



"Everyone Brings Their Grain of Salt": Designing for Low-Literate Parental Engagement with Children's Literacy in Côte d'Ivoire

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ABSTRACT

Significant research has demonstrated the crucial role that parents play in supporting the development of children's literacy, but in contexts where adults may lack sufficient literacy in the target language, it is not clear how to most effectively scaffold parental support for children's literacy. Prior work has designed technologies to teach children literacy directly, but this work has not focused on designing for low-literate parents, particularly for multilingual and developing contexts. In this paper, we describe findings from a qualitative study conducted in several regions of rural Côte d'Ivoire to understand Ivorian parents' beliefs, desires, and preferences for French literacy. We discuss themes that emerged from these interviews, surrounding ideas of trust, collaboration, and culturally-responsive design, and we highlight implications for the design of technology to scaffold low-literate parental support for children's literacy.

KEYWORDS

Literacy technology, family literacy, mobile literacy, ICTD

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1 INTRODUCTION

Decades of research into early literacy learning has demonstrated the crucial role that parents and other caregivers play in supporting their children's literacy [50, 81]. This support may take the form of explicit instruction of letters [29] or joint reading activities [53]. In addition, parents and other adults in the home environment also model productive learning attitudes or dispositions [15], provide a supportive socio-emotional environment or "secure base" in which children may develop literacy [68], and provide a stimulating language environment for their children [31]. However, in low-resource contexts where overall adult literacy is low and the home environment may have few reading materials, and in multilingual contexts where children are developing literacy in a language their parents may not be literate in [43, 96], parents may not be able to effectively support children's developing literacy at home [61].

Low-resource contexts present unique challenges for families to support in-school education at home. Côte d'Ivoire is one such context, where adult literacy rates (53% of adult men and 33% of adult women [56]) lag far behind the regional and global average. In addition, children enter the Ivorian school system at highly varied levels of early literacy, speaking a wide variety of mother tongues in addition to (and often instead of) French [37, 83]. These educational challenges may compound the cycle of low adult literacy, particularly for families where adults may feel disenfranchised by not speaking the official language [92]. However, the high mobile phone penetration in Côte d'Ivoire, as in

many developing contexts [55], suggests there may be opportunities to supplement in-school literacy instruction with additional support for family literacy [7, 16, 91].

There has been significant prior work in designing mobile literacy systems for low-resource contexts [47, 48, 71], but with few exceptions [75, 97], these systems focus on the child alone, and do not engage with the parents or other adult supporters in the home environment. The systems that have included scaffolds for parental support have primarily targeted literate parents in Western contexts [75, 97]. Additionally, while prior work has designed technologies for low-literate users [58, 59, 65, 73, 74], these systems have often not been designed to support family learning.

Thus, there remain significant open questions around design considerations for literacy systems to scaffold low-literate parents in supporting their children's literacy development, particularly for bilingual families in low-resource contexts. In this paper, we describe findings that emerged as part of a larger research program on literacy in cocoa production communities, with a focus on educational stakeholders (e.g. parents, children, teachers) in rural Côte d'Ivoire. In this paper, we report on findings from nearly 60 hours of semi-structured interviews and storyboard "speed-dating" [18] with parents and adult caregivers in three Ivorian villages.

This paper contributes to a larger conversation around designing for the robust social ecology of the home learning environment, as well as contributing at the intersection of the learning sciences, human-computer interaction, and technology for development, with a focus on designing for low-literate families in low-resource contexts. We contend that designers of literacy systems should attend to the larger socio-economic context and implications of multilingualism, the relationships between parents and schools, and parents' beliefs, attitudes, and desires for their children's learning. We highlight themes and implications for designing literacy technologies, including designing for multiple members of the family learning ecology and aligning with families' existing literacy activities, findings situated in the context of Côte d'Ivoire, but with implications for similar contexts.

2 RELATED WORK

Parents and the Social Ecology of Learning

Significant prior research in child development has demonstrated the crucial role that parents play in literacy acquisition [50]. In addition to the benefits of the *instrumental* support of book reading and letter naming [29, 53], parents provide *metacognitive* support for maintaining children's attention and scaffolding self-regulation [50], as well as *motivational* and *dispositional* support by communicating to children that literacy-building behaviors have value [15, 68]. Such socio-emotional scaffolding has been described as the

"secure base" that parents and adult guardians provide for learning, where children feel supported in taking risks [68].

Parents' socio-emotional support is only one part of what some have referred to as the "ecocultural" context for learning. In this model, children's development is a co-constructive process, involving individual factors (e.g. self-efficacy, goals, beliefs), interpersonal factors (e.g. relational support from peers, parents), and socio-cultural factors of the larger home environment and community context (e.g. local political and economic conditions, cultural norms) [43, 87]. For parents with low or nonexistent literacy in the target language - or for parents with low self-efficacy for their own literacy [34] - instrumental support (e.g. book reading, letter naming) may be particularly difficult [27, 52, 90]. Prior work suggests that low-literate parents can be supported by intergenerational family literacy training [7], but in low-resource contexts, it is not clear that such programs will be accessible for parents.

Mobile-Based Literacy Technologies

A meta-analysis of the impact of educational interventions in Sub-Saharan Africa found the largest effect size for adaptive (or, personalized) learning when compared against other interventions (e.g. investing in class sizes, meals, student incentives, etc) [16]. There have been many adaptive learning technologies recently designed for low-resource contexts, with some using tablets [88] or e-readers [76]. For instance, Ojanen et al. developed a mobile app for 3G smartphones to teach children to recognize phonemes and map letters to sounds [64]. Others, such as Kumar et al., developed voice-controlled literacy apps for rural India, incorporating local cultural knowledge into games to encourage students to read words aloud [48], while another quizzed students in Zambia on the written form of various phonemes in ciNyanja [38].

