

“Rosita Reads With My Family”: Developing A Bilingual Conversational Agent to Support Parent-Child Shared Reading

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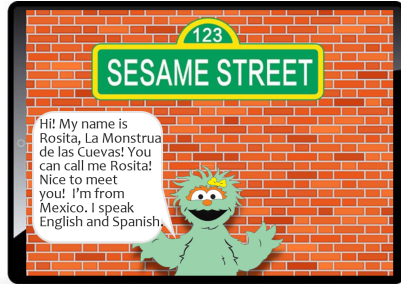
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Rosita introducing herself, building rapport with families.



Rosita engaging children in story-oriented conversation by raising “child questions” and providing feedback or scaffolding that aims to facilitate comprehension.



Rosita encouraging social-oriented conversation by suggested a family question for parents and children to discuss.

Figure 1: Story reading user interface of “Rosita Reads With My Family”

ABSTRACT

Bilingual children have unique needs for school readiness as they navigate between two languages and cultures. A supportive home language environment, where children are frequently exposed to language through conversation and reading, can positively impact their language development and prepare them for school. However, current conversational agents and e-books designed for children do not typically take into account the cultural and linguistic needs of bilingual children and do not involve parents. This project presents the development of a bilingual conversational agent and accompanying e-book, designed to support parent-child interactions and

promote language development for Latinx Spanish-English bilingual children. Results from a user study indicate that the bilingual agent effectively engages children verbally and encourages parental involvement in reading processes. The study also provides design insights for creating conversational agents for bilingual children.

CCS CONCEPTS

• **Human-centered computing** → Empirical studies in HCI; • **Social and professional topics** → Children.

KEYWORDS

shared reading, parent-child interaction, conversational agent, culturally-responsive design, bilingualism, Latinx

ACM Reference Format:

Ying Xu, Kunlei He, Valery Vigil, Santiago Ojeda-Ramirez, Xuechen Liu, Julian Levine, Kelsyann Cervera, and Mark Warschauer. 2023. “Rosita Reads With My Family”: Developing A Bilingual Conversational Agent to Support Parent-Child Shared Reading. In *Interaction Design and Children (IDC '23)*, June 19–23, 2023, Chicago, IL, USA. ACM, New York, NY, USA, 13 pages. <https://doi.org/10.1145/3585088.3589354>

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IDC '23, June 19–23, 2023, Chicago, IL, USA

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ACM ISBN 979-8-4007-0131-3/23/06...\$15.00
<https://doi.org/10.1145/3585088.3589354>

1 INTRODUCTION

In many countries, the number of children growing up in multilingual households is rapidly increasing. In the United States, for instance, nearly one in four children live in a household where the primary spoken language is English. [3], with the majority of these children being from Spanish-speaking families in Latinx communities [46]. In 2020, Latinx children comprised approximately 26% of the preschool population in the US, and this number is expected to grow in the foreseeable future. Compared to monolingual English-speaking children, young Latinx English-Spanish bilingual children have unique school readiness needs, as they constantly navigate between two languages and cultures [18]. When bilingual children initially start formal education, they need to learn how to speak, read, and write in English at school while also continuing to engage in interactions outside of school that are likely predominantly in Spanish.

Early language experiences at home, particularly shared book reading with parents, play an essential role in all children’s school readiness [11, 41]. The frequency of parent-child storybook reading and the quality of story-related conversations are positively associated with children’s language development [4, 33]. Furthermore, when it comes to Latinx bilingual children, the language (i.e., Spanish, English, or both) in which the reading and conversation is carried out also matters [5, 22, 40]. While there is a widely documented misconception among parents that exposing Latinx children to Spanish at home may hinder their acquisition of English [8], neither empirical evidence nor theoretical models support this idea. In fact, early language input in both English and Spanish contributes to children’s proficiency in both languages [14, 17, 39].

Like nearly all other children in the US, bilingual preschoolers’ daily language experiences now increasingly revolve around interactive media, such as electronic books (e-books). While earlier e-books allowed children to click or tap the screen to receive visual or auditory feedback, more recent research has incorporated in e-books conversational agents similar to Siri and Alexa that ask children questions, encourage them to respond verbally, and provide them with responsive feedback [13, 31, 53], simulating how an engaging parent might read to their child [53]. Such agent-guided conversations have been found to enhance children’s engagement, motivation, and comprehension during storybook reading [49].

Despite the promises of using conversational agents for enriching the digital reading experience, there are two potential avenues for improving upon these media. First, the conversational agents developed as part of current e-book research only support dialogue in one language (typically English) and do not sufficiently accommodate the unique linguistic flexibility of bilingual children. Second, the conversational agents are primarily designed to engage an individual child in *one-on-one dialogue*, and this design might discourage parents from co-reading with their child, a practice that provides additional learning benefits for children [9]. Furthermore, parents’ co-engagement with conversational agents could also make the child’s experience more smooth and enriching by mitigating some of the technologies’ inherent limitations, such as imperfect ability to decipher a child’s speech [1] and limited ability to carry out dialogue concerning a child’s life experience [50].

