childbearing mothers often feel the burden of new parenthood more strongly than fathers [53, 91] since mothers must learn to navigate and cope with social norms and judgments around their ability to balance their multiple roles as mother, partner, and professional [91]. Further, mixing genders within workshops can reinforce existing gender hierarchies within communities, leading to less participation and engagement by women [88]. Therefore, we found it acceptable to focus on mothers as the primary participants of workshop activities in phases two, three, and five.

The ParentCoach study recruitment protocol did not require participants to disclose if they were participating in multiple research studies, and as such, did not exclude based on participation in other studies. However, I expressed a preference for new participants to the partner gatekeeper organisations, Black Equations in Oceanview and BBP, who assisted in the recruitment of parents through convenience sampling. None of the parents recruited at Mowbray Maternity Hospital had prior or current participation in research studies involving my supervisor at UCT.

3.3 Data Analysis

For phases one, two, three, and five, researchers at each partner institution in the ParentCoach consortium analysed the workshop and interview transcripts using open-coding, inductive thematic analysis to best represent the meaning of data as communicated by the participants [14]. We followed the iterative process of thematic analysis outlined by Braun and Clarke [83]. The analysis progressed through six phases, with researchers moving back and forth between steps as necessary: 1. Familiarization with the data, achieved through repeated reading of transcripts, reviewing notes, and listening to audio recordings; 2. Coding the data and assigning descriptive labels to meaningful quotes; 3. Identifying recurring patterns across the codes to develop initial themes; 4. Revising and refining these themes through on-

going reflection and comparison; 5. Naming the final themes; and 6. Writing up the analysis included revisiting earlier phases to ensure coherence and clarity in the final presentation. This cyclical process ensured that our understanding of the data evolved and deepened throughout the analysis.

I used an inductive or data-driven approach to develop codes based on a detailed familiarization and repeated engagement with the data. In inductive thematic analysis, the themes are the outcome of the analytic process rather than a starting point [83]. This method allowed the analysis to be more open to new and different ideas within the data.

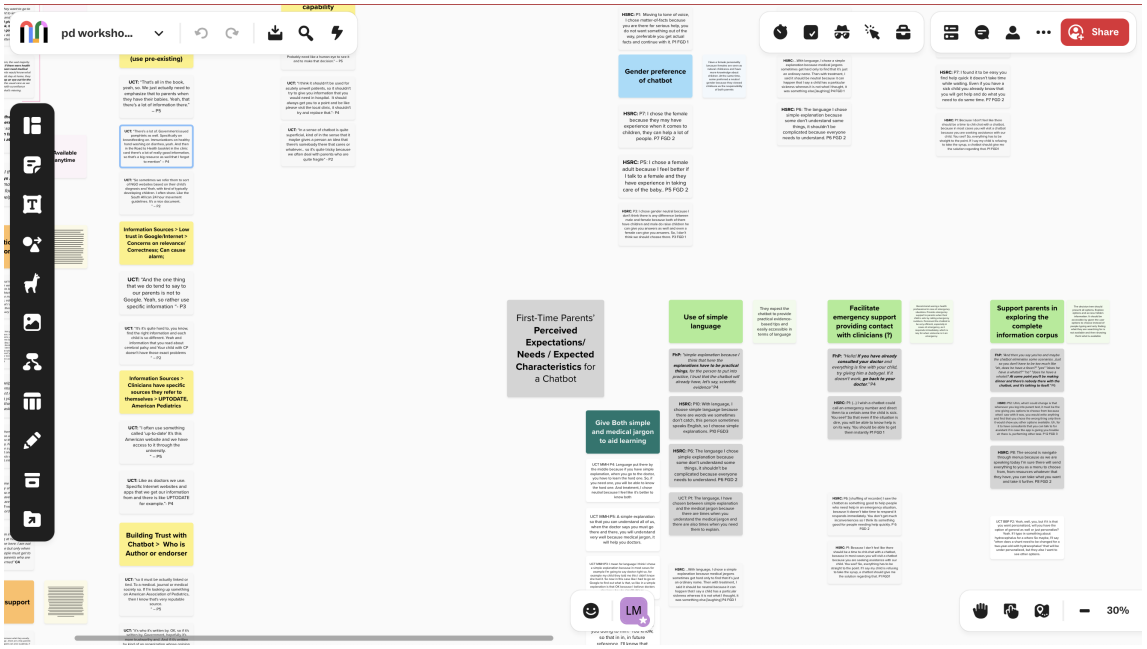

Figure 3.2: Affinity Mapping Example

Following the thematic analysis process at the different institutions involved in the study. The larger ParentCoach consortium team then met to discuss the respective analyses and find the most relevant and common themes using affinity mapping. Affinity mapping, or affinity diagramming, is a systematic team-based method used to generate and refine ideas into broader conceptual categories. In this process, team members' "sticky notes" are grouped together based on their affinity, helping to identify overarching themes [40].

We organized our quotes and codes onto virtual sticky notes on Mural (www.mural.co), a visual work platform. We then proceeded to group them into thematic categories. This analysis was the basis of our initial prototype design, which we piloted with parents. This visual process is shown in the Figure 3.2.

Although this dissertation focuses specifically on my research activities in Cape Town, the broader analysis conducted across all ParentCoach study sites is relevant and necessary to include. This is because key study design decisions, including interpretation of research findings and formulation of recommendations, were based on the combined insights from all consortium partners. Omitting reference to the broader study would obscure the collaborative nature of the research and the shared analytical foundation that informed the study's overall direction.

3.4 Ethics and Data Management

Participants in this study were anonymous. No data that could enable the discovery of the identity of any of the participants was to be made public, and all transcripts and recordings were anonymized and stored on the UCT data cloud.

I asked participants to provide written informed consent before participating in activities. I also sought the permission of parents or caregivers of any underage participants. I explained that participation in the study was voluntary and that participants could request to leave the study at any time. Audio recordings of the interviews were listened to or transcribed shortly after, and the original audio recordings were to be deleted to ensure the privacy and anonymity of participants.

The archiving of the data is to be done by Fraunhofer Portugal AICOS, University of Cape Town, and the Human Sciences Research Council in locations protected by key (physical materials) or password (digital materials) and restricted to the investigators involved, complying with all the requirements of the General Regulation on Personal Data Protection (EU) and the Protection of Personal Information Act (SA). The investigators also committed to maintaining confidentiality in all their activities.

3.5 Chapter Summary

In this chapter, I outlined the methodological approach used in this study to investigate first-time parents' information needs and the design of a parenting support chatbot. The chapter began by describing the recruitment process and participants, detailing contributions from three key research sites: the Bhabhisana Baby Project (BBP), Mowbray Maternity Hospital (MMH), and Black Equations in Ocean View (OV).

The chapter also detailed the qualitative data analysis methods used to interpret insights from interviews, workshops, and co-design activities. I discussed ethical considerations, including safeguarding participant confidentiality and adherence to

ethical research standards, and detailed the data management strategies employed to organize and secure collected data.

This chapter establishes the methodological foundation for the findings presented in subsequent chapters.

Chapter 4

Understanding Context - Phase 1: Clinician Interviews

4.1 Introduction

In the previous chapter, I situated my research within the literature to highlight the knowledge gap addressed by the ParentCoach study, provided essential context on the terms and concepts used throughout this dissertation, and how literature informed the methodological and conceptual design of the study.

In this chapter, we delve into the perspectives of clinicians through five one-on-one interviews. The findings are thematically analyzed and organized. This phase of the research aimed to uncover contextual information on first-time parents' maternal health literacy, learning habits, and information needs, as well as to gather clinicians' recommendations and guidelines for a chatbot intervention. These insights provide valuable context on parents' learning patterns and practical considerations for designing a parenting advice chatbot.

For successful co-design of an information system (IS), it is essential that not only the end users of the IS participate but also those individuals who are affected by the IS, even when they have no direct interaction with the system itself [15, 41]. It was, therefore, crucial for us to involve a wider variety of stakeholders in research activities, even though the target users of the proposed intervention are first-time parents. Further, community participation is also found to stimulate reflection and a commitment to action within that community [15].

Additionally, this chapter is complemented by exploratory workshops with parents, detailed in the next chapter, which sought to validate our contextual findings on

parenting from clinicians' perspectives and further investigate parents' learning experiences, habits, and priorities.

4.2 Methodology

I conducted interviews with five clinicians who interact regularly with first-time parents. I recruited clinicians by convenience sampling through a co-investigator on the ParentCoach consortium, a reputable practicing neonatologist. Four interviews were conducted in person at the clinician's place of work, while one was conducted virtually via Zoom.

Table 4.1 below shows the demographic distribution of our participants in this phase:

Table 4.1: Clinician Demographics

Category	**Total**
Role	
Pediatrician	1
Nurse	0
Physiotherapist	1
Speech and language therapist	1
Occupational therapist	1
Consultant	1
Gender	
Male	0
Female	5
Non-binary	0
Years of Experience	
0 - 10 years	0
10 - 20 years	2
20+ years	3
Work Sectors	
Public	1
Private	1
Social	3
Both public and private	0

Participants for this study were recruited through convenience sampling via professional contacts of a study investigator who is a Cape Town-based neonatologist.

The final sample included five clinicians: two doctors, one speech therapist, one occupational therapist and one physiotherapist and sample adequacy was determined by the point of data saturation, where additional interviews no longer yielded new insights. While the inclusion of nurses and other frontline clinicians would have enriched the data, given their close interactions with first-time parents, I was unable to recruit any during this phase of the study. However, this sample represents a subset of the wider participant pool interviewed by consortium partners in Portugal and KwaZulu-Natal as part of the larger ParentCoach study. Nurses were included in interviews conducted by partner institutions, contributing to the depth and diversity of the broader analysis.

Before starting the interviews, I obtained informed consent from each participant. I read the form loud and explained the expectations of participation in the study, the purpose of the interviews, and how the resulting interview data would be used by the research team and protected.

The interviews were approximately 60 minutes and were audio-recorded and later transcribed. Transcription was a combination of a manual and automated process. The transcripts were first processed through the Word Online transcription tool to get an initial draft. After that, I listened minute by minute to validate the automated transcript, correcting any errors as they occurred. The outputs of data collection in this phase were interview notes and five interview transcripts.

I analyzed the interview transcripts using Braun and Clarke's thematic analysis process [12] to identify themes relating to the clinicians' practices and teaching priorities, first-time parents' information and care-seeking behaviors, and first-time parents' learning habits. We also sought to gather applicable considerations and guidelines for building a chatbot intervention for first-time parents from a clinician's perspective. I used an open coding inductive thematic analysis approach described in Chapter 3. Following coding, we[1] used affinity mapping between the ParentCoach consortium partners to verify the codes generated and find emerging similarities and differences in the clinician's perspectives.

[1]The term "We" refers to the ParentCoach consortium and gatekeepers for collaborative decisions and activities as described in Chapter 3.

4.3 Findings

4.3.1 Perceived care and information seeking habits of parents

Parents are generally motivated to take care of kids

Participating clinicians observed that first-time parents often showed strong motivation to prioritize their children's health, sometimes even more so than their own personal health and well-being. This observation suggests parents are generally willing to take proactive steps to ensure better outcomes for their children. Clinicians suggested that by empowering parents with the right information, routines, and practical strategies, it would be possible to support them in providing even better care for their children.

For instance, one clinician noted:

> "Generally, people want to look after kids. You know, they want to make things better for their children as opposed to often, like with adults, it's really hard to motivate someone to, you know, do better for themselves." - P4

This finding suggests that interventions targeting child health might achieve higher engagement by leveraging this parental motivation. Empowering parents with actionable resources could, therefore, not only improve child health outcomes but also align with parents' existing willingness to take proactive steps.

Parents often go to the clinics to seek information rather than care

Participants highlighted that many parents visit clinics not necessarily for medical interventions but rather to seek information, clarification, and reassurance regarding their children's health. This suggests a shift in the role of health facilities, where they are increasingly relied upon for guidance on childcare rather than purely urgent medical needs.

One clinician explained this trend by pointing to a shift in family dynamics:

> "I find people are coming more and more to hospitals for things that in the past you probably would have asked your granny or your mom about." - P4

This observation reflects how, in the absence of strong family support structures, parents turn to healthcare providers for advice traditionally obtained from older family members. Given the strain on healthcare resources, clinicians emphasized the

need to streamline visits to ensure that only critical cases reach health professionals, thereby optimizing clinic capacity.

Parents tend to focus more on visible skills and competencies

The participating clinicians noted that parents tend to be more aware of easily observable developmental milestones, such as gross motor skills like walking while paying less attention to more subtle developmental indicators that are equally crucial for a child's overall growth. This focus often means that parents may overlook early signs of developmental challenges related to communication, fine motor skills, or vision, and as a result, potential developmental delays may go unnoticed, delaying necessary medical interventions.

One clinician emphasized this gap in parental awareness:

> "So often the more subtle things (delays) with the communication and kind of the fine motor, the visual problems are not picked up as early as we would like." - P5

This insight underscores a critical area where educational initiatives could make a substantial difference. By raising parents' awareness of less visible developmental milestones, healthcare providers can empower them to recognize early warning signs and seek timely care. The clinicians suggested that a more comprehensive understanding of child development among parents could bridge this gap, ultimately supporting more proactive and holistic childcare.

4.3.2 Information and teaching Priorities

The participants noted that many parents frequently seek guidance on whether their child's behaviors align with age-appropriate norms, particularly in areas like feeding, sleep, and motor skills. These concerns are often rooted in a lack of understanding of typical developmental variations. One clinician explained the need for parents to understand typical development:

> "there's a lot of like normal baby behavior that is interpreted as illness or disease, but it's actually just normal. Baby behavior, so there's a big gap in education on what normal baby behavior is" - P5

This insight underscores the need for educational efforts that help parents distinguish between normal variations and actual concerns, ultimately reducing anxiety and unnecessary visits to clinics. They also highlighted the knowledge gap in understanding developmental milestones, emphasizing that parents need to recognize both challenges and positive progress to support their children's development better.

Helping parents to establish a routine and teaching daily activities

Participating clinicians emphasized that a child's development is largely influenced by the daily routines and actions of parents rather than by the limited interactions during clinic appointments. However, they noted that many parents may not fully realize the significant impact they can have on their child's progress, often attributing developmental improvements to clinicians. To address this, clinicians aim to empower parents with practical information and skills that they can apply in their daily routines.

> "You see your child every day, And so whatever you do for your child, every day, every minute of the day, has more impact than what I do once a month." - P1

By empowering parents with actionable strategies, clinicians believe they can facilitate a more sustainable approach to supporting children's growth at home.

Clinicians working with parents of children with developmental delays also stressed the importance of establishing structured routines to ease the burden on families. They believe that having a clear, manageable routine helps parents integrate developmental practices seamlessly into their daily lives, making interventions more effective and reducing stress.

> "Then we set some goals with the family. Yeah, about what we're going to work on, and then we give the family a home program, and they are the ones really that do the intervention on a daily basis, and we kind of facilitate the growth of that home program." - P3

Danger Signs, First Aid

Clinicians also prioritize danger signs as crucial information for first-time and inexperienced parents. They try to teach parents to identify when there is something wrong with their children, what to do in the meantime, when it is necessary to seek help, and when it is not. This shows a prioritization of the safety of children and empowering parents to cater to it at a point where clinicians themselves could likely not intervene.

> "And then, as I mentioned, just the general danger signs are always. So whenever I'm seeing a consult like, say, in the casualty or in the emergency ward or whatever they come in before they leave, we always tell them the danger signs" - P5

4.3.3 Information delivery practices

Beyond the relevance of information, our participants also stressed the importance of how information is delivered. They did this in three ways: pacing information, filtering information to only the most important at a given time, and lastly, delivering information to parents at appropriate times for them to take it in.

Pacing and filtering Information

Clinicians expressed that they sometimes need to deliver information on a need-to-know basis to not overwhelm parents and ensure that the information has been learned before moving on to the next point. This pacing of information was intended to improve focus, adherence, and retention of information and skills passed on to parents.

> "If it's a very complicated condition and there's a lot of information and they feel overwhelmed, it's too much. And I say no. This is just all that I need to look at for now, yeah" - P5

Here, the clinician stresses the importance of narrowing the focus to only what's necessary at the time, ensuring the parent doesn't feel overwhelmed. This approach supports the idea of pacing, where too much information could hinder learning.

Timing Information

In addition to pacing information, the timing of information delivery is also perceived to be important. One participant expressed that in a period of high stress for the parents, teaching information that does not directly alleviate the stress or satisfy their present health needs may prove ineffective.

> ""and then also often those kinds of things (passing info) should be done as an outpatient because you know when the person's in hospital they're stressed. They just want to get out. They're tired, they're not really thinking about what to do next, and it's often later when you can reflect upon it" - P4

Interestingly, the clinicians who work with children with developmental delays expressed the importance of interacting with parents during the first 1000 days of their child's life. They observed that the parents were most motivated and receptive to learning parenting practices during this early period.

> "we are lucky we get them (parents) in the first two years of life, and so by that time, they're not yet despondent [about caring for their child]" - P1

Probing parents for health and situational context

Clinicians expressed that it was a priority to understand the situational context before suggesting an intervention to parents. They felt that a chatbot may not be able to have this context immediately and could, therefore, suggest an inappropriate solution to the patient's query.

> "That's it (we are investigating), how did you get here today? by bus? Where do you live? Who's in the house with you? So those will give us an indication. And then we could pitch there. What our intervention is or what we would use for intervention" - P3

Using an elimination process to find the best solution

Some participants indicated that, in many cases, they do not have an immediate answer to a problem and instead must test various hypotheses before reaching the correct diagnosis.

> " You know people, I think expect they go to a doctor, we know exactly what's happening, but it's often an evolving process, so you come with a cough. We think it's Pneumonia. We do the X-ray, [and] we realize it's not really Pneumonia. Then we go to the next thing. So like being a doctor is more like being a detective. You like working through a list of possibilities" - P4

This finding highlights the iterative nature of medical diagnosis, where clinicians refine their understanding of the problem through a process of elimination. The analogy to detective work emphasizes the importance of critical thinking and problem-solving rather than expecting an immediate, definitive answer.