Some mobile literacy systems, such as MobiLiteracy [71], Ready4K [97], and Sesame Street [75], have sent reminder messages for parents to teach letters, read stories, or teach literacy lessons [71]. However, while some of these studies did increase parents' frequency of joint reading [97] and letter-naming [75] activities, others described an inverse relationship between time parents spent teaching the system's lessons and time spent engaging in their previous literacy activities, such as reading to their children [71], suggesting more design work is needed to understand to avoid supplanting parents' existing literacy activities. Further, these literacy systems that do involve parents in the intervention often require that the parents themselves are sufficiently literate, either to read the reminder messages sent via SMS [75, 97] or to teach the lessons provided [71]. In many low-resource contexts, however, parents may not have sufficient literacy to benefit from or even use such support.

Designing for Family Learning

Prior work in the CHI and IDC communities has highlighted the importance of incorporating families into the design process of learning technologies, from Yip et al. who identified how parent-child relationships impact the co-design process [95], to Wong-Villacres et al. and Khanipour et al., who identified design guidelines for parent-school engagement in low socio-economic communities [46, 92]. As others have argued, socio-economic factors are likely to intersect with other aspects of parents' identities (e.g. race, gender, etc) to influence how they engage in their children's learning [93, 94]. Prior work has identified the various roles parents of different socio-economic strata play in accessing information about out-of-school learning experiences for their children [22], and the roles English language learning parents play in engaging with their children learning programming [4] and using technology [43]. This suggests that even when parents may not have the domain knowledge to provide instrumental support, they may still play the role of resource broker, mentor, or even collaborator or co-learner [4, 6, 22]. This body of prior work highlights the importance of attending to the learning ecosystem that bridges home and school learning environments. This approach may be particularly useful in understanding how to scaffold low-literate parental support in low-resource, developing contexts such as Côte d'Ivoire.

Designing for Low-Literate Users

Prior research on designing mobile interactions for low-literate users suggests that voice-based interactions are the most effective [59], with existing approaches typically focusing on either speech recognition-based systems, as in the SMART system [48], or interactive voice response (IVR) systems - as in the widely-used Baang and Polly systems [73, 74]. IVR systems have been widely studied in the CHI and ICTD communities [54], particularly for their effectiveness in engaging low-literate rural users, as in work on voice forums for agriculture [65], grievance redressal [58], and community radio [44], among many others. However, this prior work on IVR systems for low-literate users has primarily targeted adults as the users of the system, and has not addressed how to design for parents engaging with their children's learning.

Another line of work has explored the role of technology "intermediaries" who assist the primary user in operating technology [41, 42, 63, 80]. In their study of information-seeking in urban slums in Bangalore, Sambasivan et al. identified design considerations for low-literate users who rely on intermediaries to help them access information on their devices [80]. In designing for low-literate parental support for literacy, it may not be clear which user (e.g. parent or child) is the intermediary and which is the primary user, as Yip et al. found in their work on youth "information brokers"

helping their parents access information in bilingual Latino communities [96]. Particularly in contexts where the official language of instruction may not be many people's first language - as in French in Côte d'Ivoire [83] - the national language policy may further disenfranchise adults in rural populations who only speak local languages [1, 8, 14, 67]. Differences between parents' language and the official language of schooling may result in parents feeling like they lack the cultural capital [9] to engage with schools [34, 92].

In sum, while substantial prior work has demonstrated the importance of parents' role in the social ecology of early childhood literacy acquisition and shown how literacy technologies can supplement this role, such systems are often designed exclusively for the child, and do not account for the challenges of scaffolding low-literate parental support. Meanwhile, prior work in designing technologies for low-literate adults in developing contexts has not typically focused on family learning. Given the low literacy rates of adults in many developing contexts, it is important to understand how the particular beliefs, values, and goals that low- and non-literate parents have for their children's literacy may shape the design of literacy technologies that can scaffold parental engagement in their children's learning. To address this gap, we propose the following research questions:

RQ1: How might the design and deployment of a literacy system in rural communities in Côte d'Ivoire be impacted by parents' beliefs, values, and goals for children's literacy?

RQ2: What are design guidelines for a literacy system to scaffold low-literate parental engagement in children's literacy in rural communities in Côte d'Ivoire?

3 CONTEXT

This study is part of a larger research program on literacy in cocoa farming communities, conducted by an interdisciplinary team of American and Ivorian psychologists, linguists, economists, sociologists, and computer scientists, which began in 2016, in partnership with the Ivorian Ministry of Education [36, 37]. To understand the particular beliefs, preferences, and design guidelines for low-literate parent-scaffolding literacy systems, we conducted a qualitative study of educational stakeholders (parents, children, teachers), in several regions of rural Côte d'Ivoire.

Site Descriptions

Regional overview. This phase of the study was conducted in three villages in two rural cocoa producing regions in south-east and south-west Côte d'Ivoire - two villages in the Adzopé region, and one village in the Soubré region. As of the most recent census in 2015, the village we visited in Soubré had 2,822 inhabitants, one in Adzopé had 6,619 inhabitants, and the largest, also in Adzopé, had just over 24,610 inhabitants [19, 20]. While French is the official language and the one

in which business is conducted, there are over 60 languages actively spoken in Côte d'Ivoire. Only 6.9 million of the 23.7 million Ivorians speak French, and of those, 6.8 million speak it as their second language [83]. In our research sites, the primary ethno-linguistic units spoken by the populations is Attié in Adzopé and Bété in Soubré.