This is seen as a crucial role for human clinicians, especially when dealing with complex or ambiguous cases. As the participant notes, the process is not instantaneous and requires continual reassessment based on new information. In this context, participants felt that such a high-risk process should be performed by human clinicians to ensure the safety of patients, particularly vulnerable ones like children.

Building on this, participants suggested that a chatbot could be more effective if it first gathers detailed contextual information from the user before attempting to provide a diagnosis or solution. The reasoning behind this is that effective diagnosis requires sufficient background knowledge, which can be obtained through a series of probing questions that help clarify the user's situation.

> "So on a chatbot, if the parent said. My child's not sitting. Yeah. Well, I suppose a chatbot can't really answer that because you'd have to have

> a Question: is your child sitting? No, how old are they? No, they are a year.." - P3

The participant points out that a simple statement like "my child's not sitting" lacks sufficient detail, making it difficult for a chatbot to generate a useful response. Probing questions about the child's age and specific symptoms is, therefore, necessary to narrow down possible causes and guide the conversation toward a relevant diagnosis.

By systematically determining whether certain responses resolve the issue, the chatbot can offer a more accurate recommendation. If certain conditions are met, the situation may be deemed non-critical, but if not, the chatbot can advise the parent to seek professional help. This highlights the potential role of a chatbot as an initial step in triage, ensuring that parents are properly guided based on their answers to specific questions.

4.3.4 Perspectives on parents' Information Retention

Parents often forget new information

Participants noted that parents sometimes struggle to absorb new information, especially when it is presented in large quantities. Clinicians are aware that the information provided may not be fully retained, and as a result, they often need to repeat key points using different methods. If the information is overwhelming, parents tend to remember only the most prominent or striking aspects of it.

> "If it's a very complicated condition and there's a lot of information, then they feel overwhelmed. So we say no, this is all that you need to look at for now, yeah" - P5

The participant's statement suggests that information overload can hinder retention, making it necessary for clinicians to simplify and prioritize the essential details for the parents by filtering and pacing the information they provide. By breaking down the information into smaller, more digestible pieces, clinicians can improve the chances that parents will absorb and retain what is most important.

Clinicians may need repetition to deliver info

Since the parents tend to forget information taught to them, the clinicians often have to explain information multiple times in subsequent appointments, sometimes using different approaches. This iterative process is seen as necessary to ensure that the information is eventually absorbed.

> "Then the next time they come a month later. Yeah, they ask another question, and then you think now I already explained that last time, but you actually have to resay it again in a different way or the same way. The parents do need the information [to be] repeated so that they absorb more and more [each time]" - P1

The repetition serves not only to reinforce the information but also to facilitate better understanding over time. This is a common strategy used to increase retention, as parents tend to absorb more and more with each explanation.

Use of written information resources for parents to reference later

Clinicians reported using various methods to address issues around parents' information retention. One such method is providing supplementary written information, which allows parents to review and absorb key details at their own pace after a consultation. This approach helps reinforce the information shared during the visit and ensures that parents have a reliable reference to revisit later.

> "And then we also always write in A little book as in that way the mum can show the nanny or Whatever, yeah. Yes, so for the first session, they get an A5 book. Yeah, and then each time, we write down five or six things that we would like them to focus on. Activities to do in everyday life" - P2

The use of written materials, such as patient booklets and information leaflets, is perceived by participants to help reinforce key points discussed during consultations. The booklet serves as an easily accessible reference that parents can share with other caregivers to ensure consistency in understanding and follow-through. By highlighting only the most essential information, clinicians aim to make it easier for parents to remember and act on the advice provided.

In this way, clinicians view written materials as an essential supplement to verbal communication, helping bridge the gap between the consultation and day-to-day application of the information relayed.

4.3.5 Clinician's preferred Information Sources

The Road-To-Health Booklet (RTHB) is a trusted yet underutilized source of information

Clinicians favored maximizing the use of existing, though underutilized, informational resources rather than creating new ones. One such resource is the Road to Health booklet (RTHB), a government-issued resource given to parents in South

Africa upon the birth of their child. The participants consider it a comprehensive and adequate guide for parents to care for their children's health and frequently refer parents to specific sections of the booklet for supplementary childcare information. They also prioritized emphasizing its importance to parents.

> "There are a lot of government-issued pamphlets as well. Specifically on breastfeeding. Immunizations on healthy hand washing on diarrhea, yeah. And then in the Road to Health booklet in the clinic card, there's a lot of really good information, so that's a big resource as well that I forgot to mention" - P4

In addition to the RTHB, clinicians noted that it is complemented by other existing government-issued pamphlets, NGO websites, and other materials that cover specific health topics such as breastfeeding, immunizations, and hygiene, depending on the child's specific needs or developmental stage. The clinicians expressed that information already existed, but the bigger issue was that it was underused by parents.

4.3.6 Perspectives on informational resource trust

Clinicians express low trust in internet searches

Clinicians expressed concerns about the reliability of information found online, particularly information found through search engines like Google. They perceived that much of the content available may not be entirely medically accurate, and the order of search results can be influenced by factors unrelated to the quality or credibility of the information. This has led clinicians to caution parents against relying on internet searches for health-related information.

> "So there's a lot of people who Google everything, and then obviously, whatever comes on top of Google is dependent on a lot of things that have nothing to do with medicine." - P4

They also highlighted that parental fear and anxiety can result from finding alarming health information online. When searching for information, parents may find it difficult to discern what is factual due to the prevalence of contradictory opinions and sensationalized content. This adds to the justification of their overall mistrust of internet sources for health-related queries.

> "It's quite hard to, you know, find the right information, and each child is so different. Yeah, and information that you read about cerebral palsy and Your child with CP doesn't have those exact problems" - P2

Finally, clinicians point out that, especially for children with developmental delays,

health information found online may be too general or not applicable to the child's unique developmental characteristics, making it even more challenging for their parents to find relevant and accurate advice on the internet.

Factors influencing clinician's trust in an informational resource

Our participants expressed two significant factors determining their trust in an informational resource. Their assessment of its content and the perceived credibility of its provider or endorser. The latter is a quick heuristic that they use to verify its validity by transferring previously gained trust and reputation to the provider.

Participants expressed that the presence of references is an essential indicator of an informational resource's legitimacy, providing a way for clinicians to verify the quality and credibility of the information. It is, therefore, essential for an informational resource to reference its sources.

> "Like, I would be more comfortable with a resource that has a reference. So tell me what it is, but it also tells you where it got it from. Because that's important, I think from both parent and doctor's point of view, like where did this actually come from?" - P4

In addition to referencing the sources of information, it is crucial for clinicians to know who the provider or endorser of a chatbot is. Their existing perceptions of the provider's authority heavily influence their decision on whether to trust the information provided by the chatbot and, by extension, whether they would consider recommending it to other clinicians or their patients. This finding emphasizes that different sources and institutions carry varying levels of weight in healthcare, often influenced by their reputation.

> "it's [important] who it's written by. OK, so if it's written by. Government, hopefully, is more trustworthy, and if it's written by kind of an organization whose opinion we respect, or a professional who should have that expert knowledge." - P3

The credibility of the entity behind the information plays a significant role in clinicians' trust. Government sources and established organizations or professionals are viewed as more trustworthy, making their recommendations hold more weight. One participant recommended that chatbots be endorsed or linked to reputable entities as a way to gain the trust of clinicians.

> "So it [a chatbot] must be actually linked or tied to a medical journal or medical society, so if I'm looking up something on [the] American Association of Pediatrics, then I know that's a very reputable source." - P5

By associating a chatbot with a recognized medical journal or society, clinicians are more likely to trust the information it provides, as it aligns with the high standards set by these respected institutions.

One participant expressed that they not only value knowing the origins of the chatbot but also noted that a well-documented review process from a trusted authority would increase the likelihood that they would rely on it. Further, they expressed that trust in an informational resource can be transitive based on their peers' trust in it, which would increase the likelihood that they will trust it themselves, which highlights an interesting social aspect of trust-building.

4.3.7 Perceived role of a chatbot to support first-time parents

Our participants indicated that chatbots should not be tasked with handling more complex or subjective tasks that require human judgment or expertise. Instead, they noted that chatbots could be useful in delivering general, "objective" information to patients in a timely way. They perceived that this role could help alleviate some of the pressure on healthcare infrastructure by addressing less complex, more straightforward queries.

4.4 Chapter Summary

In this chapter, we explored the perspectives of clinicians through five one-on-one interviews. This phase of the research aimed to uncover contextual information about first-time parents' maternal health literacy, learning habits, and information needs, as well as to elicit clinicians' guidelines for a chatbot intervention. Key findings revealed that parents often visit clinics seeking information rather than care and that clinicians prioritize addressing parents' knowledge gaps in child development, along with teaching daily routines and caregiving activities. Clinicians emphasized pacing, filtering, and timing information carefully to enhance parents' learning, employing diverse strategies to improve information retention. Additionally, we identified essential considerations for earning clinicians' trust and explored the roles they perceived a chatbot could play in supporting first-time parents.

The outcomes of this chapter provide a foundational understanding of clinician perspectives, which will complement the findings of the subsequent exploratory workshops with parents discussed in the next chapter. These workshops aim to validate the contextual findings reported here while delving deeper into parents' learning experiences, habits, and priorities toward identifying design considerations for a parenting support chatbot.

Chapter 5

Understanding Context - Phase 2: Exploratory Workshops with Parents (W1)

5.1 Introduction

In the previous chapter, we explored the findings from interviews with clinicians, which provided valuable insights that complement the research conducted in this chapter. Here, we shift focus to the findings from exploratory workshops with parents. These workshops aimed to deepen our understanding of first-time parents' information needs and learning experiences. Additionally, the workshops aimed to validate the clinician interview findings that had offered an initial perspective on parents' learning habits and experiences.

This chapter presents the key findings from these participatory workshops. Notably, teenage parents face stigma and mistreatment, which limits their access to information and reduces their willingness to visit clinics. Parents identified clinic visits and family as their primary sources of information and indicated they use technology to support their informational needs despite facing significant technological constraints.

MCH research in low-and-middle-income countries (LMICs) in Africa has been seen to largely include community health workers (CHWs) rather than the parents who are the intended direct beneficiaries of the planned interventions [88]. Such interventions delivered without the involvement of the direct beneficiaries are likely to be ineffective in the long term. Through a participatory exploratory approach, we[1]

[1]The term "We" refers to the ParentCoach consortium and gatekeepers for collaborative deci-

aimed to ensure that the needs of the communities were centered in the resulting interventions.

5.2 Methodology

During the workshop sessions, the researchers took notes and recorded audio. The output of this phase was interview notes, transcripts of audio recordings of the workshops, and artifacts built during the workshops.

I conducted two exploratory workshops with parents at Ocean View and Mowbray Maternity Hospital with six and four participants, respectively. All our participants in this phase were mothers.

I recruited participants by convenience sampling through our gatekeepers. At Mowbray Maternity Hospital, we approached parents in the waiting room of an antenatal clinic and recruited those who expressed interest in participating. The workshops were approximately 4-5 hours long, with breaks in between whenever a parent needed to tend to their child. Table 5.1 shows the demographics distribution of W1 participants.

5.2.1 Workshop Activities

Each workshop comprised four activities:

1. **Ice Breaker and Introductions** I asked parents to write down their baby's name on paper and prompted them to select an emoji to describe their baby. They then shared what they had written down and said why they had chosen that emoji. This ice-breaker activity helped the participants loosen up around each other and establish rapport with me as the facilitator and among each other. A sample ice-breaker activity output is shown in Figure 5.1
2. **Discussion on challenges faced in taking care of their child**: I asked participants to share their challenging experiences in caring for their child, reflecting on challenges they had overcome through gained experience, aspects they had thought would be difficult to but turned out not to be, and challenges they had faced that necessitated them to seek help from health professionals. This discussion helped highlight important priorities for parents and how they attempted and preferred to get around them.
3. **Discussion on lessons learned from various stakeholders** I asked participants to state childcare-related lessons they had learned from the following

sions and activities as described in Chapter 3.

Table 5.1: W1 Participant Demographics

Category	Oceanview	Mowbray	Total
Age			
16-19	1	0	1
20-24	3	1	4
25-29	0	2	2
30-34	0	0	0
35-39	1	0	1
40-44	1	0	1
45+	0	1	1
Role			
Mother	6	4	10
Father	0	0	0
Education			
High School	4	4	8
College	1	0	1
PhD	0	0	0
Number of Children			
1	6	2	8
2	0	1	2
3+	0	1	1
Child's Age			
0-6 months	1	1	2
7-12 months	3	3	6
13+ months	2	0	2

groups: family and friends, educators, doctors, nurses, and pharmacists. This activity aimed to identify the different informational support mechanisms parents use to learn how to care for their children.

4. **Information Sources** I prompted users to name information sources they usually relied on or used previously. The categories of resources were books or magazines, blogs, forums or newsletters, radio stations or podcasts, TV shows, and social networks, among others.

I gave the parents time to reflect and write their contributions individually on paper and post-its during each activity. For each activity, I pinned a large A0 sheet of paper to the wall where participants would stick their post-its, as shown in Figure 5.2

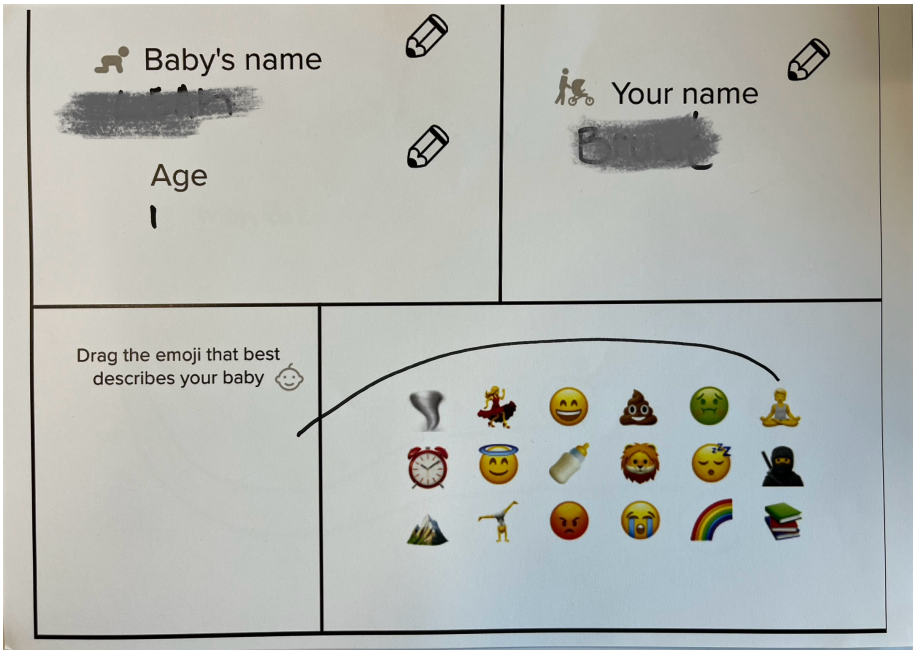

Figure 5.1: W1 Ice Breaker Activity

below. Following this, they would take turns explaining what they had written down, prompting discussion among the larger group. The figure below shows some of the resulting artifacts from this collaborative process.

I audio-recorded the workshops and took notes during the workshops. The audio recordings were transcribed using an automated tool and cleaned up manually. I analyzed transcripts using open coding inductive thematic analysis [12] (as detailed in the methods Chapter 3) to identify themes relating to first-time parents' experiences, informational needs, and priorities. We shall now explore the findings from our analysis of these workshops.

5.3 Findings

5.3.1 Challenges and stigma for teenage parents

Participants who themselves had been teenage parents in the past expressed that teenage mothers faced a stigma and mistreatment in healthcare settings. This mistreatment created a barrier to these mothers accessing necessary health support during and after pregnancy, as these mothers often avoid seeking help due to the fear of further stigmatization and mistreatment.

Figure 5.2: W1 workshop Artifacts

> "It's when you go for first staff when you are pregnant, and the nurses tell you why did you open your legs [have sex], they are rude to young mothers instead of supporting them... they [teenage mothers] know that they're pregnant, [but] they don't go for checkups or things like that" - MMH P1

> "Yes. And by the clinic, usually those people at the hospital, when they see [you are] a school child, will be rude to you. They were like, why get pregnant and you are still in school and all of that." - MMH P2

Participants also reported that the mistreatment extended beyond the healthcare system and included other members of their communities, such as teachers and family members.

> "When I was pregnant with my first son, I was in school, right? My teachers were so nasty with me. My math teacher was so nasty. So, she liked saying drop out [and that school was] not like a place for me to be pregnant" - MMH P3

> "When I came home [after giving birth to my baby], I was worried because my family didn't want to help me. They said you must want [have wanted] the baby, and now you must hold your child. [take care of the child]" - MMH P2

Teenage mothers may also lack support at home and face stigma from their own families. As a result, the mothers may have to take on the responsibility of motherhood without assistance or understanding, contributing to feelings of isolation and anxiety.

Participants expressed that first-time mothers in their community often lacked adequate support from their families, which led them to seek assistance from external sources. They noted that the experience of raising their first child often felt overwhelming and challenging. However, as participants gained more experience and their family structures changed, they found that caring for subsequent children became less difficult.

> "Sometimes you want [look for] support outside [of the home]. Sometimes, young women look for help from outside, like their neighbors or anybody they can find. Because the people they stay with are not even worried [concerned], even when they see you struggle [with taking care of your child]." - MMH P1

The absence of concern or support from the community around them exacerbates the struggles mothers face in caring for their child, presenting a significant barrier to effective maternal care for the child and affecting the well-being of the parent.

5.3.2 Information Sources

Clinic Visits

Clinic visits remain a primary source of information for parents. During these visits, parents reported learning various essential skills and receiving valuable information from healthcare workers. The source of this information—trusted healthcare professionals—made parents value it greatly. However, the volume of information provided in a single visit could be overwhelming, making it difficult for parents to retain everything they were taught. This undermined the effectiveness of clinic visits for information dissemination.

> "The clinics give you a lot of information, and then you come home and you [already] forgot what they said" - OV P1

> "Yeah, when he was a baby, I had like the pamphlets at the clinic, what you gave, how much you breastfeed, what you can do, how to let the baby fall asleep, what you can expect, a lot of things. A lot of pamphlets I liked to read" - MMH P4

One participant reflected on the utility of the informational materials provided during clinic visits. The pamphlets contained practical advice on breastfeeding, sleep routines, and general expectations, which the mother appreciated and used to guide her caregiving practices.

Peer and group support

One participant noted that health workers at local clinics sometimes recommended parenting workshops based on the immediate needs of their babies. This suggests that health professionals are proactive in connecting parents with additional support resources when necessary.

> "maybe at the clinic, they tell you to go to the parenting workshop. If they see your baby is underweight or something and they say there's a workshop at this place" - OV P5

This demonstrates the role of healthcare workers in directing parents to targeted external support services based on their child's needs.

Similarly, another participant expressed a desire for peer support within her community, noting that mothers would benefit from sharing experiences with others who could relate to their challenges. However, she pointed out a lack of information about how to connect with these peer support networks.

> "You know there's a lot of people who don't have anyone to speak about experience about. So, you need to speak to someone that is in the same situation as you, [someone] that knows about [what you are experiencing], and you don't hear a lot about that [kind of support]." - MMH P1

Parents' technology use for learning

Parents said they often use internet searches to find information on caring for their children, most frequently using Google. Further, they expressed openness to trusting the information they found online. At Mowbray Maternity Hospital, some parents shared that they assess the usefulness of the information through trial and error, only disregarding sources if they do not provide helpful guidance.

One participant highlighted how the advent of smartphones and internet access has provided them with a new means of finding information about child care, specifically through Google.

> "That's another thing that time [when I had my first child], there was no phones and. But now I google how to do this with him [her child]." - MMH P2

Some parents also use other online social media platforms, like Facebook, as resources to learn about child-rearing practices and access entertainment materials for their child to aid in calming their child.

5.4 Methodological challenges

We observed the following methodological challenges in conducting the exploratory workshops.

5.4.1 Tendency for group consensus contributions

In Ocean View, a small community, we observed the desire for mothers to discuss questions posed to them together to come to a consensus before selecting their individual preferences. This tendency was a significant obstacle to getting richer and more diverse participant insights. The facilitators repeatedly had to remind participants to reflect on prompts first individually before discussing the prompt with other participants.

Further, participants would engage in these informal discussions in Afrikaans, which I do not understand, highlighting the importance of having a local facilitator present during workshops to bridge this gap. Though these informal discussions were audio recorded, I elected not to have them transcribed and translated. This decision was due to an ethical concern around whether participants wanted these informal conversations incorporated in the research since they were aware of the language barrier and chose to speak a language I did not understand.

5.4.2 Influence of a dominant participants

Secondly, dominant voices emerged within the participant groups in the exploratory workshop activities at Ocean View and Mowbray Maternity Hospital that touched on the mothers' learning experiences. The dominant voice in both cases was an older mother. They presented a challenge in ensuring equal contributions within the group, especially for more quiet participants. More significantly, the influence of these dominant participants also sometimes resulted in the discussion taking a tangent as the other participants picked up on what they had said.

These tangents, however, were often very intensely discussed, leading me to believe that they could actually be crucial in bringing out the priorities of a participating community outside of the issues researchers organize for them to discuss.

5.5 Chapter Summary

In this chapter, we gathered insights into parents' challenges, information needs, and learning experiences through exploratory workshops conducted at two sites with ten participants.

Key findings revealed that teenage parents often face stigma and mistreatment, which restricts their access to information and discourages clinic visits. Parents identified clinics and family as their primary sources of information while also demonstrating a reliance on technology to meet their informational needs despite significant technological constraints.

These findings highlight important design considerations for developing a chatbot to support parents. In the next chapter, we will discuss these considerations in detail, integrating them with the findings from Chapter 3, where clinicians provided their perspectives during interviews.

Chapter 6

Understanding Context: Discussion of Exploratory Workshops and Clinician Interviews

6.1 Introduction

In the previous two chapters, I presented findings from contextual interviews with clinicians and exploratory workshops with parents. In this chapter, I build upon those findings to identify and discuss key design considerations for a parenting support chatbot. These considerations draw from the insights gathered about clinicians' teaching practices and parents' learning experiences, as explored in the earlier phases of this research.

The findings revealed that parents frequently feel insufficiently supported by their family, community, and health systems, highlighting a significant gap that a chatbot intervention could address. Clinicians corroborated this, noting parents' increasing reliance on them to compensate for the lack of familial and community support, which further strains already overburdened healthcare resources. A parenting chatbot could help bridge this gap by giving parents ubiquitous access to essential childcare information, reducing their dependence on health professionals.

Although technological constraints such as limited device ownership and internet access remain prevalent in under-resourced South African communities, our findings indicate that parents actively use the internet and technology to access childcare information. Furthermore, parents in these communities demonstrate an openness

and eagerness to adopt new technological interventions, underscoring the potential of chatbots in addressing their needs.

This chapter outlines the key design considerations for developing a chatbot to support first-time parents in South Africa. These include the importance of designing empathetic chatbots to support vulnerable teenage parents, ensuring chatbots complement rather than replace health professional support, fostering clinicians' trust in chatbots for wider healthcare acceptance, and enabling repeated access to information to aid parents' learning and retention.

6.2 Design empathy in chatbots to support vulnerable and teenage parents

Participants in our exploratory workshops who themselves had been teenage parents in the past expressed that teenage mothers faced a stigma and mistreatment in healthcare settings. This mistreatment created a barrier to these mothers accessing necessary health support during and after pregnancy. Given the significant teenage parent population in South Africa, using digital platforms has been suggested to improve access to information, support, and services to reach them [7]. These parents could benefit from a digital resource that allows them access to support without the fear of judgment and mistreatment.

First, chatbots provide a unique advantage in offering privacy and anonymity, which are crucial factors for teenage parents who may feel stigmatized by their communities. This sense of security and confidentiality within chatbots can encourage them to access sensitive healthcare information and seek guidance on critical topics [61, 99], thereby fostering a safe space for learning toward informed decision-making. Secondly, empathy within chatbot design is particularly beneficial for promoting positive user engagement. Research has shown that empathic responses enhance user motivation and engagement, especially for those experiencing social exclusion or mistreatment, as these users may feel more supported and understood through interactions with emotionally intelligent systems [2, 20]. Finally, by addressing the emotional needs of teenage parents, chatbots can reduce feelings of isolation and provide the necessary emotional support during challenging times. Chatbots can be emphatic by adapting responses to what has been said by the user, such as demonstrating sadness after the user informed something went wrong or by echoing users' responses by reaffirming what the user has just said [79].

In conclusion, designing chatbots that integrate personalized, empathic features is critical for encouraging vulnerable teenage parents to engage with healthcare resources. This design approach can begin to address their emotional needs and en-

hance the likelihood of positive health outcomes. Empathy is only one aspect of addressing this need for emotional support. Further work must be done to explore the ability and appropriateness of chatbots to effectively provide emotional support to vulnerable parents in this context. It is also important to note that I had no direct feedback from current teenage parents during my exploratory workshops.

6.3 Design chatbots to play a complementary role to health professionals

Both parents and clinicians in our study agreed that digital interventions can complement human health support. Physicians view chatbots as a promising solution to relieve pressure on health facilities with the potential to scale to meet surges in demand where there is a shortage of qualified human capacity [22] as is the case in many low-income communities in Cape Town, South Africa where healthcare infrastructure is strained. Their application could potentially free up healthcare professionals to focus on more complex and urgent care [99].

Our findings on clinicians' foreseen roles for a chatbot align with existing literature, indicating that health professionals perceive chatbots to be better suited to more straightforward tasks [67]. The design of chatbots should prioritize tasks that are better suited for automation. These include providing patients access to immediate objective medical information such as danger signs, first aid, and developmental milestones. Another complementary chatbot role would be linking parents to relevant external healthcare support, given our findings that healthcare workers often direct parents to targeted support services following consultations.

Designing chatbots that complement, rather than replace, human health professionals is a critical consideration. Chatbots can enhance the healthcare delivery system by focusing on automating routine tasks and connecting patients with the appropriate healthcare resources.

Clinicians emphasized the importance of understanding the context around a health concern and considering the unique characteristics of the parent and child before offering care or guidance. They do not perceive chatbots to be able to capture the nuance around a health concern, which is vital in delivering accurate and relevant support to parents in more complex situations. Existing literature aligns with these concerns, indicating clinicians perceive chatbots as lacking the intelligence to assess patients' needs accurately and could lead chatbots to harm patients by overlooking key personal characteristics essential to giving them the appropriate health support [67].

However, this perception will likely continue to change, given the massive advancements in chatbot technology using generative AI over the last two years.

Given these considerations, it may be beneficial to incorporate contextual probing into parenting support chatbot systems. For instance, the initial interaction with the chatbot could prompt users to enter key health and demographic characteristics akin to triage at the clinic. This process would ensure the chatbot has background information from the outset, even before the user has raised any health concerns.

Alternatively, the chatbot could incorporate follow-up questions users query to clarify their health concerns. The chatbot algorithm would then consider these characteristics and additional information to provide a more appropriate and accurate response. However, these mechanisms increase the complexity of the chatbot implementation. If generative AI techniques are used to achieve this, it could also potentially increase the risk of misinformation due to the inherent uncertainties of generative AI [100, 31].

Another approach could be to incorporate human involvement in the chatbot system. The chatbot can triage parents when they have a health concern, after which either the chatbot or the user can escalate the issue to a human agent based on the severity of the situation or an assessment of the chatbot's capability to address it.

6.4 Design to gain clinician trust in chatbots

Clinicians indicated that their trust in a chatbot would depend on the authority of its provider, the credibility of its information sources, and whether their peers were also utilizing the chatbot. A 2020 study found that the primary factor driving perceptions of the ability of an agent, human or chatbot, was the user's trust in the provider of the agent [22].

Given the high level of trust patients have for their physicians, approval from physicians is deemed crucial for chatbot integration into medical practice. Physicians themselves need to be convinced of the usefulness of chatbot systems for them to recommend them to patients, increasing their patient acceptance and adoption [2]. It is a priority to foster clinicians' trust in chatbots, which can be achieved in various ways.

The chatbot should clearly reference the chatbot's provider and the sources of its information. Chatbot designers should seek to leverage existing trust by partnering with reputable institutions to develop and endorse the chatbot. They should also carefully select the chatbot's content sources based on the source's credibility, which could further enhance clinicians' trust in it. These strategies would build trust

among clinicians and, in doing so, possibly result in broader acceptance among parents.

Leveraging pre-existing health information materials for chatbot corpus generation is also essential. Our participating clinicians identified informational resources such as the Road-To-Health Booklet and governmental pamphlets as trusted yet underutilized sources of information. Given our findings, the reputation of information sources plays a massive part in securing clinicians' trust in a chatbot. Using these existing resources to generate chatbot corpora could significantly enhance clinicians' buy-in into these systems.

Our findings indicate that the primary challenge lies in disseminating parenting information rather than its generation. Future work could be creating ways to transform diverse existing informational resources, such as governmental pamphlets and booklets, into chatbot corpora. Reusing these existing informational resources would expedite chatbot creation and expand the range of health-related topics within chatbots that address the informational needs of more parents.

6.5 Design chatbot interfaces for ease of repeated information access

Clinicians reported that they often need to repeat information because parents struggle to understand and absorb all the information given to them during a consultation. Participating parents corroborated clinicians' observations on the difficulty of retaining information after clinic visits. These findings are consistent with existing literature documenting that parents face challenges comprehending and retaining information [4].

To address this difficulty, clinicians stated that they usually use multiple strategies for information dissemination, such as explaining from a different angle and giving parents supplementary written informational materials to support the information they have relayed.

Various approaches are documented in existing literature to address the challenges of information retention among parents. Providing an audiovisual presentation of information "is an effective way of producing significant improvement in short- and long-term recall of information in patients and parents" [4] with mind maps improving retention better than leaflets. It is also recommended that verbal information given to patients is always supported with written/visual or visual materials [84]. Similarly to pamphlets, a chatbot could be an effective supplementary tool to reinforce clinicians' educational efforts.

The need for repetition of information and supporting written and visual materials to aid parents' learning further highlights a key emerging design consideration: to design chatbots to enable ease of viewing information multiple times. Chatbot designers could achieve this in various ways. In the ParentCoach prototype, we [1] eventually developed, we incorporated a feature to pin and save information of interest for later reference. This information was then accessible quickly on a separate screen whenever the user desired to view it, eliminating the need to follow the informational retrieval process again.

6.6 Design to consider individual characteristics of parent and child

A chatbot should consider the individual characteristics of parents and children. Our interviews with clinicians revealed that clinicians take different approaches when working with children with developmental delays as compared to when they are working with children with typical development. Due to the specificity of each child's developmental delay, clinicians working with them prefer not to offer generic information to the parent. Instead, they tailor the informational support they provide to the parents based on their consultations and the child's current state. They also try to limit and pace the information parents they work with have access to due to the alarm and fear it can cause. Therefore, a chatbot for these parents would be better if it limited their access to information strictly to what they needed to know, given their child's current developmental stage.

A chatbot intervention catering to these two parent groups would also need to differentiate between them. Having a one-size-fits-all approach for the two groups would not be easy. The content a chatbot offers and how it presents that content to the parent would likely need to be different.

6.7 Chapter Summary

This chapter focused on identifying and discussing key design considerations for a parenting support chatbot through an analysis of the findings from contextual interviews with clinicians and exploratory workshops with parents presented in the previous two chapters.

Key findings discussed are that parents often feel insufficiently supported by their family, community, and health systems, creating a gap that a chatbot intervention

[1] The term "We" refers to the ParentCoach consortium and gatekeepers for collaborative decisions and activities as described in Chapter 3.

could help fill. Clinicians highlighted the strain on healthcare resources caused by parents' reliance on them to compensate for this lack of support. They also emphasized the potential role of a chatbot in providing ubiquitous access to essential childcare information. Further, despite technological constraints in under-resourced South African communities, parents actively use technology to access information and display a readiness to adopt new tools, underscoring the feasibility of a chatbot intervention.

The chapter proposed some key design considerations for developing a chatbot to support first-time parents in South Africa. These were designing empathetic chatbots to address the needs of vulnerable teenage parents, particularly those facing stigma and mistreatment. Ensuring chatbots complement rather than replace health professionals, reducing the strain on healthcare resources while maintaining trust and collaboration. Fostering clinicians' trust in chatbots is a critical factor for broader acceptance and integration into healthcare practices. Enabling repeated access to information to aid parents' learning and information retention.

These considerations set the foundation for the next steps in developing a chatbot tailored to the unique needs of first-time parents in South Africa. In the next chapter, we explore co-design with parents thematically, highlighting findings and discussing them towards proposing further design considerations that informed the design of our chatbot prototype evaluated in phase 5 of the study.

Chapter 7

Phase 3: Chatbot Co-Design

7.1 Introduction

In the previous chapter, we discussed the findings of interviews with clinicians and exploratory workshops with parents that provided a contextual foundation to inform the design of a parenting support chatbot that considers clinicians' teaching practices and parents' learning habits and experiences.

In this chapter, we present and discuss the findings from co-design activities with parents that provide insight into their perspectives on various interactive and personality characteristics of chatbots. The first workshop, W2, aimed to adapt a chatbot to the participating communities' local and cultural contexts. We invited participating parents to give us their ideas about chatbot modalities. The second workshop, W3, then aimed to validate and refine our prototype design with parents within the target community.

I shall thematically report on the findings of co-design workshops (W2 and W3). I will then discuss key design considerations for parenting chatbots stemming from the thematic analysis of these findings. Some key design considerations I identified included parents' preference for the English language in a chatbot in their multilingual context, a desire for simple explanations of medical terms, a desire for control over chatbot interactions, and customizability of chatbot features as well as perspectives on chatbot personality attributes.

Co-design is seen to democratize design towards creating sustainable and context-appropriate innovations [88]. Further, it is indicated in literature that users' expectations affect their actual perceptions of chatbots during interaction, influencing their overall satisfaction [77]. Taking a participatory approach through co-design in

the different study contexts was crucial, given that unique regional and cultural characteristics play a significant role in determining a project's success [13]. Co-design was also vital in managing and establishing common expectations of what the resulting intervention could and could not offer its users. We sought to leverage the participating communities' existing local knowledge and experiences to understand the appropriateness of certain technological design choices over others.

Ethically, it was important for us to take a participatory approach to understand the perceptions around chatbots within the participating community before implementing any such intervention. The Minimum Ethical Standards for ICTD suggests that "researchers should not introduce new technologies into a setting without first understanding how those technologies relate to the existing technology ecosystem in that setting" [21]. In addition, "interventions and technologies should be designed with end users wherever possible to ensure the needs and interests of research participants are at the heart of the intervention" [21].

A key ethical dilemma we faced was around the benefit the research had for participants. In phases one to three, we did not foresee any direct benefit to participants. Due to the open nature of the co-design approach, we could not reasonably guarantee to the participants that we would implement a chatbot to support their needs. However, we knew that our research activities could create an implicit promise of a real-world solution. We mitigated this by stating explicitly to our participants that the purpose of our co-design and trials was to document the research findings in literature for future work and not necessarily to build a real-world solution for them. While there was no direct benefit of participation to participants in phases one to three, there was a degree of benefit for participants who participated in the pilot feasibility trial since the app contained health information that they could learn from.

This chapter sets the stage for the prototype implementation described in the chapter, which will expand on the outcomes phases one to three, presenting a sample chatbot implementation to illustrate key outcomes.

7.2 Methodology

7.2.1 Participatory Design Workshops with parents (W2)

Following the exploratory workshops in phase 2, the researchers engaged 16 first-time parents in co-design workshops at Bhabhisana Baby Project (BBP), Ocean View (OV), and Mowbray Maternity Hospital (MMH). We initially planned to retain the same parents participating in the exploratory participatory workshop phase and participants in the co-design workshops. In Ocean View, we retained parents from

the exploratory workshops (W1) to the co-design workshop (W2). However, we could not retain participants at the Mowbray Maternity Hospital (MMH) site due to the nature of recruitment there. Table 7.1[1] shows a breakdown of participant demographic characteristics.