Infrastructure and Economy. The rural economy of the south-east and south-west regions is largely dominated by cocoa production. In the Adzopé region, 57% of 122 children surveyed in an earlier phase of this research reported working on a cocoa plantation, while in the Soubré region, 41% of 106 children surveyed reported working on a cocoa plantation. Additionally, in Soubré, many people cultivate rubber in addition to cocoa farming, as an additional source of income [45]. 80% of the population of both regions are connected to the national electricity grid and have cellular coverage from the three major Ivorian mobile operators - Orange (42%), MTN (34%) and Moov (24%), with technological equipment for 3G+ internet access [21]. In addition, despite its small size, the village in Soubré has a radio tower and broadcasting station, and an agro-industrial latex processing factory.

There are also significant regional differences in socio-economic status at a household level, as indicated by results from a household inventory index given as part of an earlier phase of this research, with items asking about household amenities (e.g. television, running water, etc). Households in Soubré reported having significantly ($t(330)=4.977, p<.001$) more household items ($M=6.52, SD=2.42$) than households in Adzopé ($M=5.15, SD=2.45$), though populations surveyed in both regions commonly use mobile phones: 88% (Adzopé) and 89% (Soubré) of 334 children surveyed in the two regions reported having a phone at home. In Soubré, while 97% of children surveyed lived in homes with electricity, 81% with running water, and 36% with toilet facilities, only 83% of the children surveyed in the Adzopé region reported living in homes with electricity, none reported having running water at home, and only 20% reported toilet facilities.

Educational Context. In Adzopé, both villages we visited each have five schools, including primary schools that teach in French and, in one village, one school that provides bilingual education for early grade levels for learning in both the local language (Attié) and French. Though French is the official language of instruction, as in many Francophone West African countries [8, 14], the Ivorian government recently instituted a program (PEI) to teach in the mother tongue at early grade levels and transition to the French language over time [10]. However, that policy has not had full implementation in all schools in Côte d'Ivoire. The schools in these two villages primarily use teachers hired from the local community, paid for by members of the community via a community fund. In Soubré, the village we visited also has

three primary schools, one of which is dedicated to learning in the local Bété language in addition to French. All of the schools in the three villages in this study are public schools, under the authority of the national government. In general, education is free for all children aged 6 to 15 throughout the country. However, parents are expected to pay for various other educational expenses for uniforms, school supplies, contributions for the examinations, and payments for the local community-school association, COGES (Management Committee of Public School Establishments).

In an earlier phase of this research, 830 students aged 6 to 14 years ($M = 9.56, SD = 2.13$) were assessed for their literacy levels, finding that across each of the 3 sites discussed in this paper, children were below grade-level expectations for reading fluency [37]. That study used the Early Grade Reading Assessment (EGRA) tool, with performance standards based on other French-speaking African countries (e.g. Senegal). The minimum level expected for students to be on-track for literacy is between 45 and 60 words per minute for a Grade 3 student in the French version of EGRA [2, 72]. However, we found that across our 3 sites, children at grade 5 are reading significantly below this level, with students in one village in Adzopé reading an average of 11.7 words per minute (wpm) ($SD=13.58$), students in the other reading an average of 14.7 wpm ($SD=15.66$), and students in the village we visited in Soubré reading an average of 26.11 wpm ($SD=18.88$). Students in the Soubré village we visited are closest to reading fluency, though they still remain significantly below regional literacy levels, and many students in both regions were not able to read a single age-appropriate word [37].

4 DATA COLLECTION

To understand the design considerations for parental support for literacy systems, we conducted semi-structured interviews, storyboard speed-dating, and prototype tests with children, parents, and teachers in the three villages we worked in. We worked closely with the directors of schools, the village chiefs, and the head of the local parent-teacher association (COGES), to ensure that our study would adhere to local norms for meeting with children and families. Throughout April and May 2018, we spent several weeks in these communities, collecting over 60 hours of audio and video data, not all of which is reported on here.

Participants were recruited through a combination of identification by the head of the COGES, as well as a convenience sampling of walking through the village, and knocking on the doors of the families who were home, both during weekdays and weekends, to ensure that parents would be available. Our team was comprised of HCI researchers, Ivorian linguists, as well as an interpreter from a nearby village in the region, who translated the local language (e.g. Attié in Adzopé, and Bété in Soubré) for parents who had difficulty with French.

For the study reported here, we conducted interviews with 17 parents (7 in Adzopé and 10 in Soubré), from 13 families - until we reached saturation on the questions we were asking. We interviewed 10 fathers and 7 mothers, with ages ranging from 25 to 53 ($M = 35.33$, $SD = 9.66$). Fathers' occupations were mostly farmers of cocoa or rubber, while several of the mothers were bakers, and one mother sold food at the local school. All parents were bilingual, with Attié or Bété as their primary language. Most spoke enough French to conduct the interview partly in French, though portions needed to be translated to the local language to explain certain concepts. Two parents spoke only Attié, and two only Bété during the interview, with one speaking only Baoulé. Unfortunately, we were not able to collect data on parents' literacy levels in this study, but we intend to for future work.

Each session length, including the semi-structured interviews and storyboards, was between 45 and 90 minutes. We attempted to interview parents individually whenever possible, though for some families the husbands requested that we interview them and their wives together. The interviews were conducted around a set of themes relating to parents' daily life with their children, parents' and children's use of mobile phones, and parents' beliefs about and involvement in their children's education, among others. Following the semi-structured interview, we showed parents a set of storyboards to exemplify possible interactions and explore divergent design concepts, asking parents about their preferences for the design concepts. We follow [18] in using a *speed-dating* approach to presenting structured comparisons of design concepts, to allow the juxtaposition of alternative designs to surface preferences and design considerations that might be otherwise missed [18]. All sessions were transcribed and translated prior to analysis. An example of a storyboard session can be seen in Figure 1.

5 DATA ANALYSIS

To understand the most salient themes from our data, we adopt a grounded theory method for qualitative data analysis from Strauss and Corbin [13, 84], an abductive reasoning method that leverages curiosity and surprise as analytic tools to allow meaning to emerge from the data [60]. We follow an iterative approach to thematic analysis, engaging in four primary levels of analysis of the data: beginning with open coding of the raw data, then generating axial codes that capture a more abstract representation of the data, then organizing those axial codes into a set of categories, which, finally, are summarized by "core categories" [84], such as parents' beliefs about literacy, families' mobile phone usage, parents' relationship with the local schools, and more.

As this is designed to be an iterative process of sensemaking from data, two of the authors each went through the



Figure 1: Storyboard "speed-dating" with Ivorian parents

coding process and discussed our emerging themes, synthesizing the emerging codes as necessary to arrive at what is referred to as theoretical saturation, or the point at which our data is fully described by our codes [84]. Throughout the data collection process, we conducted regular debrief sessions with our interpreters and others from the Soubré and Adzopé regions to help resolve questions about concepts that arose during the interviews, or what Brown et al. describe as "peer debriefers" [12]. We recorded these discussions about emerging themes and our introspective reflections as voice memos, and returned to them later during the initial open coding process to triangulate with our other data sources, as part of a "constant comparison" approach [13, 84].

6 FINDINGS

In interviews and storyboard sessions with parents in two rural regions of Côte d'Ivoire, several major themes emerged, clustered around 1) parents' perceptions of local economic conditions and the quality of schools; 2) parents' beliefs, attitudes, and values about French literacy; 3) the support parents provide for their children's education; 4) parents' attitudes towards their family's mobile phone usage; and 5) parents' desired contexts for their children's learning. In this section, we describe themes from our data and discuss how the local Ivorian socio-economic context may influence the acceptance, adoption, and use of literacy technology.

Economic Conditions and School Quality

Across our data, concerns emerged about the local economic conditions and the quality of the schools in the region. Given how often during our time in the villages people discussed these issues with us - both during the interviews and in casual

conversations - we present this theme first, as it provides a critical context for understanding the rest of the findings.

Perceptions of local economic conditions. In both regions, we heard parents describing how the local economy impacted their children's education. In Adzopé, parents described the limited job opportunities in the region, and how even after completing school, they were concerned their children would not be able to find a job in the village. In Soubré, we heard from many parents who described how economic conditions had recently worsened in their region. Specifically, one participant described it in an interview as such:

Cocoa is old. The earth is not good. It does not produce much. There is not a lot of money. Before, when there was still a lot of money, when the land was still good, there were bananas, there was everything. [SP10]

Other data we observed corroborates this account of worsening economic conditions in the Soubré region. On our first day in the village, we met several men on the road to the local school who began the conversation by telling us (unprompted) how the price of cocoa had recently dropped significantly. According to Reuters, in April, 2017, roughly a year prior to this data collection, the Ivorian government had reduced the guaranteed price for cocoa farmers by 36%, to 700 CFA francs (\$1.14 USD) per kilogram of cocoa [17]. Though not all adults in the village farmed cocoa, in nearly every home we visited in Soubré, parents described finding it hard to afford enough food for their family, perhaps due to the reduced price of cocoa, with many telling us about recent increases in local rubber production as a result [SP10].

Perceptions of school quality. Across both regions, parents described concerns about the quality of the local schools, though parents in Adzopé and Soubré differed in their trust in the teachers and engagement with the schools. Parents in Soubré voiced concerns about the quality of the local education, with one mother describing not being "satisfied with the way the teachers teach, because they do not teach as they should" [SP9]. Parents in Soubré also described concerns about teachers' chronic absence from schools and advancing students' grade levels without the necessary skills. In light of this, parents often paid for tutors (*maitre du maison*) to supplement schools' education, as one father describes:

The education system in Côte d'Ivoire has changed so much that the children must have tutors, because without the tutors, I am sure that the child cannot make it out of the education system. [SP4]

This parent was one of many we encountered who paid for a tutor to teach their children at home, though parents varied in their reasons for paying for these tutors, which we discuss in more detail in subsequent sections.

In Adzopé, while some parents did describe their concerns about the schools' quality, these concerns were largely focused on the physical school infrastructure (e.g. "the roofs that are there... start to leak" [AP7]). In fact, in the Adzopé region, more parents described their engagement with the school. Parents described the roles they took on at school (e.g. "student parent", "treasurer" [AP6]), saying that they regularly called teachers on the phone. In Soubré, by contrast, while one teacher we spoke to described calling parents' phones if their children were absent, none of the parents in Soubré mentioned that they called the teachers themselves. In Adzopé, parents told us of their desire to "reinforce" at home what the schools are teaching their children. Parents in Adzopé also described paying for tutors, as in Soubré, but instead of hiring them to fill in gaps in what children were learning in school, parents told us how they hired the tutors "to reinforce what the teacher gave the children" [AP3]. This suggests a trust in the schools that did not seem present among parents we spoke with in Soubré. In spite of this trust, however, children's literacy rates were lower in the two villages in Adzopé region than in Soubré.