Table 7.1: W2 Participant Demographics

Category	**Ocean View**	**MMH**
Age Range		
15-19 years	1	0
20-29 years	2	2
30-39 years	2	2
40-49 years	1	0
50+ years	0	0
Role		
Mother	4	5
Father	1	0
Education Level		
Middle School	2	-
High School	4	-
College	0	-
PhD	0	-
Household Size		
3 - 4 people	3	-
5 - 6 people	1	-
7 - 8 people	0	-
9+ people	0	-
Child's Age		
0 - 12 months	3	5
12 - 24 months	3	0
24 months +	0	0

At MMH, the participants we recruited were patients coming into the hospital for their clinic visits. The hospital serves patients who travel there to seek care from a vast geographical area. It was, therefore, unlikely that the group of participants we recruited would return to the hospital again at the same time so that we could organize another workshop including them.

[1]I was unable to collect complete demographic details at BBP and MMH due to the nature of recruitment. However, this did not have an impact on the analysis of findings.

For the first exploratory workshops at this site, we approached parents who had come in for their clinic appointments. When we returned to Mowbray Maternity Hospital the next day for the co-design workshop (W2), we faced more difficulty recruiting parents at the clinic's waiting room. To address these difficulties, the clinician on the ParentCoach research team, who assisted me in facilitation at MMH, suggested recruiting mothers of newborns who were already gathered in a single ward waiting to be discharged. He sought institutional approval from the hospital administration, and we approached mothers in the ward to participate in our workshop. Though the mothers were initially skeptical, the nurses in the ward acted as gatekeepers, explaining to the mothers how their participation could benefit them in the long run. The nurses used the existing trust mothers had in them and common language to convince the mothers to participate.

We conducted half-day workshops at each of the three study sites, Ocean View, Mowbray Maternity Hospital, and BBP, with the workshops having six, five, and five participants, respectively. Before each workshop started, I obtained written informed consent from the participants. I read the informed consent form aloud and explained the expectations of participation in the study and the purpose of the workshops. After that, I explained how the research team would use and protect the resulting workshop data. (This is detailed in chapter 3 of this dissertation). I also clarified that participation was voluntary and that participants could withdraw at any point, even once the workshop had begun.

The W2 workshop activities were as follows:

1. **Introduction and Ice Breaker** I prompted parents to share the worst piece of advice they had received, its source, and how they determined it was bad. I then prompted the rest of the group to collectively turn that piece of bad advice into a piece of good advice. This helped parents loosen up to each other as they related to each other's contributions.
2. **Chatbot Interactive characteristics** In the second activity of the workshop, we provided each participant with a card and asked them to reflect individually and select which interactive characteristic they preferred. The interactive characteristics we investigated were:
    - Chatbot proactivity: user-initiative or proactive;
    - User input mechanism: menu-based or typed input;
    - Content form: Text, Video, Audio, or Images.

    Once every participant had indicated their individual preferences, we invited each parent in the room to state their selected preferences and, where possi-

ble, justify them, allowing other participants to engage in discussions around contributions.

3. **Chatbot Personality** I gave each participant a card and asked them to reflect individually and select which chatbot personality characteristic they preferred. The personality characteristics we presented were:

   - Gender: Female, Male, or Neutral
   - Age: Young, adult, or Elder
   - Chatbot language: Simple explanation or medical jargon
   - Chatbot treatment: Personalized or General
   - Chatbot tone of voice

   After that, we invited each parent in the room to state their selected preference and, where possible, justify them, allowing other participants to engage in discussions around contributions.

4. **Chatbot Demonstration** One of the initial activities of our workshops involved allowing the participants time to try out two different healthcare-related WhatsApp chatbots. We used existing chatbots in a variation of technology probing. Probing involves introducing technology in a real-world context, watching how it is used over time, and then reflecting on it to gather information about the users and inspire ideas for new technologies [43]. These chatbots were:

   - AskNivi chatbot This is a free and automated service on WhatsApp and Facebook Messenger that "aims to help people learn about family planning, identify suitable methods of contraception based on their goals, and find nearby providers" [35].
   - NDOH chatbot

     This WhatsApp-based chatbot provided vital information on COVID-19 toward containing the spread of COVID-19 in South Africa. It was available in Sotho, Zulu, Afrikaans, and Xhosa, in addition to English, broadening the accessibility of this service. In its first two weeks, it had over 3 million users. It was a menu-based chatbot presenting menu options with responses to the most frequently asked questions about COVID-19 and the coronavirus [92].

5. **Chatbot role-playing activity** This activity was an interactive role-playing exercise designed to simulate and evaluate different service experiences of a

parenting support chatbot. Participants, working in pairs, took turns acting as either a parent or the chatbot. The "parent" drew three cards representing an event, a feeling, and a context (e.g., a baby's health issue, emotional state, and setting) and sought help from the "chatbot". The "chatbot" responded using message/feature cards to address the parent's scenario or created solutions on blank cards if necessary. The activity concluded with participants voting and discussing which messages or features were most effective. This exercise fostered empathy, creativity, and feedback for refining chatbot functionality. Figure 7.1 illustrates further how this activity was conducted.

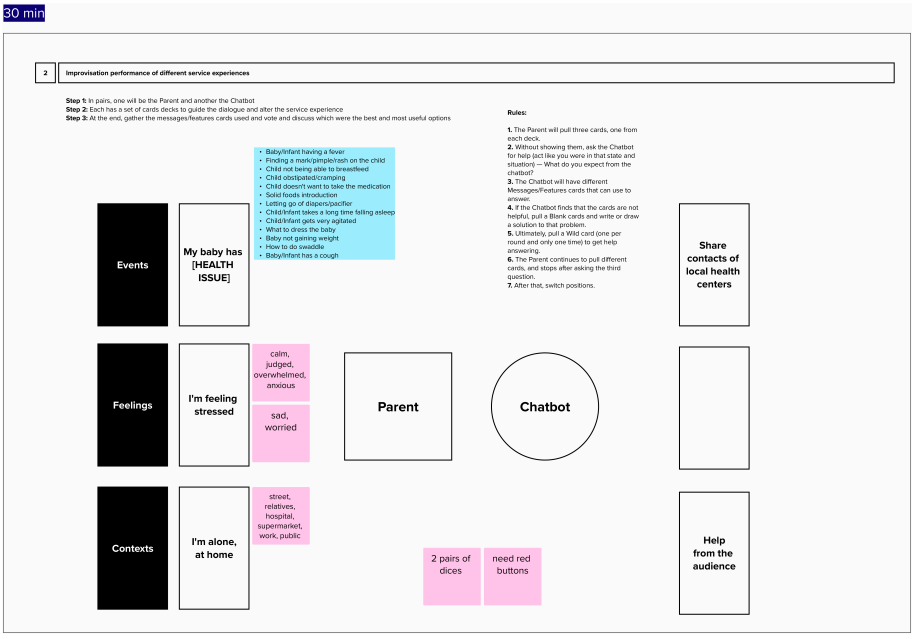

Figure 7.1: Chatbot role-playing activity

6. **Chatbot user characteristics** In the final activity, I prompted users to select from a list the type of parents they believed could benefit most from a chatbot providing parenting support.

Figure 7.2 shows a sample of cards I used to collect participants individual preferences which we then discussed during the workshop.

I took notes and audio-recorded the workshop activities. The workshop was approximately three hours and was audio-recorded and later transcribed. Transcription was a combination of a manual and automated process. I first processed the transcripts using the Word Online transcription tool to generate a transcript draft. After that, I listened to the audio recordings minute by minute to validate the generated transcript, correcting any errors as they occurred. The outputs of data collection in this

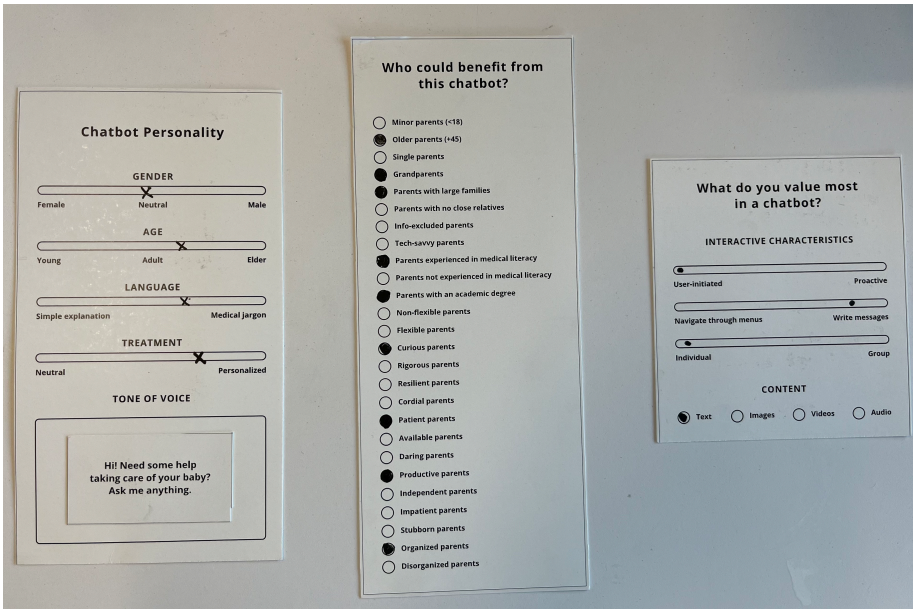

Figure 7.2: Sample W2 chatbot characteristic cards

phase were notes and workshop transcripts.

I analyzed the transcripts using Braun and Clarke's thematic analysis process [12] (described in detail in Chapter 3) to identify themes relating to the parents' existing experiences and perspectives of chatbots and their preferences regarding various chatbot modalities I presented to them in co-design. I consolidated the participants' responses, inputs, sketches, and ideas generated in these workshops and organized them according to themes. Some of the themes I identified were limited prior experience with chatbots, desire for user control and flexibility of interaction, varied preferences for menu-based and typed input, and preference for video and text-based content.

Since the research was collaborative and activities were running in parallel in Porto, Portugal, and Sweetwaters, South Africa, we needed to combine our findings and analysis to design one resulting prototype that we would then use to run a pilot study. We analyzed data from the workshops separately at each partner research institution. Thereafter, our teams met to discuss the analysis and find the most relevant themes using affinity mapping. Our joint analysis formed the basis of our initial prototype design, which we implemented and piloted with first-time parents. The ideas generated were compared to existing digital interventions for MCH to identify gaps our intervention would seek to fill.

7.2.2 Prototype wireframing workshop (W3)

Following our preliminary analysis of the co-design workshops in Portugal and South Africa and a brainstorming session, we developed an initial prototype design of a potential intervention. We then presented wireframes to five parents/caregivers recruited in Ocean View to get feedback and refine the flow and features of the prototype.

Table 7.2: W3 Participant Demographics

Category	Number of Participants
Gender	
Female	4
Male	1
Age	
16-19 years	1
20-24 years	1
25-29 years	3
30+ years	0
Occupation	
Unemployed	4
Contract	1
Education Level	
Middle School (Grade 7-9)	1
High School (Grade 10-12)	4
Household Size	
0-5 people	3
5-10 people	2

The W3 workshop activities were as follows:

1. **Co-design Sketching** I gave each participant an A4 sheet of paper with a blank smartphone screen outlines and prompted them to sketch what they imagined some screens of a chatbot would be to provide them with information about taking care of their child. The sketches were done before the participants had seen any of prototype wireframes. Figure 7.5 and figure 7.6 show some of the outputs of this activity.
2. **Evaluation of low-fidelity paper prototype** I presented wireframes of the prototype design and invited users to give feedback on the features and flow.

They provided feedback by annotating the paper prototype of the wireframes with sticky notes and drawing on it and discussed their contributions as they added them. One of the outputs from this activity is shown in figure 7.3.

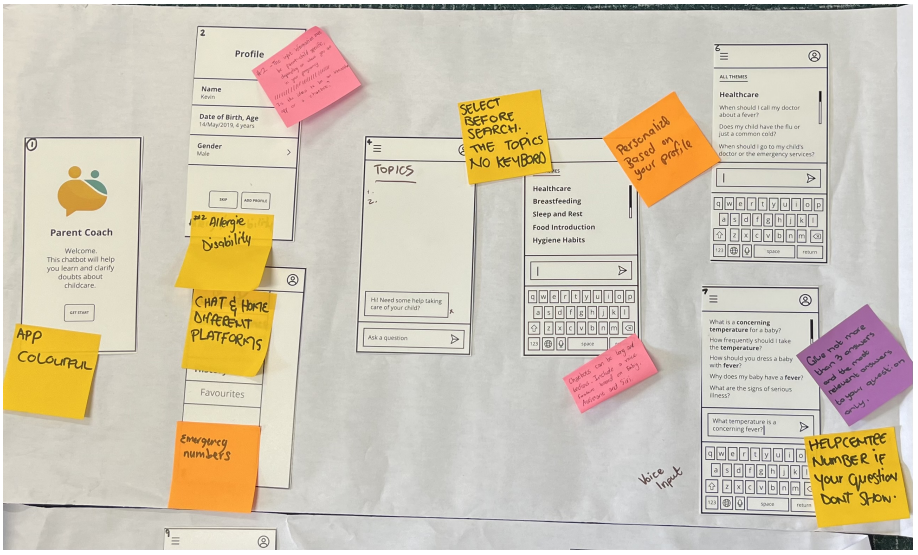

Figure 7.3: W3 wireframing annotation by participants

This workshop was a quick way to get an initial idea of whether the prototype aligned with what the parents in Ocean View desired. As such, I conducted this workshop at only one site in Ocean View because that was the intended site for the trials in the subsequent phases of the study. I gathered data through note-taking during workshop discussions and a review of the annotation of the wireframes and sketches that the participants made during a brainstorming activity. As the ParentCoach research team, we[2] used this data to refine the prototype design into the final prototype, piloted in phase five of the study.

7.2.3 Methodological challenges and limitations

It is important to note that all but one participant in the first set of participatory design workshops was male, and the rest were female. This bias was primarily due to mothers' easier availability and willingness among parents found through convenience sampling. This lack of gender diversity may reduce the applicability of our findings to first-time fathers or male guardians since we did not include them extensively.

[2]The term "We" refers to the ParentCoach consortium and gatekeepers for collaborative decisions and activities as described in Chapter 3.

Secondly, it was often a challenge to steer participants towards writing down their individual design preferences first before discussing the chatbot modality with the other participants. This presented a challenge in gathering data on parents' individual preferences. Our intention in asking participants first to select their individual preferences was to create richer and more diverse points in the discussions of their choices and minimize bias created by stronger voices in the group.

Particularly in Ocean View, where workshop participants came from the same community, they often wanted to discuss things together before making individual choices. The activity prompt would spark a brief discussion. Often, one participant would follow the activity prompt with a simplified understanding of what the facilitator had asked in their native language, Afrikaans. The discussion could also have been a mechanism for participants to ensure that they clearly understood what the activity prompt asked of them before selecting an answer.

The desire for consensus aligns well with co-design. Still, it could indicate that our approach in asking for individual preferences did not fully align with the participants' cultural ways of making individual decisions. The participating communities often make their decisions in consideration of those around them more than just in consideration of their individual needs and desires, as seen more in Western culture [29].

7.3 Findings - Chatbot Co-Design Workshops (W2)

Below is a summary of parents' individual preferences that they indicated during the workshop:

Table 7.3: Chatbot Interactive Characteristics

Dialogue Initiation		**Input Mechanism**			**Content**			
User-Initiated	Proactive	Menus	Written	Both	Text	Video	Audio	Images
12	5	**12**	7	2	11	**12**	2	5

Table 7.4: Chatbot Interactive Characteristics by Demographics and Personalization

Gender		**Age**			**Language**			**Personalized Info**		
Female	Male	Neutral	Adult	Elder	Simple	Medical	Both	Personalized	Neutral	Both
5	0	**13**	**16**	3	**10**	3	6	6	5	**7**

These initial user selections indicated that most participants prefer initiating dialogues themselves. Most users favored menu-based input mechanisms, but a sig-

nificant number still wanted to type in their queries. Video-based and text-based content were equally preferred, while audio and images were less favored. Regarding chatbot personality, participants generally prefer a gender-neutral, middle-aged chatbot persona and desire simple language in chatbot responses. Personalized and general information are nearly equally valued, with most participants desiring to have both. These insights emphasize the importance of tailoring chatbots to align with user preferences regarding interaction style and personality for optimal user satisfaction. The workshop discussions then provided richer qualitative insights to situate these selected preferences toward a clearer understanding of users' perspectives on the chatbot modalities were presented.

Figure 7.4: W2 workshop participants taking part in activities

7.3.1 Limited prior experience with chatbots and Co-design Readiness

Most participants had never heard of or interacted with chatbots before participating in the workshop, which limited their ability to imagine how a chatbot might function in their daily lives. Generally, the parents had difficulty participating in the role-playing activity. Specifically, at Mowbray Maternity Hospital, the parents attempted

the activity briefly. They then insisted that one of the facilitators play the chatbot role since they lacked the technological and medical knowledge to role-play as a chatbot.

Lack of familiarity also impacted participant engagement in certain co-design activities. A study working with historically underserved populations in the U.S. found that despite the intended benefit of collaborating to uncover individual and community needs, design workshops practice can bring expectations that may further marginalise and ultimately undermine the participation of certain individuals [39]. In this study, the expectation that parents were familiar with chatbot technology as well as brainstorming and prototyping activities presented a barrier to their participation.

Fostering technological co-design readiness, which entails participants' confidence and familiarity with technologies used supported by appropriate planning of methods, is essential for the success of community-based co-design activities [89].

During W3, which was conducted in Ocean View, we asked participants to sketch how they imagined a chatbot could assist them in addressing health concerns. Some of the parents' co-design sketches (Figure 7.5, Figure 7.6, Figure 10.3) comprised lists of questions, while other parents drew a search bar interface. The sketches pointed to an innate perception of a chatbot as other previously used interfaces since most had not interacted with a chatbot interface before.

Interestingly, many workshop participants had used WhatsApp, even if it was not on their own devices. In the Ocean View workshop (W2), several participants implicitly assumed that the resulting chatbot prototype would be WhatsApp-based, reflecting their familiarity with the platform. Most participants had never heard of or interacted with chatbots before participating in the workshop.

7.3.2 Language Preferences

Desire for simple explanations paired with medical jargon to aid learning

Participants preferred that information be delivered in simple, straightforward language. However, they also valued having access to the corresponding medical terminology. This approach would allow them to gradually learn medical jargon, which they could then use during clinic visits and consultations with healthcare professionals.

> "If we have only a simple explanation when you go to the doctor, you then have to learn some hard words. It's good to know the simple one and also know the hard one." - BBP P3

Figure 7.5: Co-design Sketch 1 - Ocean View, South Africa

> "I think the chatbot is useful because you get all the information you want, like signs and symptoms and how to prevent those things. Before you go to the doctor, you already have basic information that might help you when you go in for a consultation." - BBP P3

Participants noted that healthcare professionals often used complex medical terms they did not fully understand. By having access to both simplified explanations and medical jargon in the chatbot, parents felt they could be better prepared for their interactions with doctors and more confident in their conversations.

When I asked about participants' language preferences for accessing medical information, participants generally favored English. They indicated that English would be their preferred language in a chatbot, either as the primary language or alongside their native language. The preference for English was largely driven by the fact that it is commonly used during clinic visits and medical appointments.

> "I would use it in both English and my language in case I go to a hospital, and they tell me something in English, then I'll be able to know." - MMHP3

However, participants also desired flexibility in switching between languages, partic-

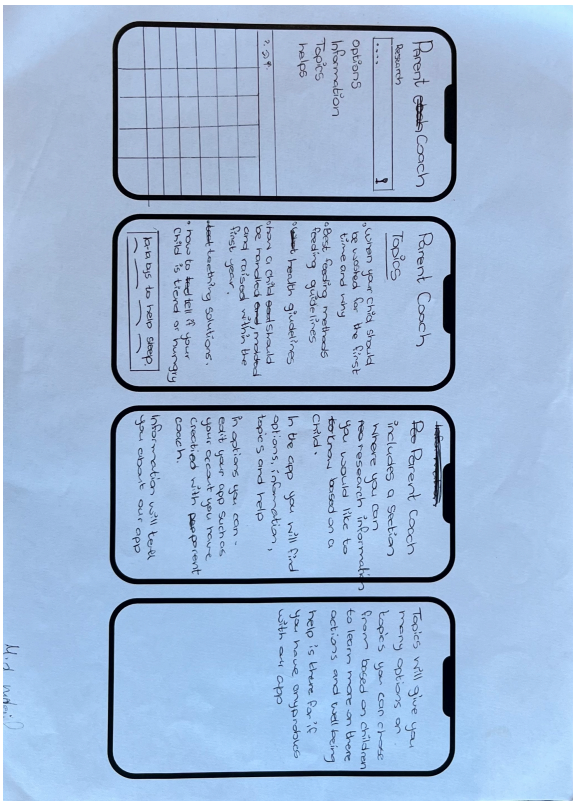

Figure 7.6: Co-design Sketch 2 - Ocean View, South Africa

ularly when encountering unfamiliar or complex English terminology. This ability to toggle between languages would help bridge gaps in understanding, especially for those who might feel less confident with medical terminology.

> "Maybe I will choose English, but if I find a hard word, I will go to Shona. I think in order for everyone to be heard, it is better if they use all languages because there are other ways you get to know using your own language." - MMHP4

Participants from Afrikaans-speaking communities in Ocean View noted that reading and learning technical, medical terms in Afrikaans felt cumbersome due to lengthy words. They found it easier to understand these concepts in English. This could be attributed to how the Afrikaans language spoken within some Coloured communities differs from formal Afrikaans.

> "The way we speak is different from the way it is read [and written]. It's difficult; the words can be very long in Afrikaans, and you wouldn't necessarily understand the word." - OV P3

Recognizing the linguistic diversity of their communities, some participants emphasized the importance of language inclusivity. They advocated for the chatbot to support multiple languages to ensure that language barriers would not prevent access to essential childcare information.

7.3.3 Preferred user input mechanisms

Regarding user input mechanisms, most participants favored menu-based input at BBP and Ocean View. In contrast, at Mowbray Maternity Hospital, participants leaned towards typed or written input for a chatbot.

Menu-based input

Participants expressed a preference for menus because of the assistance they could provide in discovering information, exploring corpus content, and reducing the barrier of formulation of chatbot queries. However, participants expressed the desire to be able to write their own custom queries in cases where the menu options presented were not sufficient.

They viewed menus as a helpful tool for discovering information that parents might not naturally think to ask about. By browsing through predefined categories, parents could learn about new topics they may not have considered but found useful once encountered.

In addition, they perceived menus as a way to quickly grasp the chatbot's content's scope. By exploring menu options upfront, users could understand what range of topics the chatbot covered, reducing the risk of wasted time and effort in querying the chatbot for information outside the scope of the chatbot's capability, leading to frustration.

Additionally, some participants considered the varying literacy and education levels within their community when discussing input preferences. They viewed menus as an assistive mechanism that could help parents who might struggle with formulating coherent queries or knowing what questions to ask. By allowing users to navigate through predefined options without needing to type or articulate a specific question, they thought menus could make the chatbot more accessible and inclusive, particularly for individuals with lower literacy or language proficiency.

> "So, for instance, some people can't write, so it would be best if they just scroll down and select what they want to select." - MMH P4

This finding highlights the potential for menus to enhance information retrieval and support users in bridging gaps in language and education, making the chatbot more usable for a diverse range of parents.

Typed Input

Some participants, particularly those from Mowbray Maternity Hospital, strongly preferred typed input when interacting with a chatbot. They perceived typed input as a more precise and efficient way to convey their specific questions or concerns. Participants felt that typing allowed them to communicate exactly what they wanted, thus ensuring they received the most accurate and relevant responses.

> "I like to write messages because then they know exactly what it is that you want" - MMH P1

This preference was also influenced by participants' previous experiences with digital customer service interfaces, reporting frustration with navigating menu-based systems, which they found limited and often unable to address their specific needs. They wanted the flexibility to type out their questions if the available menus did not cover their query.

> "I think both will be useful because sometimes, in most apps, we do get the option to navigate through menus right, but we don't get the help that we need [through the menus]. Maybe, for instance, it's not there on that main menu. So, it would be best if you write it [the question you have]" - MMH P4

Some participants viewed typed input as a way to overcome the constraints of structured menu options, allowing for more personalized and direct interactions with the chatbot.

7.3.4 Chatbot proactivity: Parents desire locus of control in interaction

The majority of participants expressed their preference for user-initiated interactions with a chatbot. They stated that they desired the agency to choose when to access information according to their needs. Drawing from previous experience with digital interventions, they also cited that it could be upsetting to be prompted proactively to access information.

> "So, I chose user-initiated because I think I would like to use the app when I need it. So, like sometimes, for instance, if I downloaded it [an app], sometimes I get annoyed every time it constantly reminds me, there's a pop-up message that, oh I'm here, yes, I'm here, so I get annoyed and delete the app. " - MMH P4

Parents have a desire for customizability of chatbot features

Participants often selected multiple options when asked about the different chatbot design modalities, specifically, chatbot language, content form, chatbot personalization, and input mechanism. Rather than making a one-off choice, participants expressed a desire to be able to dynamically toggle between different modes depending on the situation and current at a given time.

Throughout the study, participants expressed a desire for flexibility in the chatbot's features to ensure it could accommodate the diverse needs of their broader communities. Their feedback revealed a strong consideration for inclusivity, emphasizing that the app should cater to various demographics, literacy levels, and cultural backgrounds.

When discussing preferences for chatbot characteristics like gender, input methods, and content formats, participants were conscious of how these choices could impact other community members. For instance, some participants preferred a gender-neutral chatbot in order to ensure fathers feel included, particularly when they needed to take on primary caregiving responsibilities.

> "For gender, I chose neutral because there are also like fathers out there.. maybe, for example, if a mother passed away during birth, the father has to step in and take care of the child, so it would also like to benefit them so they don't feel like excluded in all of this" - MMH P3

Participants also expressed the need for diverse input mechanisms to accommodate varying literacy skills. For example, incorporating audio features could enhance accessibility for users who struggle with reading or writing. By offering both text and voice options, the chatbot could better serve parents with different literacy and language proficiency levels.

> "The reason why I chose the three options is because, as I said before, we get people who can't read or write, right? So, it will be best if like they do audio, and then like the app also responds in the audio. So like they can understand it." - MMH P5

Additionally, participants emphasized the importance of multilingual support in supporting the linguistic diversity in their communities. They advocated for the app to include various languages to ensure that no one would feel excluded based on their language preference.

Overall, participants' responses demonstrated a commitment to ensuring that the chatbot could be as inclusive as possible, reflecting the diverse needs of families within their communities. They expressed that flexible features could better fulfill its role as a supportive tool for all parents.

Some participants expressed a desire for personalization of chatbot content, specifically in terms of tailoring recommendations to the unique characteristics of both the parent and their child. They perceived value in receiving suggestions specific to their child's age, health status, or current developmental stage. However, participants emphasized that personalization should not come at the expense of access to a broader range of information.

While they appreciated the usefulness of content tailored to their specific context, participants did not want the chatbot to limit their informational access strictly to what its personalization algorithm deemed relevant. Instead, they desired the flexibility to explore the entire content library on their own. This dual approach—combining personalized recommendations with open access to general information—was expressed to be crucial to their learning and decision-making processes.

This balance was important to them, as it allowed them to address both immediate, specific needs and unexpected challenges that might arise outside the scope of the chatbot initially identified as relevant.

7.3.5 Content Form Preferences

Most participants preferred both text and video content, often describing how these two formats could complement one another to convey childcare information effectively. Participants particularly valued video content for demonstrating skills and procedures that parents needed to learn visually, making it easier to understand complex tasks step-by-step.

> "There's also going to be times when I'm going to ask them, look here, I do not know how to do this and whatever, and then I would like them to show me how to do it in a video." - MMH P3

Some also highlighted the value of video content in supporting users with lower literacy or education levels, as videos and voice instructions could provide an accessible way to receive information without needing to read extensive text, especially for lower literacy parents within their communities.

Despite their appreciation for video content, participants consistently selected text as a favored mode of content delivery because of its affordability and ease of access due to the participants' bandwidth and data cost concerns.

> "And then content, for the first one, I chose the text because it's much cheaper." - MMH P4

In summary, while participants favored video content for its instructional clarity and inclusivity, text remained a constant preference due to its lower data consumption, making it more accessible for users with limited financial resources.

7.3.6 Chatbot Personality

Gender Preferences in chatbot

When I asked participants about their preferences for the chatbot's gender, their responses were closely tied to their perceptions and experiences when interacting with human beings. Given their limited prior interactions with chatbots, it was unclear if participants fully understood or could imagine how gender would manifest in a chatbot.

The majority of participants preferred a gender-neutral chatbot, with some expressing that gender was not a critical factor in their interaction and that they were largely indifferent to it. Other participants chose a neutral gender with inclusivity in mind, emphasizing that it would be more accommodating for both mothers and fathers seeking information.

> "For gender, I chose neutral because there are fathers that can take care

> of the newborn; it could also benefit them so they don't feel excluded in all of this." - MMH P3

A smaller group of participants expressed a preference for a female-gendered chatbot. They associated a female persona with being more knowledgeable, experienced, and trustworthy, especially on childcare and maternal health topics. This preference was linked to comfort levels when discussing sensitive matters, where participants felt that a female chatbot would create a safer space for open communication.

> "And I will feel uncomfortable, so then it's best, it's a lady [female]." - OV P1

There was a perception that females possess greater experience in childcare, and maternal issues were another reason some participants preferred a female chatbot. They believed that a female persona would naturally provide more detailed and informative responses than a male persona.

> "I chose female because I feel like they go through it more than men. I just feel like females, maybe, like taking care of the baby or they had to, so it's better she is the one who has given us that message because she knows better than the men." - MMH P4

A participant also indicated that women tend to provide more depth and length in their answers, which they believed would result in more comprehensive responses from the chatbot. This suggested that participants valued not just the content but also how it was delivered, and they felt that a female persona would better align with their expectations for thoroughness in responses.

Tone of Voice

Our participants generally wanted a warm and welcoming tone from the chatbot in its responses to them. They expressed that their comfort level depended on a health professional's behavior, which included the tone of voice they used.

> "It depends on the doctor. If you have a doctor who just wants to get done with you so that you can move on to the next patient, then you feel like you are taking up all his time, and you don't feel free to ask questions " - BBP P5

> "I would prefer soft voices because maybe you're anxious about something about your son and your child. Yeah. So it would be like I would be so soft " - BBP P2

Another indicated the behavior of a health agent affected their level of comfort and willingness to seek advice and information, emphasizing the role tone of voice could

play in health interactions.

7.3.7 Trust in Chatbot

Participants did not express significant concerns regarding the accuracy of information or the privacy of their data in the context of a potential chatbot intervention. When asked directly, most participants expressed confidence in the chatbot's trustworthiness, largely due to the trust they had developed in the study's research team. This trust was established during the informed consent process, where I informed participants that the University of Cape Town was conducting the study and that the research team included a clinician. The affiliation with a reputable institution and the presence of medical expertise seemed to transfer a sense of credibility to the chatbot.

Some also indicated that their trust in the chatbot would be further reinforced if it clearly cited verifiable sources for its information. They saw the source's authority as the key determinant of whether to trust the information presented.

> "If, like, for instance, it quotes the reference of the doctor or maybe the researcher that's written there at the bottom when it tells you the information. OK, this information comes from 'doctor this and this.' Then, you can also go to Google and Google this doctor. OK, this is a legit doctor." - MMH P3

Citing credible sources was perceived as an essential factor in establishing trust. Participants appreciated the ability to independently verify the information, suggesting that transparency regarding the origins of the chatbot's knowledge base could increase user confidence.

When it came to privacy concerns, participants generally demonstrated a pragmatic approach. They expressed a willingness to share personal information if it meant receiving better, more personalized support. For some, the urgency of obtaining help for their child outweighed concerns over data privacy.

Participants also acknowledged that using a personalized chatbot would likely require providing additional details to receive more tailored advice. However, they viewed this as a necessary trade-off to get more relevant and specific information for their needs.

> "So if you choose personalized, you should be prepared to answer more questions and give more detail of what's wrong with your baby... because you want. To help your child, you need the help. Yeah. So that's why you are going onto the app." - BBP P3

Overall, the findings suggest that while participants valued data privacy, their need for accurate and personalized support outweighed those concerns. The key factor in establishing trust was ensuring that the information provided by the chatbot was transparently sourced and verifiable. By doing so, users would feel more confident in relying on the chatbot as a trusted source of support.

7.4 Findings W3

We shall now briefly outline some interesting findings from W3 that aimed to refine the prototype design before we implemented the intervention. Figure 7.7 shows one of the outputs of the paper prototype evaluation activity.

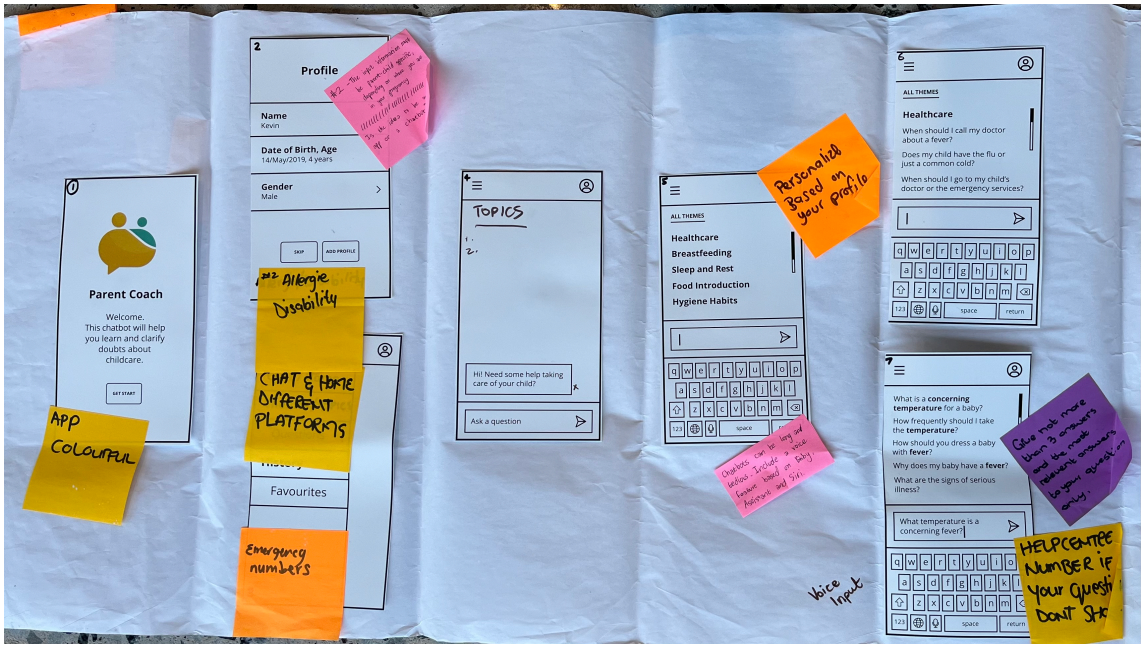

Figure 7.7: W3 paper prototype co-design feedback

7.4.1 Minimize user input steps

Participants expressed that they wanted as few steps as possible between their query and the eventual answer. When presented with our initial prototype wireframes, participants in Cape Town indicated that they did not want the chatbot to probe them with multiple steps/questions in a decision tree before it responded to their request. One participant suggested that voice input could also make their queries to the chatbot faster.