Parents' Attitudes towards French Literacy

Another set of themes from our interviews revolved around parents' beliefs and attitudes towards French literacy. This is particularly salient for designers of educational literacy technologies in bilingual contexts, as in Côte d'Ivoire, where there are likely to be differences between the official language of instruction and families' home language [1, 8, 33]. Parents from both Soubré and Adzopé told us how they felt it was important for their children to learn French in order to communicate with others, find jobs, and travel beyond their village. One parent described the importance of learning French as providing access to economic benefits:

Because it's an intermediary language that can allow them to access a lot of things. When you speak French, you have access to a lot of things. You can have a job. You can travel. [SP3]

For this parent, French is an "intermediary" language to provide their children with access to jobs and "a lot of things". Multiple parents referenced this idea that learning French would allow their children to travel and access opportunities:

The French are the ones who colonized us. If you leave here and you do not understand French, you cannot evolve, you cannot travel. It is necessary to learn French. It is not so bad to learn French. You must understand French. [AP6]

Other parents across regions also echoed this tension around learning the language of the colonizers, with others saying reluctantly "we are colonized by the French, so

one must necessarily learn French" [SP1], and it is "an obligation" [SP1] for children to learn. This aligns with the current state of Francophone West African linguistic policy, with educational, economic, and political affairs conducted in French, limiting access to such activities to French-speakers [8, 14], despite a minority of the population speaking French [83]. Beyond their specific attitudes about French, parents described at length the benefits of literacy for their children in "advancing the family" [SP1]. One parent described children who can read as a "relay" (*relais*) for the family:

The child is the relay of the parents. So, when the child knows how to read... you can trust the child with tasks later because little by little they will grow up. These are the children who will take our places tomorrow. The children who know how to read are relays. [SP4]

Other parents echoed how literate children could be given responsibilities such as helping around the house by reading and writing notes for parents, or buying lists of items at the store. As one mother put it:

I can send my child out into the world without worrying, knowing that my child knows how to write... If I see that they are planning to go out alone to the shop nearby, I can write a little something, "buy me a biscuit". [SP5]

Parents' attitudes and values towards French literacy in these rural Ivorian communities reflects the socio-political landscape of Côte d'Ivoire, where French is the official language of schooling and business, despite being spoken by a minority of Ivorians.

Current Parental Support for Literacy

In addition to parents' beliefs and attitudes about literacy, another set of themes emerged about how parents supported their children's literacy development. Some described communicating their beliefs and values about education to their children through advice, stories, and encouragement (similar to [50, 68]), while some described supporting their children's literacy through instrumental support (e.g. teaching letters, as in [81]) and providing learning resources (as in [6, 22]).

The responsibility is on both of us, it's me and my husband who are responsible for the child. One way or another, everyone in the house brings their grain of salt in reinforcing the education of the child. [SP9]

This sense that parents marshal many people and resources in the child's life to each bring "their grain of salt" (*grain de sel*) to support their children's education - in whatever way they could - was echoed in many of the other interviews.

Communicating educational values. One of the ways parents in our data supported their children's literacy was by communicating their values and beliefs about the importance of literacy and ways of learning (as in [15]). Some did this through stories or advice, as in one parent who described how they tell their children that "it is reading that makes man evolve" [AP6]. Others told us how they told their children about the economic consequences of *not* learning to read: "If you do not study, then you do not know and if, for example, I die and leave you all alone, what are you going to eat?" [AP7]. Many parents told us how they gave their children advice and encouragement to continue learning, as this parent describes how she tells her children to "pay attention to everything you learn at school because that is what will allow you to move ahead" [AP3]. This encouragement echoes other parents' description of how French literacy will "advance the family" [SP1]. Other parents supported their children by communicating specific dispositions for learning ([15]), with one parent describing how she would tell her children that mistakes were part of learning:

In learning, one is allowed to make mistakes. So I can say to him, "It's alright you did not get it today. What's important is not giving up". [SP9]

Instrumental support. In addition to communicating their values about the importance of literacy and modeling effective learning dispositions, a few parents across both regions told us about how they provide literacy instruction at home themselves (what has elsewhere been described as "instrumental support" [50, 81]). Though it was not common among our participants, some parents described teaching their children how to read or write specific letters on a chalkboard at home:

Every night, I tell him, you must take your slate and go study. We have a board there. Children stand in front of it and they study. Whoever doesn't know "A", I write it on the board, I show them look: this is how you write "A". [AP7]

This parent is teaching their child the names and written form of letters, in similar ways as we observed teachers teaching in class. However, as with much of our data, the parents' motivation for engaging in their children's education was shaped by their relationship with the local school system. This was summed up by one parent, in Adzopé, who described the role of parents as reinforcing the teachers:

When he arrives home, his father must tell him again what the teacher said at school. He must say: this is what the teacher said, this is what it means... We must explain this to our children. We parents, we have our own homework too. We must help the teachers with the development of

our students. If we don't, what is done in class, is not enough. [AP6]

This idea of parents "having their homework" echoes the parent who told us how each person brings "their grain of salt" to reinforce the education of the child. For this parent, that entails helping teachers with the development of the child at home, but we can see echoes of the parent in Soubré [SP4] who told us that without having additional help, their child would never make it out of the school system.

Providing resources for learning. However, despite these examples, not all parents in the communities we worked in had sufficient literacy to provide this instrumental support. To address this, parents supported their children's education in other ways, such as by paying for private tutors to teach their children at home, as discussed previously. This is one way parents in these communities play the role of a "learning resource broker" for their children's education [6, 22]. Some parents we spoke with told us that, while they *wanted* to help their children learn, they were often too busy or tired to help their children at night (e.g. "Because some parents are busy doing activities, they do not have the time" [AP1]). As one parent said: "sometimes when we come back from the fields, we are tired, that's why we hire the tutors" [AP6]. However, parents expressed concern about the price of these tutors and described pooling funds with other families to pay for a tutor for several children, with some tutors teaching groups of up to 30 students across grade levels, limiting the individual attention they could provide, much like in schools. Parents describe investing in tutors - whether to fill in gaps in schools' education or to reinforce it - as well as investing in physical resources, such as the slates or chalkboards that we saw in the majority of homes we visited in both regions (Figure 2), writing materials for their children, or even "storm lamps" that children could use to finish their homework at night. However, as described above, despite these efforts, children in these two regions remained well below developmental thresholds for literacy [37], suggesting opportunities to supplement home literacy learning.