7.4.2 Limit search results

In the evaluation of the paper prototype, one participant annotated one of the wireframes depicting the search interface. They recommended that the number of search results be limited to a maximum of three according to their relevance so that a user would not be overwhelmed by choice. The rest of the participants agreed with this suggestion.

7.4.3 Allow user feedback and human agent support

Participants also desired the ability to communicate with a human agent to provide feedback and as an escalation mechanism where the chatbot had not satisfied their needs.

7.5 Discussion: Design Considerations

We shall now discuss the findings from the co-design design workshops as well as key design considerations for chatbots that I identified from an analysis of the findings.

7.5.1 Limited prior experiences with chatbots and user readiness for co-design

The parents involved in W2 generally had little to no prior experience with chatbots. During the co-design, when asked to draw sketches of their ideas and imagination of a chatbot to assist them with a health concern, some participants drew a list (menu) of questions while others drew a search bar.

This aligns with existing literature, which suggests that when unsure about new technologies, users seem to draw comparisons with familiar technologies they have interacted with to accomplish similar tasks, such as search interfaces [77].

The lack of prior chatbot experience presented an interesting dilemma for co-design. We assumed it would be difficult or even impossible for participants to co-design a technology they were completely unfamiliar with. To address this, I opted to reorder the workshop activities to perform demonstrations of sample chatbots first to give our participants a quick idea of what a chatbot was. However, this approach may have unknowingly constrained participants' imagination of what a chatbot could potentially be. This may have impacted their answers by focusing participants on features they liked in the two chatbots we demonstrated.

In Ocean View, there was an assumption that a chatbot prototype would be deployed on WhatsApp. This assumption likely resulted from the chatbot demonstration

activities where I presented two WhatsApp-based chatbots to participants. The demonstration may have limited the participants' imagination of what could be created during co-design.

The co-design workshops took place in early 2023, very shortly after the public launch of ChatGPT. In discussions within the ParentCoach consortium, we chose not to present chatbots using generative AI like ChatGPT. We reasoned that they would increase expectations in a direction we were likely unable to meet. This was because we could not reasonably guarantee the accuracy and appropriateness of the information provided by generative AI systems such as ChatGPT, which would increase the risk of misinformation. Further, we did not have any indication that we would have the technical capacity within our team to implement a generative chatbot in-house, especially given the ChatGPT Application Programming Interface (API), which was only launched in the months following our co-design workshops.

However, by excluding generative AI chatbots from the demonstrations, we missed the opportunity to gather participants' insights into that form of chatbot interaction. This exclusion may have limited their imaginations and expectations of chatbots in co-design.

For future studies, it may be beneficial to set aside sufficient and dedicated time to familiarize participants with new technologies to ensure they are ready for the co-design process, explaining what is and is not feasible for the present prototype design process. Nonetheless, using existing chatbots as a form of technology probe was still helpful in eliciting valuable insights from the participants and prompted ideas and contributions that might not have happened organically.

7.5.2 Designing for offline use

While digital interventions can potentially improve access, unequal access due to financial constraints and limited infrastructure can further amplify exclusion [27, 90]. Given the limited internet access within the target community, this challenge motivated us to develop an offline application. Implementing an offline app limited our use of existing Artificial intelligence Application Programming Interfaces (APIs) such as ChatGPT or DialogFlow, which use Natural Language Processing to interpret the user's message [80]. Since the app had to operate offline, all computations would need to be processed locally on the user's device, restricting our capacity to deploy complex models and algorithms in the prototype.

Ensuring the accuracy and quality of the chatbot responses is crucial given the recent advancements and popularity of Large Language Model (LLM) chatbots. Human oversight and additional quality measures are essential measures to mitigate the

risk of misleading information [100]. However, in our context, without consistent internet connectivity on client devices, we would also likely lack a real-time view of chatbot operations to monitor the safety and correctness of interactions. Considering this, we prioritized implementing a predictable behavior in the prototype intervention, eliminating the alternative of implementing generative AI methods for response generation.

7.5.3 Content Risks: Misinformation and Bias

One popular approach to match responses to users' exact queries is now using LLM chatbots. However, working in an area that could be termed as "sensitive HCI" [94] with vulnerable participants, we needed a guarantee of the validity and correctness of the information that the chatbot shared. LLM chatbots do not meet these criteria.

Open domain nonspecific LLMs may present the risk of perpetuating inaccurate information from open internet sources [100] as well as hallucinating and providing false responses to users [31]. There have, however, been various approaches to deploying LLM chatbots in healthcare. Domain-specific LLMs, such as ClinicalBERT and PubMedBERT, trained on medical data, have demonstrated exceptional performance [100]. Unfortunately, even when trained this way, LLMs may generalize poorly across different contextual settings due to bias in training datasets from which minority groups are often absent [93].

Considering this and that Portuguese, Zulu and many other African languages are low-resource languages with less robust LLM support, more work is required before the widespread use of LLM chatbots for healthcare, specifically in the global south. These key ethical considerations, such as data privacy and algorithmic biases, must be addressed for responsible AI deployment of chatbots in this domain [51].

Content Form: Multimedia content

Participants were aware of their technological constraints, which shaped their content form choices. While they preferred videos for demonstration and teaching, internet access constraints influenced the desire for text content. Text remains an effective content delivery form, with parents reporting that written information is easy to read and comprehend [4]. Further, the provision of written material is recommended to support verbal information passed to parents [84].

User input mechanisms

Allowing the user to type a very specific query could increase their expectation for a precise answer. Should the chatbot not meet that expectation, this could

lower user trust. A chatbot's ability to interpret users' requests correctly and reply with helpful information increases users' trust in it [77]. A chatbot needs to be able to interpret and generate a relevant response to gain their trust. One common technique to achieve specific and appropriate responses to a user's query is generative AI; however, this would not guarantee the correctness of the response in a high-risk domain such as maternal and child health.

Design for customizability and user locus of control

It is a priority for participants to be able to continuously design and customize their interactions dynamically as they use an app. This indicated to us that design preferences were often situational rather than characteristic of the participating group. The same user may prefer different options if asked the same questions at other times or in different circumstances.

Parents also preferred to initiate chatbot interactions themselves rather than being prompted proactively. This is tied to the finding that information access happens most often when the parent faces a present challenge.

7.5.4 Humanness of the chatbot

As discussed in Chapter 2, there are various ways to make a chatbot seem and feel more human-like. This comes with its own advantages and drawbacks. It can increase a user's expectations of the chatbot and heighten frustration when it fails. With this in mind, given the limited capabilities of our intervention, increasing anthropomorphism would likely have resulted in a mismatch in the user's expectations and the chatbot's ability, which has been seen to lower user satisfaction [44].

Since most of the participants had not used a chatbot before, it is not clear how they perceived gender and other human-like attributes in terms of chatbot interaction. The answers the participants provided suggest to me that their perception of these attributes was based on their interactions with humans. They then used these perceptions and experiences to imagine what they would prefer from a chatbot agent.

Gender can be introduced in chatbots by using identity cues such as assigning a chatbot a gendered name and visual cues like avatars [34]. In our study, the female gender was perceived by participants to be better at explaining, more knowledgeable, trustworthy, and empathetic. This aligns with literature indicating that female avatars are seen to create stronger perceptions of warmth, generosity, and kindness [79].

There are dangers in humanizing chatbots that should be considered [44]. Humans tend to see other humans as bad or good, pleasant or unpleasant. Therefore, a

humanized chatbot must have a personality that pleases its target audience. Additionally, since users often trust machines more than users to keep their information secure, humanized chatbots tend to decrease users' trust to disclose data [79].

7.5.5 User trust and privacy in chatbots

Participants stated that checking the source of the information was a way for them to establish trust in the legitimacy of the chatbot. This finding is consistent with the perspectives of clinicians who we interviewed in our study on trust in a chatbot.

However, interestingly, parents had few privacy concerns associated with chatbots. The parents expressed that the level of need for support could reduce the barrier of trust in interacting with an informational chatbot. This would mean that participants who lack informational support are vulnerable to misinformation and exploitation by unethical chatbot practices.

The lack of privacy concerns could indicate a high appetite in young parents to take up new technological tools. Despite not having interacted with them before, the participants demonstrated general receptiveness towards chatbots, which aligns with existing literature. A 2021 study found that women in low-resource settings believed mHealth could offer benefits during pregnancy by providing valuable tips and information on normal and abnormal pregnancy signs and saving them the cost of hospital visits [19].

With this in mind, it is essential to implement and enforce policies and regulations to protect these vulnerable parents from under-resourced communities in the digital age to ensure their safety.

7.5.6 Chatbot language preferences

Language considerations in a multilingual context

Language and communication are essential for equitable and effective health delivery in multilingual societies such as South Africa [24]. Our initial assumption going into the co-design workshops was that participants would prefer to interact with a chatbot in the language they spoke most frequently or were most fluent in. However, we found that English generally remained the preferred language. This preference can largely be attributed to the specific domain in which the chatbot was situated and the participants' use goals. Although participants had a more robust understanding of their native languages, they perceived these languages as less helpful in acquiring medical knowledge. This is because they did not often use their native language in its formal form and were not familiar with scientific and medical terms in their languages.

For this reason, users expressed that a formally correct way of explaining medical concepts in their native tongues would not necessarily be easier for them to understand. As is also seen in the literature, our participants perceived chatbots to be useful in preparing them for future interactions with health professionals [2]. Therefore, they did not perceive any benefit in learning medical terms in their native language, as healthcare interactions are typically conducted in English.

Interestingly, participants expressed the desire to toggle between their native languages and English during interactions with the chatbot. These findings suggest that being able to approach a concept from multiple linguistic perspectives could facilitate a better understanding. In literature, multilingual parents are seen to prefer accessing health information in various languages to improve their medical vocabulary and knowledge, which in turn empowers them to engage in their infants' health care and decision-making [56].

This multilingual approach is similar to the natural code-switching in everyday conversation by multilingual people, where speakers alternate between two or more languages in one utterance to enhance their communication. In South Africa, which is a multilingual country, code-switching is seen to be used "to affirm one's identity and sometimes social status", to compensate for the lack of proper or equivalent terminology in healthcare interactions, or expand on ideas or concepts that the recipient may understand better in another language[54].

These uses of natural code-switching highlight the potential value of designing a chatbot capable of supporting dynamic code-switching to enable more natural, flexible, and effective communication. However, this automated code-switching would be unlike natural code-switching in that this code-switching would need to be initiated and controlled by the recipient of the communication rather than the deliverer.

Desire for simple explanation accompanied by medical terms

Participants expressed their desire for easy-to-understand explanations for their queries. Interestingly, they desire not only to understand their current health concern but to grow their health literacy through it. The parents do not view simplification alone as beneficial in the long term. This is because it would not help them map the explanation to complex terms they would face in future interactions with health professionals. This aligns with literature indicating that users perceive chatbots as a tool for preparing them for interactions with their healthcare providers [1].

It is essential to ensure that the language used in a chatbot is accessible at varying levels of education and to consider pairing simple explanations with their corresponding medical terms to aid parents in learning and growing their health literacy.

7.6 Chapter Summary

In this chapter, we focused on co-designing a chatbot with parents. We began by conducting an initial co-design workshop where we gathered parents' perspectives on various interactive and personality characteristics of a chatbot.

From an analysis of findings from these activities, we observed key design considerations, including parents' preference for the English language in a chatbot in their multilingual context, a desire for simple explanations of medical terms, a desire for control over chatbot interactions, and customizability of chatbot features as well as perspectives on chatbot personality attributes.

The ParentCoach consortium then jointly analyzed findings and brainstormed to create a paper prototype. We evaluated this paper prototype with users in a second workshop, using their feedback to refine its design.

The insights uncovered from these activities, together with the considerations identified in phases one and two, form part of the justification for the prototype implementation that we explore in the next chapter. However, due to contextual constraints and the fact that this is a multi-regional, multi-site study that combined findings to come up with one prototype, the specific preferences of parents in Cape Town are not all directly reflected in the prototype implentation described in the nxt chapter. The prototype implementation rather serves as a tool to further elicit information from participants on the identified design considerations.

Chapter 8

Phase 4: Chatbot Implementation

8.1 Introduction

In the previous two chapters, we discussed key design considerations from interviews with clinicians, exploratory workshops with parents, and co-design workshops with parents. These discussions formed the basis of the prototype design and implementation we detail in this chapter.

We[1] developed a prototype design through a joint analysis of findings from the three previous phases by the ParentCoach consortium partners in Sweet Waters, South Africa, Cape Town, South Africa, and Porto, Portugal. We then validated our prototype design by presenting wireframes to parents in a co-design workshop (W3) conducted in Ocean View, where we intended to conduct our pilot feasibility trial. We refined our design based on our participant's feedback in W3. This refined design served as a basis for the prototype development described in this chapter. It serves as a sample implementation reflecting key design considerations identified in the previous phases of the study.

Though the prototype was to be evaluated in Portugal and South Africa, we elected to design an intervention for the lowest common denominator leveraging the "curb-cut effect" [69]. This refers to inclusive design that benefits even the needs of higher-resource communities when working with groups with distinct physical and socio-economic needs. For this reason, a discussion of co-design findings in South Africa is sufficient to capture the most significant part of our design justification.

[1]The term "We" refers to the ParentCoach consortium and gatekeepers for collaborative decisions and activities as described in Chapter 3.

8.2 Contextual Constraints for our design

In low-middle-income communities in South Africa, there is often limited internet access due to high prohibitive mobile data costs and, in some cases, poor network coverage. However, despite this, people employ different strategies to use the internet still [72]. Our co-design activities revealed that parents in participating communities in South Africa desired an intervention that would be accessible and affordable for them outside and within these strategies.

The ParentCoach study took place in three distinct contexts in South Africa and Portugal. Consequently, our corpus needed to cater to three languages our participating communities spoke: English in Cape Town, Portuguese in Portugal, and isiZulu in KwaZulu-Natal, while remaining contextually appropriate for both countries. IsiZulu and Portuguese are low-resource languages with limited Natural Language Processing models and few training datasets for building these models [32, 103]. isiZulu is an agglutinative language typologically distinct from the Indo-European languages for which many search and NLP algorithms are developed [59]. Further, available medical training datasets often lack data on minority groups, especially in the global south, increasing the possibility of bias in domain-specific Large Language Models (LLMs) [93].

Additionally, working with first-time parents of children less than a year old at what is often a stressful and sensitive time as they adjust to having a new child [42]. It was our priority to minimize any potential risks to them. One of the most significant risks we foresaw was misinformation from a chatbot, and we therefore prioritized guaranteeing the correctness and safety of information.

A popular approach to match responses to users' exact queries is now to use LLM chatbots. However, designing with and for vulnerable participants in MCH could be termed as "sensitive HCI" [94]. Therefore, we needed a guarantee of the validity and correctness of the chatbot's information. Open domain nonspecific LLMs may present the risk of perpetuating inaccurate information from open internet sources [100] as well as hallucinating and providing false responses to users [31].

8.3 Description of the intervention

Though we set out to investigate the design of a chatbot to support first-time parents, we did not end up building a chatbot due to the contextual constraints we have discussed. Our prototype, the ParentCoach app, is a question-and-answer informational resource presented in a chat-like user interface. The ParentCoach App is a multi-lingual Android mobile app that works offline and has the following main features, as shown in Figure 8.1 and Figure 8.2. Users can create a chat, browse through

the menu or search for questions, select a question to view its answer, save useful answers for future reference, and browse through and access emergency contacts.

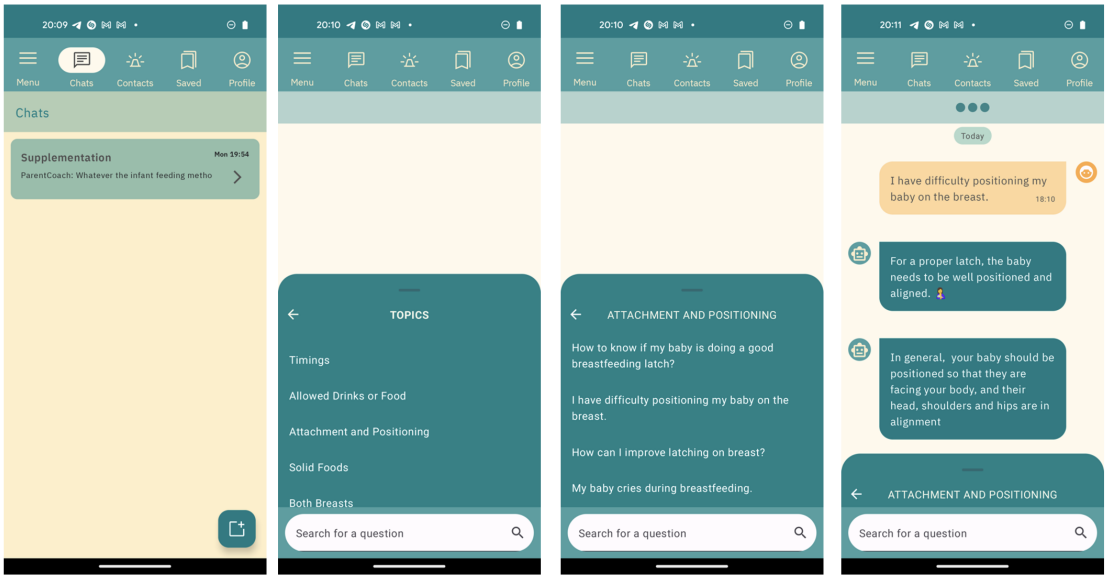

Figure 8.1: ParentCoach App "Chatbot" Flow Example

Since most smartphone users in the participating community of Ocean View use Android devices, I developed the app specifically for Android in Android Studio using Kotlin and JetPack Compose. As the ParentCoach consortium, we considered various options before making this choice.

With WhatsApp and Facebook being very widely used messaging platforms in Africa and globally [18, 82], they presented an opportunity to meet the technology users where they were using a social messaging-based intervention. However, we elected not to go in this direction due to the high running costs of Facebook and WhatsApp Business APIs, as well as the design guidelines enforced by Meta that would limit our design choices. Further, such an intervention would likely require users to have internet connectivity, which did not align with one of our primary design constraints.

Figure 8.3 outlines the app's architecture.

I implemented the app database using the MongoDB Realm library. Beyond the initial setup when an internet connection is required, the MongoDB library supports fully offline use and syncs data to the cloud whenever the mobile device has an internet connection. Using MongoDb allowed us to cater to our participants, who often only had intermittent internet access. The app data was stored on a local

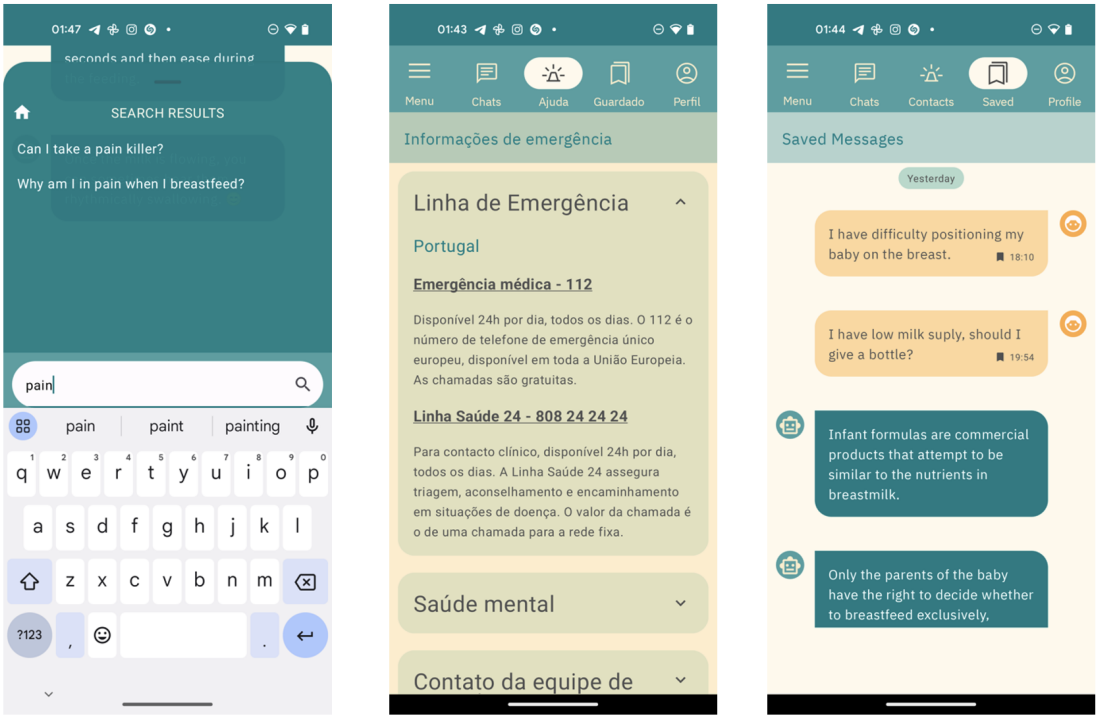

Figure 8.2: ParentCoach App “Chatbot” Features

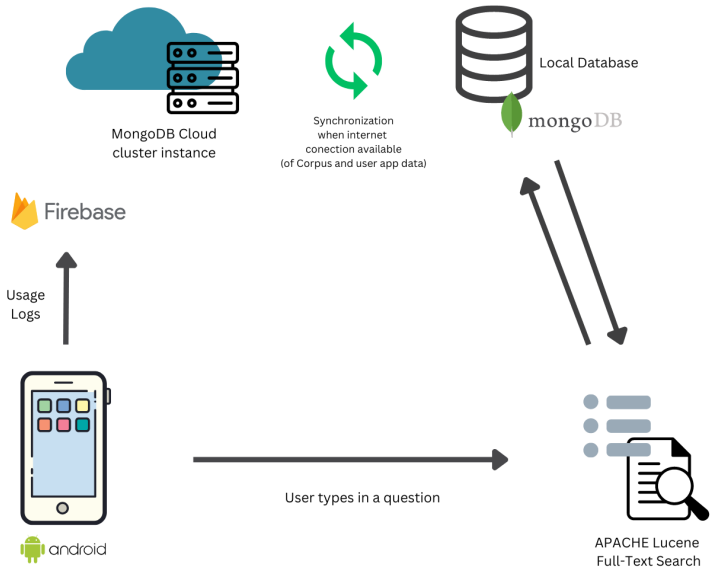

Figure 8.3: ParentCoach App Architecture

database on the user's phone linked to a MongoDB cloud instance that synchronized changes to the corpus whenever an internet connection became available.

I implemented usage monitoring using the Google Firebase Analytics library. It had a limitation in that it only fully guaranteed to sync locally cached logs for 72 hours. If our users were offline longer than this period, we could not guarantee that the logs would be synced. We also faced challenges configuring Google Analytics for our pilot feasibility trial, which resulted in not being able to analyze the logs across the sites conclusively. We, therefore, do not discuss this usage data in this dissertation.

I implemented the search functionality using Apache Lucene, an open-source Java library, an industry standard for rapid full-text search. It employs a reverse index of words in a corpus mapped to documents containing those keywords (in our case, words occurring in the corpus mapped to question-answer pairs containing those words) and returns them ranked by similarity [16].

We opted for primarily text content because multimedia would also have to be stored locally on the participants' phones, potentially increasing the size of the application significantly. Specifically in Ocean View, Cape Town phone storage was an important consideration for our user's mid-range Android devices.

8.3.1 Corpus structure and content presentation

Since we needed a guarantee of the validity and correctness of the information the chatbot shared with our participants, we structured our corpus into pre-defined question-and-answer pairs. We tied every piece of information to a specific question, making information inaccessible to parents in contextual isolation. This structure allowed us to provide the parents with context to information and minimize the likelihood that the intervention could present them with inaccurate or misplaced information. This approach differs from many AI-based chatbots that respond to free-text questions based on their interpretation of the question, introducing a degree of error. This poses a risk, given that user-formulated questions may not always be coherent and well-formed, resulting in poor interpretation by the agent and an inappropriate response.

We presented these question-answer pairs in a "chat-like" user interface to increase the familiarity of the application to participating parents. We broke answers into message blocks employing a delay between messages with a typing animation. We used this structure to make the information presented easier for users to read and digest, bearing in mind that message delays are also seen to increase the feeling of natural conversation for the user [60].

8.3.2 Content Navigation

The app provided two alternative ways to explore content. We offered a menu organized into subtopics relating to breastfeeding and a search bar where users could type in their questions to be matched to suggestions of questions contained in the corpus. In the menu, users could overview and explore content by selecting a breastfeeding subtopic and browsing through available questions that interested them.

We also offered a search bar where users could type in a query. This query was then matched to a list of suggested pre-defined questions within our corpus based on similarity. The app continuously repopulated the search results as users typed in their queries through a rapid full-text search to provide a quicker and more responsive experience.

8.3.3 Content Types

The app content was primarily text, employing emojis to add nuance to information delivery. Emojis can express a deeper range of emotions [79] and make generated chatbot responses more anthropomorphic and engaging, enhancing the users' experience. Though W2 participants favored video content for demonstrative skill

acquisition, they were aware that video content would likely result in higher mobile data costs and viewed text as a viable alternative form of content delivery.

8.3.4 Key User Interface choices

We opted to present the information in a chat-like conversational interface to leverage technology users' existing digital skills and habits today. Users spend most of their time on their phones on chatting applications, such as WhatsApp, Telegram, and Facebook [64], making these interfaces familiar and comfortable. We were able to take advantage of this without building a chatbot. Participants indicated the app was easy to learn and use even without extensive training, as we shall explore further in the discussion of our feasibility pilot trial findings.

8.4 Chapter Summary

In this chapter, we detailed the prototype design and implementation process, building upon the key design considerations identified through interviews with clinicians, exploratory workshops, and co-design workshops with parents discussed in the preceding chapters. These insights formed the foundation for the collaboratively designed prototype developed by the ParentCoach consortium, which was refined through a set of co-design workshops (W3), as described in Chapter 7.

This refined design was the basis of the prototype I developed, which serves as a tangible implementation to demonstrate and validate the key design considerations uncovered in earlier study phases. While the workshops surfaced participant preferences, the design of the application was shaped more significantly by contextual constraints uncovered during the research specifically in South Africa. These included limited and inconsistent internet connectivity, and multilingual requirements across the study regions, which introduced challenges for corpus development and interface presentation. As a result, the prototype was not designed to implement the preferences expressed in the workshops, as a product might. Instead, it served as a probe to test key design assumptions under these constraints and to further elicit usability-related feedback. Thus, the workshop findings informed the design indirectly by highlighting user expectations, while the actual application design was primarily driven by what was feasible within the constraints and aligned with the overall goals of the chatbot.

Some of the notable considerations that informed our design were the requirement to develop an offline intervention to cater to users with limited internet access, minimizing the risk of misinformation in a high-stakes domain, enhancing the ease of content navigation for parents, and leveraging familiarity of chat interfaces towards

aiding learning. Additionally, we prioritized creating an inclusive intervention that accommodates the distinct physical and socio-economic needs of under-resourced communities in South Africa.

The prototype described in this chapter was subsequently evaluated through a two-week pilot feasibility trial with parents, as discussed in the next chapter. There, we explore key findings from the trial and identify additional design considerations to further refine and enhance the intervention.

Chapter 9

Phase 5: Feasibility Pilot Trial

9.1 Introduction

In the previous chapter, we described the design and implementation of the ParentCoach App prototype, laying the foundation for its evaluation in a feasibility pilot trial. This chapter focuses on the feasibility pilot trial conducted to assess the app's usability, functionality, and overall effectiveness. The trial involved three key stages: an entry interview and onboarding process, a two-week trial during which participants used the app on their devices, and exit interviews to capture insights into their experiences.

We present findings from the trial, exploring information access patterns, the significance of content quality, chatbot structure, and personality, and how these influenced user engagement. Based on these findings, we discuss design considerations, such as improving corpus content, incorporating empathy, leveraging familiarity with social messaging app interfaces, and fostering trust. Finally, we highlight the trial's limitations, including content constraints and logging reliability.

9.2 Methodology

I recruited five first-time parents through our gatekeeper in Ocean View to participate in a two-week pilot feasibility trial of the prototype we [1] had developed following the analysis of our exploratory and co-design activities. However, two participants dropped off and did not complete the trial. Table 9.1 shows the demographic distribution of our participants.

[1]The term "We" refers to the ParentCoach consortium and gatekeepers for collaborative decisions and activities as described in Chapter 3.

Table 9.1: Feasibility Pilot Trial Participant Demographics

Category	Number of Participants
Age Range	
16-20 years	2
21-25 years	1
Child Age	
0-6 months	2
7-12 months	1
Gender	
Female	2
Male	1
Favored (Native) Language	
English	1
Afrikaans	2
Highest Education Level	
Middle School (Grade 7-9)	0
High School (Grade 10-12)	3

Data collection involved interviews with study participants conducted at the beginning, midpoint, and end of the trial to evaluate the prototype we developed.

Since the content we included in the prototype was limited to information on breastfeeding, we elected to include only parents with a child below the age of one year for whom this content would be most relevant. We onboarded parents individually, obtaining their written consent, conducting an entry interview, and demonstrating essential app functions to them. Throughout the trial, we collected metrics on app usage asynchronously using Google Firebase Analytics.

At the end of the two-week trial, we conducted exit interviews with participants to understand their experiences with the app. Two out of the five parents recruited did not complete the trial. They were not responsive to our follow-ups, and our community liaison and I could not ascertain the reasons for their drop-off.

Overall, parents across the three sites indicated that the interface was easy to learn and use, found responses valuable and easy to understand, and valued being able to save responses for later reference. However, they sometimes struggled to find exact answers relevant to their present parenting needs, which was frustrating.

9.3 Findings

9.3.1 Information Access Patterns

The participants' app usage was closely tied to their immediate informational needs. Participants explained that they typically turned to the app when faced with a specific challenge in caring for their child, seeking relevant information to address the issue at hand. Parents used the app as a targeted resource to find answers to specific questions at a given moment, highlighting the app's role as a tool for addressing immediate concerns.

> "When I go into the app, I am looking for a specific thing that I need, and I ask it [the app]" - OV P2

> "[I wanted] More [information] about like formula and because I didn't know. I was not in the right mind when they told me [at the clinic] that my baby is not gaining weight. So I went to the app while I was sitting at the clinic." - OV P1

This quote illustrates a scenario where a parent turns to the app for additional information during a stressful situation. In contrast, parents without immediate challenges reported using the app when they had free time away from caregiving responsibilities, work, and house chores.

9.3.2 Content is king

During our trial interviews, participants primarily evaluated the app's content before considering its interactive features. Our participants were more focused on whether the app provided the specific information they needed at the time rather than on how the app's design or presentation looked. This tendency to prioritize content made it challenging to refocus participants on discussing the app's interactive features, as they often defaulted to discussing whether the chatbot's content met their needs.

> "right now it's mostly about breastfeeding, so I would use it [in the future] when there is like [more] medical information and things like that" - OV P2

This, coupled with our finding that app usage was seen to be tied to parents' immediate childcare needs and challenges, posed an interesting challenge for us during the trials. Since we limited the app's content during the feasibility pilot to a single topic, it reduced participants' app usage frequency. Consequently, participants had fewer opportunities to engage with the app's features, limiting their ability to offer detailed feedback on those aspects. P1 expressed that she had fully explored the

app's content within a few days of the trial, which resulted in her not using it as much for the remainder of the trial period. It underscores the importance of content relevancy and volume to allow for an evaluation of the app's design.

Participants expressed a desire for a broader range of information beyond breastfeeding. One mother highlighted that the breastfeeding content would only be relevant to her if she had another baby, indicating a need for more diverse content as her child's developmental stage progressed. Therefore, the continued use of the ae appeared to depend on whether the content applied to their child's current needs.

Interestingly, the father (P2) was particularly vocal about the limitations of a breastfeeding-focused corpus. He emphasized that parenting involved much more than breastfeeding, citing teething as one of the primary challenges he was facing at the time. His objection may reflect his lesser connection to breastfeeding-related issues, which may resonate more with mothers themselves.

Other topics parents wanted information on included teething, caring for sick children, nutrition, and home remedies. These preferences reflect a broader interest in a holistic approach to parenting, underscoring the need for content that caters to the diverse challenges parents face as their children develop.

App content was perceived to be dependable and up-to-date

The app was seen as the preferred first point of contact for parents when they encountered challenges in caring for their children. Participants regarded the app's information as more reliable and up-to-date compared to suggestions from family or community members.

Participants favored the app's content when given the option between information from the app and advice from their immediate family or community. They attributed this preference to the understanding that the app's information had been reviewed and researched by a clinician on the research team, as explained during the informed consent process. In addition, participants perceived the childcare advice they received from older family members as outdated and believed it may not be relevant to current parenting needs.

> "Yeah, [I trust the app more] mostly because of the research done behind it. And my mother doesn't always know everything. Because they did stuff way different back then, and already things have changed." - OV P3

However, despite the trust they placed in the app, parents did not view it as a substitute for professional healthcare providers. They considered health professionals to

be more trustworthy and authoritative sources of information, believing that doctors should have the final say in any concerns regarding their child's health.

> "I would take this [app] information, but then again, to make sure that my baby is safe, I would go to the doctor. To be sure and to be safe, I'd go to the doctor" - OV P2

This underscores the distinction participants made between the role of a chatbot and the role of health professionals, particularly when it came to the safety and well-being of their children.

9.3.3 Chatbot structure

Menus aid in information discovery

Although the limited content sometimes did not fully meet the immediate informational needs of parents, the intervention still supported learning and the discovery of new information. Parents reported that even if they didn't find the exact information they were searching for, they often encountered suggested search queries or menu items that piqued their curiosity and provided valuable insights.

> "[when I searched] I didn't [always] find what I was looking for, but I found something else [that was useful] Yeah, so it was a mistake, but yeah" - OV P2

> "There was stuff that I wasn't looking for that I found. How can I say, [information] that I needed, not needed it, [information that I did not need] but that I found useful." - OV P1

These findings align with earlier findings from our co-design workshops (W2), where parents across the study sites shared that they do not always know what questions to ask upfront. As a result, they highly value guidance when querying important information.

Predefined questions in menus reduce the cognitive load of information retrieval

Some participants expressed that after using the app for a short period and trying out the search feature, they preferred scrolling through the predefined topics and questions in the menu. This preference stemmed from the menu options eliminating the need for the user to formulate a coherent search query or question to find information, thereby reducing the cognitive load associated with information retrieval.

> "Because it [the menu] was easier, I think, yeah, than me just typing in random stuff. Maybe it is easy [to other users], but [when I search], it doesn't really show [results] because of the words I'm using. So then I found out that it's easier to scroll through the topics." - OV P3

Similarly, the pop-up suggestions while typing a search query were noted to expedite the process of finding information. Users could quickly select a predefined question similar to their query without needing to finish formulating a query, streamlining the search experience.

Parents expressed a strong appreciation for the ability to save specific pieces of information they found through search or by scrolling through the menu. This feature allowed them to bypass the process of finding the same information again and provide convenience for reviewing content at their own pace the next time they opened the app.

The save feature also reduced the workload associated with using the app, as parents did not need to repeat the search process to retrieve a specific piece of content.

> "I think [my favorite] is the save [feature] because then I don't have to go back all the time. Yeah, and I can just go in there ... Yeah, because there's a lot of topics, so it will be confusing if you wouldn't have to save it. So I think that's very helpful." - OV P3

Furthermore, participants noted that saving information was useful for revisiting previously viewed content to learn from it. This finding aligns with our earlier findings from the clinician interviews, where they noted that parents often need to engage with a piece of information multiple times before fully understanding and absorbing it.

Familiarity with chat interfaces made the app easier to learn and use

Participants generally found the app easy to navigate and learn, citing its visual similarity to WhatsApp, a widely used social messaging app within their community. This resemblance helped participants quickly familiarize themselves with the app, as they could leverage their prior experience with chat applications.

> "I think they [parents in the community] would [be able to learn it] yes... because it's not that hard, it's almost like WhatsApp anyway, so it's easier to use." - OV P2

Additionally, participants appreciated how the content was divided into sections using multiple "chat bubbles" for each chatbot response. This format enhanced readability and made it easier for users to absorb and understand the information.