Attitudes towards Family Mobile Usage

The fourth cluster of themes that surfaced in the interviews with parents centered around parents' attitudes and desires about their family's use of mobile phones. Parents in every family we visited had more than one mobile phone in their family, with every parent in the families interviewed having at least one "basic" phone (e.g. feature phone), four parents having at least one touchphone, and one family with up to six phones. Parents told us that they used their phones on a daily basis, with one parent telling us how she calls people "three or four times a day" [AP7]. In several interviews, parents took



Figure 2: Child demonstrating his family's chalkboard

phone calls during the interview, some answering multiple calls during a single one-hour interview.

Parents described using their phones to call family members and friends, to support their work on the job (e.g. to calculate "how much I need to produce such a number of chickens" [SP3]), and to connect to global information networks (e.g. "We are trying to surf the net, to use Facebook to see what is happening elsewhere." [AP6]). This desire to connect to a larger information community mirrors what we heard from parents about the benefits of French literacy for their children. Many parents we spoke with were interested in the potential for their children to use their mobile phones not just to learn literacy, but also to learn how to use the phone itself. For some parents, the phone presented an opportunity for their child to learn about technology, saying: "...because it's to know, to know what is inside it. In this too, she can know, know the things that are in there, especially the internet" [AP4]. One parent describes how in addition to learning to read in French, "they master more things that are in the phone itself... that in any case can make them intelligent." [AP3]. Other parents describe how they are willing to "give the mobile to our children so that they advance in their education, we are ready for that. We want the advancement of our children's education." [AP7]. For these parents, access to mobile devices and the Internet may provide their children access to global information resources and social networks.

Some parents told us at length about how their children already used their phones quite often, but some parents described wanting their children to wait for permission to use the phone. Some families described how only the older children were allowed to use their parents' phone, typically to talk to family members, who had moved away to Abidjan for

work [SP3, SP4]. For other families, mostly in the Adzopé region, parents described a more permissive attitude towards their children using the phone to "play music" [AP4], "play games" [AP3], or "become familiar with what's on the phone" [AP3]. One mother described how her children pick up and use her phone if she leaves it lying around the house:

It's been a year since she got the phone and everyone uses the phone. When she puts down the phone, the kids use it, and start playing the games with her phone. [AP3]

This attitude was not present in all parents we interviewed, however. Some parents described how they would allow their children to use the phone, but only after giving permission:

The child also has his rights and his duties, so if he wants to play, he asks me permission to play for at least a few minutes, I can do that. [AP6]

This desire to give permission to the children before they could use their phone was echoed by other parents who said that without giving permission, "he cannot accept that; cannot allow" his child to use his phone [SP10]. When we probed deeper to understand this, many parents in Soubré described their concerns about children's lack of respect for parents and for phones. Some said simply that "when they use the mobile, they do not respect the parents" [SP10]:

The child takes the dad's units to call others, the dad is coming now, he wants to call the village, he sees there are no units, who has removed them? It is the child who took the phone. [SP10]

This parent describes his concern that children will use all of the "units" (or, airtime) on the phone without the parent's permission. Other parents described how they feel "the phone itself is private" [SP1] and "The mobile is confidential... the phone is personal. Even my wife does not answer mine for me" [SP1]. Parents' attitudes towards other family members' access to their mobile devices clearly vary widely, and are likely to impact the usage of mobile literacy systems.

Desired Contexts for Mobile Learning

Finally, we heard themes about parents' preferences for the contexts of their children's learning. To elicit these, we presented them with storyboards showing children learning on mobile devices in various contexts and followed this with questions probing their preferences and opinions of these designs. Some parents described wanting input into the timing of children's learning with their mobile phone. Several parents across both regions in our study described how they wanted to call the system to request a lesson, and not receive calls from the IVR system, saying "I will not let the system alone call me. I too must call the system." [SP5]. Others

echoed this desire to call an IVR system themselves, because they "would not accept" calls from the system [SP1].

Although some parents described wanting their children to use the phone at school, many parents, mostly in Adzopé, told us they preferred their children learn with the phone at home due to safety concerns that phones would be stolen from their children on the walk to school. As one parent put it, "I would prefer that the phones stay at home, because going to school with it, people will steal it" [AP3]. Or, more succinctly, "someone can snatch the mobile" [AP5] or "There are too many dangers." [AP7].

For many parents, themes emerged about their desire for the family to learn with the phone in collaborative contexts. Parents described how in their families, "those who are further ahead help those who are behind, in the lower classes" [AP2]. Perhaps because their children were already learning together in multi-age classes, when we showed parents storyboard options of children learning alone or together with a mobile device, many wanted their children to use the phone to learn together - because, as one parent told us, they did not want to "leave the others" [AP4]. As another parent put it, they wanted a group learning activity,

...so that all the children are at the same level. All my children must be at the same level. There is none who can be above the others. If I have five children and show something to one, the others must also understand that thing. I have to play with them all together. [AP6]

In addition to wanting their children to learn together on the phones so they will all be "at the same level", some parents also described wanting to learn French literacy themselves, along with their children. One mother described wanting to play a literacy game with her child so that "together they have fun - I am capable and I too want to learn" [AP3]. Another parent describes how he wants to receive instruction from the mobile along with his child because "I want to move ahead. I want to go in front. I do not always want to stay behind." [AP4], echoing the desire for "advancement" afforded by access to French literacy seen earlier. However, when shown storyboards of parents playing word games with their children, many parents preferred not to play games with their children, but most parents did want to monitor, direct, or be involved in their children's learning in other ways.

7 DISCUSSION

Parents and the home environment are crucial elements of children's social ecology for early literacy learning [50, 69, 81]. Yet for families in low-resource contexts, children may

lack a home environment with reading materials or sufficiently literate adults to provide stimulating literacy experiences, a situation that may be exacerbated in multilingual contexts where the language of instruction may be different from families' home language [39, 61, 62]. Mobile devices, ubiquitous even in developing contexts [55], may offer one way to supplement family literacy environments via adaptive instruction [16, 71, 91], but they must account for parents' beliefs, attitudes, and desires for their children's literacy and use of mobile devices in order to be effectively adopted and used. As others have argued, there are complex socio-cultural, economic, historical, and political influences that intersect to impact users' experiences with technology in culturally specific ways for different contexts [43, 93].

In light of this, this paper is intended as one part of a "design-based research" (DBR) approach [5, 26]. DBR is an iterative, mixed-methods research approach, using collaborative design with multiple stakeholders to refine our understanding of a particular phenomenon-in-context. This "situated knowledge" is then used to design and evaluate an intervention intended to positively impact the stakeholders and contribute to the development and refinement of "theories-in-context". DBR researchers argue - with others [35, 51] - that cognition is situated in particular contexts and distributed across the actors and artifacts in that context [5]. As such, the nature of the cognition in learning settings is always already intertwined with the webs of socio-cognitive relationships with other learners, teachers, parents, and others in the community and the particular socio-cultural, political, and historical context of that community [5, 66, 78], resulting in "theories-in-context" [5]. The rest of this paper is intended to highlight the situated knowledge surfaced from our findings about the beliefs, goals, and values of parents in several rural communities in Côte d'Ivoire, which may resonate for other similar contexts. Given our findings, we suggest design implications for family-based literacy technologies for low-resource contexts, though these implications are grounded in the specific context of rural Côte d'Ivoire.

Designing for Low-Literate Family Support

It is clear in our data that literacy is supported through multiple means and by multiple actors in the larger social ecology [69, 87] of the family. While many others [50, 61, 81] have argued that the family is a crucial influence on early literacy, this body of work largely leaves unaddressed how low-literate families can provide supportive environments for early literacy. In our context, we heard from low-literate families about how they involve other adults to support their children's literacy in various ways. We thus suggest that designers of literacy technologies for low-resource contexts design for multiple actors in the family learning ecology (e.g. siblings, other adults in the family, home tutors, etc), who

may each be able to support children's literacy development in different ways, at different times, given their respective literacy abilities.

First, we suggest that designers consider how to align scaffolds with families' existing literacy activities, in appropriate ways for parents' literacy levels. For instance, as we saw in our findings, many parents are already giving advice or encouragement to their children, but this may not occur in moments when it is most needed by the children. Thus, a mobile literacy system might provide suggestions for specific motivational or dispositional messages (e.g. about the importance of productive failure [40] or growth mindset [25]) at times when the system determines that children are struggling. While some systems like Ready4K [97] have sent automated messages with tips to parents, personalized by children's performance on school assessments [23], these systems have not designed the messages to be personalized based on the particular content the students need help with, at the moment they need that help. These systems have also not addressed how literacy scaffolds can be adapted for low-literate adults - perhaps via voice-based interactions, adaptation into the local language, or adoption of messages generated through a co-design process (as in [95]).

For adults with sufficient literacy, such a system might update them on the current content items children are learning or struggling with, so they could provide more instrumental support at home. However, given that Pouesevara et al. found that parents were replacing their existing story reading and letter naming with the lessons from the system [71], there may be an opportunity cost for parents' time available for literacy support. In light of this, we also suggest that designers incorporate culturally-responsive activities into literacy systems, inspired by prior work on the importance of culturally-responsive literacy instruction in school contexts [30, 49]. This may take the form of culturally-aligned lesson items, such as teaching words as part of a narrative drawn from folk stories [3] or support for intergenerational story-telling [24]. For family-based literacy systems for low-literate parents, the system might instead suggest specific words, letters, or phonemes for adults to use in the stories they are already telling their children (which we heard several examples of from parents). Alternatively, this might also take the form of suggesting that adult caregivers provide locally-relevant uses for their children's burgeoning literacy abilities - as in the grocery lists mentioned by one Ivorian mother - applications that may be of immediate practical use to the family and which could provide authentic motivation for children.

Given what we heard from parents about the games their children play (and parents' general lack of interest in playing those games along with their children), designers might

also consider ways of engaging multiple children in literacy games or activities, perhaps by having the system pair students of different ages or literacy levels to leverage the benefits of peer or near-peer supportive interactions with older siblings [57, 86, 88]. Alternatively, given the desire we saw from some parents to learn to read in French themselves, designers of literacy systems might allow parents to play a supportive role in such games (what Barron et al. calls the "collaborator" or even "co-learner" roles [6, 22]), where they are learning the concepts while playing with their children, but designed in such a way to spare them the potential embarrassment or "face-threat" of learning the same lessons as their children.

Designing for Cross-Context Learning

With the increasing ubiquity of mobile technologies in low-resource, developing contexts [55, 56], designers of educational technologies are increasingly designing for mobile devices [47, 48, 70, 89, 91]. However, in contexts where families' language and culture may not be aligned with that of the teachers and schools, or where parents may feel alienated from engaging with teachers and schools [11, 33, 92], it is increasingly critical to consider the larger socio-cultural and political factors at work in the community when designing and implementing the system.

For instance, a mobile literacy system *might* be designed to reinforce a national bilingual education program by incorporating teachers at school and parents at home, as in Kim et al's PocketSchool [47] or GraphoGame [38]. However, in contexts where parents distrust the teachers' quality, motives, or even willingness to show up at school - as we saw in Soubré - such alignment with the school or national educational policy may alienate parents and lead to a lack of uptake at home. On the other hand, in contexts where parents trust the teachers (as we saw in Adzopé), a literacy system may be designed to reinforce at home the specific lessons or content items that children are learning at school, either by supporting parents directly, or by supporting other adult literacy stakeholders in children's home learning ecology, such as older siblings, other adults in the household, or at-home tutors, if applicable.