> "And it makes it easier like this. You just split the answers into different sections. Umm, it's more better like that for me because I don't like to read the whole time ... Yeah, I think that this, pointing out the facts, is more better than writing a long paragraph explaining what to do, so I like this." - OV P2

9.3.4 Chatbot Personality

Two participants (P1 and P3) expressed frustration with a particular response within the app's corpus. The response provided information about baby formula substitution but ultimately deferred the decision to the parent. The participants indicated that they wanted the app to offer more comprehensive information and a definitive recommendation. One participant even said they would have preferred a simple "yes or no" answer.

> "My baby didn't gain weight on my breast milk, so I tried searching on the app for information about the formula to see if it's healthy. But then... [the app] just said it's up to me. They didn't give me a clear answer, like whether it's healthy or not." - OV P1

The app did not feel like a parent "coach"

Participants acknowledged that while the app provided useful information, it did not feel as personable or supportive as they expected, based on its name, "ParentCoach".

When I asked what could have made the chatbot feel more like a "coach", P2 suggested that the chatbot could have read the responses aloud to create a more interactive experience. He noted that he enjoyed apps that included voice output and input.

P3 expressed that she would have wanted the chatbot to use more encouraging, warm, and personal language. She felt this would help to provide the emotional reassurance she needed as a mother, especially in times of high stress.

9.4 Design Considerations

9.4.1 Corpus Content and Structure

Content should be well aligned to the present needs of the target parents and their children

Our interviews revealed that parents opened the app primarily when they had a specific informational need related to a challenge they were presently facing. This

finding aligns with literature indicating that parents' knowledge-seeking occurs most often when they encounter challenging behaviors in their children [8].

Due to the limited content we included in the chatbot, parents did not always find the information they desired on demand. Over time, this content constraint limited how much participants used the app and possibly how much insight they could provide us on its usability.

The usability of a chatbot's interactive features seems inherently linked to the depth, relevance, and usefulness of the chatbot's content, making it difficult to measure either in isolation. Chatbot content itself can be viewed as the primary feature on which other features are built and are assessed by users [58].

To ensure the adoption of an informational resource and to retain parents as users, the content of the chatbot must be aligned to the present phase of their child's development and address the needs within that phase. This could prove a challenge for scoping a chatbot since the needs of both parent and child constantly evolve as the child develops. Parents' expectations need to be managed with regard to the chatbot's informational scope. Despite explicitly stating the bounds of the chatbot's information at the start of the trial, parents still attempted to query the chatbot to address their wider needs beyond just breastfeeding.

It could be argued that widely used search engines such as Google, with seemingly infinite bounds of knowledge, create a heightened expectation regarding information delivery through digital resources. Since inexperienced users have been seen to map their understanding of search engines to understand chatbots [77], this expectation for content can also be transferred.

Corpus Structure

The level of relevance of responses to parents' queries was also limited by our design choice, matching them to predefined question-and-answer pairs. In a predefined question-and-answer format, it may be beneficial to increase linguistic or lexical variability answer variability using methods for slightly adapting or reformulating responses to improve the human feel of the chatbot conversations [2].

9.4.2 Use menu options and query suggestions to aid information discovery

Our participants found the menu useful and easy to use. We found that predefined questions in the menus and search results perked users' interest and exposed them to information they had not initially thought of or intended to search for.

They also, at times, found that it reduced the need for them to formulate their own complete queries and, therefore, reduced the cognitive load associated with finding information. Even where input is typed, incorporating suggested frequently asked or similar questions can help parents struggling to word their query on a specific subject.

Predefined questions can also be a way to teach users how to structure queries to the informational resource. Especially in LLM chatbots such as ChatGPT, the quality of the prompt greatly impacts the quality of the chatbot's response and its usefulness to the user [26]. This consideration has prompted numerous prompt engineering classes on the internet. Providing examples of how to query an agent is one way to teach users to query it more effectively in the future. Our predefined questions could provide this learning.

We noted the importance of menu design for information discovery. The title of an overarching topic in the menu first needed to be relevant and of interest to the parent to spark engagement and curiosity. This underscores the importance of menu design in the naming and structuring of menu options to keep users engaged with a chatbot.

Allowing users a way to know the scope of content can let them know which questions they can and cannot ask and, in this way, reduce the chances of them asking questions or searching for content that the chatbot cannot provide, which could lead to frustration. In this way, menus can be a tool to maintain realistic expectations of chatbots, which has been seen to improve the user experience and, in turn, increase user satisfaction [36].

9.4.3 Incorporate empathy and human attributes

There was a desire for specific human-like attributes, such as voice output and tonal variation, to communicate empathy and guidance in the chatbot. Voice input and output may also have been expected due to how widespread it is in common social messaging applications used within participating communities.

9.4.4 Design to leverage familiarity of commonly used social messaging apps

The visual and interactive similarity of the interface to WhatsApp and other chat applications was expressed to improve the learnability of the app despite the fact that our app was not actually a chatbot or chat app. The study finds that it is still possible to access certain advantages of conversational user interface characteristics toward information delivery to parents without necessarily building a complex

chatbot.

9.4.5 Design to prioritize user trust and anonymity

It emerged that interacting with the app was preferred as a tool to ease anxiety and privacy concerns when asking for help from humans. This finding aligns with existing literature. Chatbots are perceived as nonjudgmental since they make no moral judgments about the information the user provides, so users may be more willing to disclose socially undesirable information [22]. A study on chatbots for breastfeeding indicated that mothers found a chatbot to be a more comfortable option for seeking advice on private questions as compared to physicians or others [99]. In this way, chatbots can help ease the effects of stigma and obstetric violence against teenage parents reported in our exploratory workshops and help them be more comfortable seeking information.

Participants also expressed a desire for a more empathetic tone and language and voice output to make the chatbot feel more personable. Existing literature emphasizes incorporating empathy to build a relationship with the user and provide emotional support [2]. This speaks to the importance of human-like qualities for parents to feel like a chatbot is guiding them.

Where there is integrated human involvement in the chatbot, such as telephone helplines and live human chats, it is also important to state explicitly the identity of the provider and to assure users of the anonymity and confidentiality of the interaction, especially where sensitive health-related topics such as mental health are concerned. One participant expressed her fear that somebody could trace her query on mental health back to her. We could have addressed this concern by ensuring the participants clearly understood the external resources the app was directing them to.

9.5 Limitations

While this research culminated in the design and evaluation of an initial co-designed prototype in a two-week trial, its findings needed further verification. A longer one-month trial involving 55 participants in Portugal and South Africa was conducted to address this, incorporating prototype adjustments based on the pilot trial findings. The findings of this one-month trial are not within the scope of this dissertation.

9.5.1 Usage logging reliability

For the duration of the pilot trial, we monitored participants' usage through the Firebase Analytics library. Without an internet connection, this library only reliably caches logs on the phone storage for up to 72 hours, after which reliability is not guaranteed. In the feasibility pilot, where participants were offline for longer periods without internet connectivity, we faced issues syncing the usage logs and possibly lost some user usage data. Many monitoring libraries available, such as Firebase analytics, while designed to work with intermittent internet connections, are not guaranteed to be reliable during extended offline periods, as we find in the low-income areas of South Africa.

9.5.2 Chatbot content limitations

The scope of our study did not include the generation of a new corpus, which limited the depth of our reused corpus. It may be beneficial for future chatbot usability studies to consider allocating specific resources to corpus generation due to this linkage between content and usability.

9.6 Chapter Summary

This chapter detailed the findings of the feasibility pilot trial for the ParentCoach App prototype, which assessed its usability and effectiveness in supporting first-time parents. The trial involved entry interviews and onboarding, a two-week usage period, and exit interviews to capture participant feedback.

Key findings revealed parents' patterns of accessing information, the need for high-quality, context-specific content, and preferences for chatbot structure and personality. These findings informed several design considerations, including refining content organization, incorporating menu options and query suggestions for improved navigation, and adding empathetic, human-like attributes to enhance engagement. The importance of leveraging the familiarity of social messaging apps and prioritizing user trust and anonymity also emerged as critical.

The chapter concluded by acknowledging limitations, such as issues with usage logging and content constraints, and recommended areas for future refinement, contributing to the continued development and improvement of the ParentCoach App.

Chapter 10

Conclusion

This dissertation explores the co-design of a chatbot to support first-time parents. Through a multi-phase process that included clinician interviews, exploratory workshops, co-design workshops, chatbot implementation, and a feasibility pilot trial, this research provides valuable insights into the potential of chatbot interfaces to complement existing healthcare systems in South Africa.

The first research objective examined the implications of clinicians' perspectives, parents' informational needs, learning experiences, and patterns in the design of a parenting advice chatbot. Findings emphasized the importance of designing chatbots with empathy to support vulnerable parents, ensuring chatbots complement rather than replace health professionals, and designing for clinician trust by referencing credible sources and seeking endorsement from reputable healthcare entities. Furthermore, enabling repeated access to information to enhance parents' information retention and leveraging existing informational resources to generate chatbot corpora emerged as critical considerations.

The second research objective investigated community perceptions of chatbots. Co-design workshops revealed that the majority of our participants had never interacted with chatbots before. This unfamiliarity limited their ability to imagine and co-design a parenting chatbot and highlighted the importance of adequately preparing communities to co-design technologies that they are unfamiliar with. Despite this unfamiliarity, parents generally showed an appetite for adopting this new technology and perceived that it could benefit them.

The third research objective focused on parents' perspectives regarding chatbot design modalities and adapting the chatbot to meet community-specific needs. Insights from the co-design workshops identified key design considerations, including the importance of supplementing multilingual environments with English content, balanc-

ing simple language with medical terminology to enhance health literacy, enabling user-initiated interactions, and offering customizable features to improve inclusivity and satisfaction.

The resulting ParentCoach App prototype that was a "not-so-chatty" chatbot [58] prioritized ease of navigation, offline functionality, and content safety, mitigating risks of misinformation. The feasibility pilot trial of this prototype brought out the need to align chatbot content with parents' immediate needs to encourage sustained usage and the importance of good menu interface design to aid information discovery in menu-based chatbots. Additionally, it demonstrated the viability of leveraging familiar social messaging interfaces to enhance information delivery even without fully interactive chatbot features.

My work highlights the potential of co-designed digital tools to bridge gaps in healthcare support for new parents in South Africa. Future studies investigating chatbots should dedicate time and resources to corpus content development, as content quality significantly influences user engagement. Future work exploring safe, offline, natural language processing (NLP) models for low-resource languages could also increase chatbot feasibility in under-resourced, multilingual contexts. This research underscores the transformative role co-design can play toward addressing healthcare challenges in diverse socio-economic settings.

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Appendix

Interview Scripts

Interviews with Clinicians

Context

1. Can you tell us about your experience working with children and their parents?
2. Can you describe a typical day at the clinic?
3. What are usually the follow-up processes of children?
4. Do you work with other professionals at the clinic? What are their roles?

Challenges of caring for the health and wellbeing of children

1. Can you tell us what brings parents to your appointment? Are there some health issues that appear more frequently at your clinic?
2. Can you tell us about the challenges of the parents from your community when caring for children's health and wellbeing?
    - Do parents also identify these as their main challenges? Any differences?

Knowledge and learning

1. What would you say are the most crucial aspects that first-time parents need to learn to ensure their children's health and wellbeing?
2. Can you tell us about the most common myths from the parents that visit you?
    - Do you have an idea of where [myth] comes from?

- What is the impact myths cause? Do parents move away easily from those myths after coming to the clinic or do they stick to them usually?

3. Considering your experience, how would you say first-time parents learn to care for the health and wellbeing of their children?
    - Are there some people that they resort to for information or advice? Who?
    - Are certain websites that they usually search or look for?
    - Any other kind of resources?

Role of clinician or clinic in learning

1. Are there tips or recommendations you usually mention to parents?
2. Do you or your clinic support parents in learning to care for the health and wellbeing of their children?
    - Do you provide parents with pamphlets, web pointers, or other resources?
    - Are there materials from other institutions you usually recommend to parents?
    - Do you provide advice on where to find appropriate materials?
    - What makes a particular resource good for parents to learn with?

Wrapping up

1. Is there anything you would like to talk about that we did not touch?

Demographic Data

- Age
- Occupation
- Professional Status
- Years of experience

Feasibility Pilot Trial Entry Interview

Characterisation

- Age

- Age of youngest child
- Gender
- Country
- Native Language
- Other languages spoken
- Highest level of education completed
- Job

Smartphone Proficiency

1. Do you use your smartphone on a daily basis?
2. Do you usually install apps?
3. What are the apps you use the most?
4. Do you use any apps related to parenting or childcare?

"Chatbot" Experience

1. Have you ever used a chatbot? Can you tell us more about that?
2. (For South Africa) Have you/Do you use MomConnect? Can you tell us more about your experience?

Expectations

1. What are your expectations for this trial?

Feasibility Pilot Trial Mid-Point Follow up Interview

1. Can you tell us about your experience with ParentCoach so far?
2. Were there any specific topics or information that you expected the app to cover but did not find?
3. In what circumstances did you use the app? Can you give us two examples?
4. Can you give us an example of a situation when the app was useful for you?
5. Can you give us an example of a situation when the provided responses were not relevant to your concerns?

6. I can see you used the app more during these days [date]. What motivated you?
7. I can see you used/did not use the option to send messages to improve the system. In your opinion, does that feature make sense?
8. I can see you saved some logs. Did you use them later? Does that feature make sense to you?
9. If you had to choose something for us to work on that could improve your experience until the end of the trial, what would it be?

Feasibility Pilot Trial Exit Interview

General Experience

1. Can you tell us about your experience with ParentCoach?
2. Did you find ParentCoach's responses to be helpful and informative?
3. If you had to identify a problem, what would it be?

Use of the app

1. In what circumstances did you use the app? Can you give us two examples?
2. Can you give us an example of a situation when the app was useful for you?
3. Can you give us an example of a situation when the provided responses were not relevant to your concerns?
4. Can you give us an example of a situation when you felt you would benefit more from human assistance?
5. Can you give us an example of a situation when the app surprised you?

Specific to the System

1. Were there any particular features or aspects of the app that you particularly liked? If so, which ones?
2. Were there any features or aspects of the app that you found less helpful or would like to see improved?
3. Were there any specific topics or information that you expected the app to cover but did not find?

Patterns

1. In what time period did you usually use the app? Is there any reason why you used it more around that time?
2. I can see you used the app more during these days [date]. What motivated you?
3. I can see you used/did not use the option to send messages to improve the system. In your opinion, does that feature make sense?
4. I can see you saved some logs. Did you use them later? Does that feature make sense to you?

Usability

1. Was the app easy to use or too complex?
2. Did you feel like you need the support of a technical person to be able to use the app?
3. Do you think most people would learn to use the app quickly?
4. Did you find the look and feel of the app pleasing?

Final Questions

1. Would you consider using the ParentCoach App in the long run?
2. Would you recommend it to other parents?
3. Was there anything that we did not discuss and that you want to add?

Joint Analysis and Affinity Mapping Process

Figure 10.1: Affinity Map for Co-design Workshops

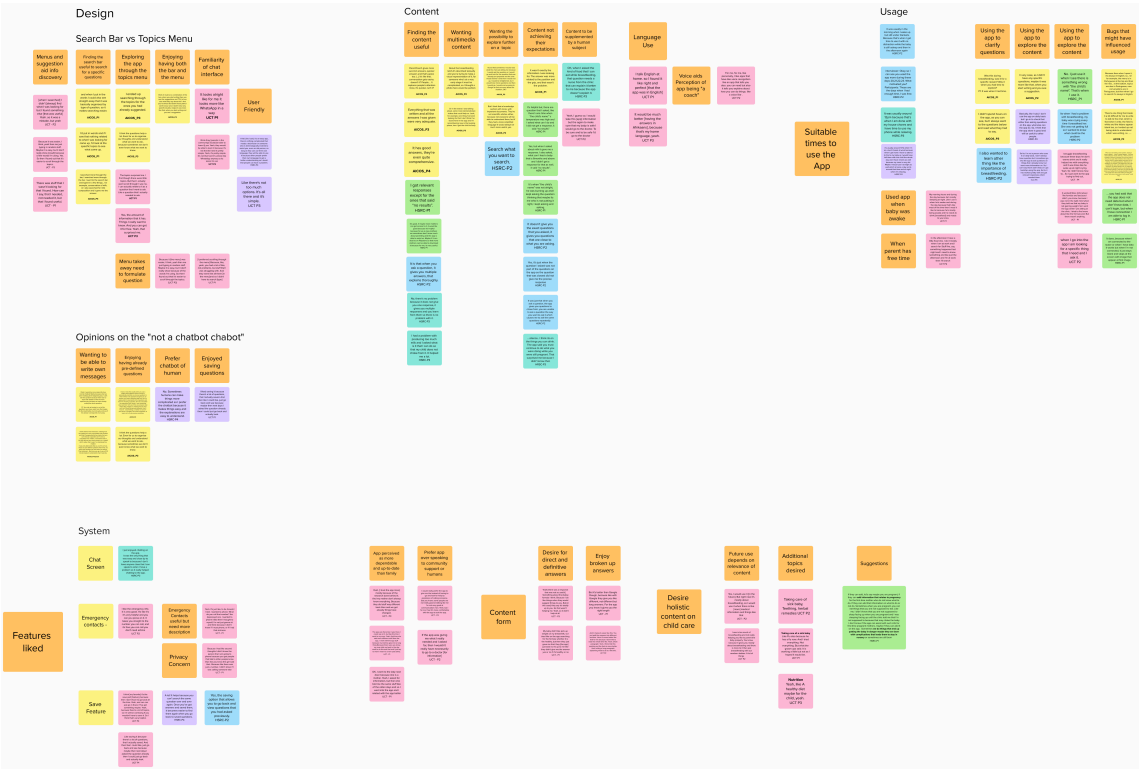

Figure 10.2: Feasibility Pilot Trial Affinity Mapping

Figure 10.3: Exploratory Workshop (W1) Coding