Further, if such systems are indeed designed to be used across school and out-of-school [28] contexts (e.g. [47, 89]), it is critical to consider not only parents' trust in and relationship with the schools, but also their concerns for their children's safety and security of the devices when used outside the home, as we often heard in our context. Some designers of mobile learning systems have proposed that children use these for learning in their free moments while walking around their community. As we heard, many parents in our context would not be comfortable with this approach.

We thus suggest that designers of mobile literacy systems consider the tradeoffs of children's autonomy of learning on the mobile device. Given what we heard from rural Ivorian parents about their concerns for children's respect for the phone and parents' airtime credits, designers of mobile educational systems may consider designing methods for parents' to influence the contexts and limits of their children's usage of the phone, as others have discussed in other contexts [32]. This may involve having the parents engage with the system as an intermediary first, allowing them to have control over the context of learning by calling in to the system. Indeed, while some prior mobile literacy systems involving parents (e.g. [71, 75, 97]) sent parents a scheduled text or call, parents in our data described wanting to decide when they or their child accessed the system. This may reflect concerns found in other studies of youth mobile phone usage in Sub-Saharan Africa [70] for children's safety when using mobile devices without supervision. However, as Uchidiuno et al. found in their work on children's use of tablets across learning contexts, child-led interactions may be more effective in home environments [88]. Perhaps, instead of designing for parents as the arbiter of the learning, this might include ways of building trust between parents and children by gradually increasing the duration of children's use, and letting both parties know if children are spending too much time (or credit) on the system.

Literacy Technologies in Multilingual Contexts

Educational technologies, particularly literacy technologies, are situated in the socio-political milieu of the languages (and by extension, cultures), which are valued by society and welcomed at school, as in prior work on the use of African-American English (AAE) in American public schools [11, 33, 82] and prior work in multilingualism in urban Ghana [39]. In multilingual contexts, particularly in former colonial contexts where the official national language - and the language of instruction in schools - is the language of the colonizers, it is thus critical to understand and respond to the ways in which literacy is politically charged, and to understand and respect the values and goals that stakeholders (here, parents) have for their children's literacy [67]. Technologies that teach literacy have the potential to either further reify the majority linguistic group's dominance over literacy education [33, 67], or they could demonstrate to minority language speakers that their language has value in the development of multiple literacies in a multilingual context.

We find that many parents in rural Côte d'Ivoire describe learning French literacy as providing access to what Bourdieu describes as cultural capital [9]. That is, they acknowledged that French can be a means for their children to access jobs and opportunities throughout Côte d'Ivoire, jobs which may not be present in their village, given current economic

conditions [17]. However, some parents *did* tell us of the importance of teaching their children the local language, telling us how life in the Soubré region necessitated that one learned Bété to resolve economic disputes around agricultural landholdings. Given these desires, and the prevalence of families speaking the local language at home, designers of literacy technologies should attempt to understand these complex perspectives for the contexts in which they work. This may take the form of bootstrapping children’s literacy by using shared phonemes between the local language and the target language, or by providing instructional support messages to parents recorded by local speakers in the local language. However, designers should also account for the ways in which parents’ perceptions of the official language education policy may impact the adoption and use of a literacy technology. For instance, in Adzopé, parents’ engagement with teachers and their trust in the quality of the schools may have had a mutually reinforcing impact on their likelihood to accept and adopt a literacy technology teaching French (the language of schooling). Given what we saw from parents’ perspectives in Soubré, care should be taken in the design and implementation of literacy technologies in contexts where families may feel disenfranchised by the language of schooling.

Limitations and Future Work

As an exploratory study, this paper is limited by a small sample size of participants (N=17) from two regions in one country, and as such, the findings should not be generalized without adaptation for a different population and context. Although we interviewed other community stakeholders in this study (e.g. teachers, tutors, and children), we report in this paper primarily on parents’ perspectives. In addition, in this study, our data is derived primarily from interviews, storyboard speed-dating, prototype testing, and field notes in the community, and not from extended home observations (as recommended by [69, 87]). We are in the process of developing a voice-based mobile literacy system, which was deployed in one village in Côte d’Ivoire in Fall 2018, informed by these findings and design recommendations, as another phase in a design-based research approach [5, 26].

As many others have described [42, 63, 79, 85], women and girls in many rural contexts may have limited access to mobile devices. This is corroborated by GSMA’s recent study on the global gender gap in access and usage of mobile technologies, where they highlighted Côte d’Ivoire as having a particularly high gender gap (22%) in women’s access to mobile devices relative to the region [77], though we did see many women using their own phones in our data. These gender dynamics were echoed in some of what we heard in this study, even in the interview norms, where we were

often discouraged from interviewing women alone. The gendered implications of mobile usage and literacy learning are complex and warrant unpacking in future work.

8 CONCLUSION

Children’s language and literacy are developed through interaction with others and given meaning situated in the social ecologies of learning in their lives. The family home environment is one such social ecology, and the primary one in early childhood, but many parents across the world lack the literacy to effectively support their children at home. As mobile devices become increasingly ubiquitous across developing contexts like Côte d’Ivoire, they have the potential to provide scaffolds for family support for literacy in low-resource areas where local schools struggle to reach every child.

In this paper, we intend to contribute to the larger conversation around designing support for family literacy, scaffolding low-literate parental engagement in education, and designing for low-literate families in developing contexts, with evidence grounded in our particular context. We provide further evidence for the importance of considering ideologies about literacy in multilingual contexts, the relationship between parents and schools, and parents’ attitudes towards children’s use of technology, and we highlight design guidelines for mobile literacy systems to scaffold parental support for their children’s literacy in developing contexts.

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