With the aim of supporting co-reading among bilingual children and their parents, our project develops a bilingual conversational agent along with a culturally relevant e-book into which the agent is embedded. In partnership with the Joan Ganz Cooney Center at Sesame Workshop, our e-book features Rosita, a well-known Sesame Street character originating from Mexico. Rosita embodies the conversational agent by not only interacting with children through a series of questions but also suggesting “discussion starters” that prompt parents to talk with their child about the family’s own experience relating to the story. A user study with 18 pairs of Latinx parents and children was then carried out to evaluate the usability of “Rosita Reads With My Family.” Through observations and interviews, our study sheds light on how well the system fulfills its intended design goals and also provides valuable design implications for future AI systems that support parent-child co-reading.

2 RELATED WORK

2.1 Shared Reading and Language Development Among Bilingual Learners

Shared reading between parents and children is a common family practice across cultures and provides rich opportunities for children’s language development [45]. One well-recognized shared reading technique is *dialogic reading*, which occurs when parents engage children in conversations about the story they are reading. Parents may ask children story-related questions and reply to the child in ways that extend the conversation [47, 55]. The benefits of dialogic reading have been demonstrated in research involving both monolingual and bilingual children [24, 43].

During dialogic reading activities, parents may ask different types of questions that elicit varying forms of responses from children and have unique educational value. For example, open-ended questions (e.g., “Wh-” questions) generally invite longer and more complex verbal responses [37, 55] than close-ended questions (e.g., multiple choice questions), while close-ended questions can scaffold children’s language output by constraining the possible range of answers. Additionally, intra-textual questions that elicit responses primarily based on story text can help clarify children’s understanding of story plots, while extra-textual questions encourage children to make meaningful connections between the story and their own experiences.

When it comes to children who speak a language other than English at home, early bilingual exposure positively contributes to their language and literacy development. For instance, research has shown that children exposed to two languages often acquire larger vocabularies and have phonological awareness advantages, two strong predictors of reading ability [26, 38]. While Latinx children who predominantly speak Spanish at home grow their language skills by reading in their home language [21, 39], their English language development and academic success also benefit from early exposure to English. Indeed, early exposure to English can help Spanish-English bilingual children both keep pace with their monolingual peers in English-language classroom environments and perform better on standardized tests of English language proficiency [36]. Nevertheless, the fact that children may lack sufficient early exposure to English if both of their parents speak Spanish at

home makes it imperative that these children have access to some form of enriching and high-quality English exposure so they can develop their language skills in both Spanish and English.

2.2 Conversational Agents and Language Development

Children interact with conversational agents through a variety of media, including virtual assistants that have become prevalent in homes (e.g., Apple Siri, Google Assistant, Amazon Alexa) [35] as well as voice-enabled tablet apps [6], Internet-connected toys like Hello Barbie [10], and social robots [44].

Past studies have demonstrated that conversational agents can serve as children’s “dialogue partners” and promote their engagement and comprehension during dialogic reading. For example, Gordon and Breazeal designed a social robot that co-created stories with children by having children suggest story plots for which the social robot then generated story narration [16]. In another example, Xu and colleagues developed a conversational agent deployed in a smart speaker that narrated stories to children, asked them questions intermittently throughout the reading, evaluated children’s responses, and gave them feedback [49]. The researchers found that this type of interactive reading with a conversational agent improved children’s comprehension of the stories being read.

Despite these benefits, children’s engagement with conversational agents may also include some obstacles, primarily those resulting from the technologies’ constraints in deciphering speech and in understanding the meaning of natural discourse. At the speech level, it is not rare for a voice interface to misinterpret one word as another [1], and child-specific language issues such as pitch, verbal intonations, and typical childhood disfluencies might contribute to the technological burdens in translating speech to text. Given that the data used for training the relevant algorithms are primarily drawn from native English speakers, these issues are particularly salient for children who grow up speaking another language [48]. A growing number of researchers have recognized this issue and started to fine-tune algorithms to improve the speech recognition accuracy for non-native English-speaking children, although the performance of these algorithms can be further improved [32]. At the discourse level, although studies have suggested that conversational agents are effective at conversing with children on narrowly tailored topics and question types, conversational agents are limited in their ability to precisely interpret children’s free-form responses, and it would be extremely challenging to build an agent that could engage children in highly personalized conversation.

2.3 Designing Educational Media for Language Minority Children

Given that educational media can be most effective when it aligns with children’s diverse cultural and linguistic practices [27], some researchers are focusing on designing educational media that is more culturally responsive. For example, a PBS station in Southern California created a series of videos for the Latinx community, showcasing math learning opportunities within their daily routines and household activities [25]. In one video, the concept of sorting was

introduced by showing how household members can separate laundry into different piles based on color, size, or utility. Parents and children were invited to discuss their own experiences with sorting laundry and expand the conversation to other household items, such as toys. According to the creators, these media resources inspire families to discover the learning opportunities already present in their daily lives and use their “funds of knowledge” [34] to make math learning culturally and personally meaningful.

Other research has focused on creating conversational agents that are culturally responsive and can communicate in a manner that is similar to how children speak. These agents, such as the one developed by Finkelstein and colleagues [12], can code-switch based on the learning context and use accents similar to the student’s native language to facilitate collaborative learning. In Finkelstein et al.’s study, the code-switching agent used African American Vernacular English in informal learning sessions and Mainstream American English in formal science presentations [12]. The authors found that African American children who interacted with the code-switching agent demonstrated stronger and more scientifically reasoned arguments than those interacting with an agent that only used Mainstream American English. Although this particular study did not focus on Spanish-speaking children, the findings do support the notion that conversational agents’ linguistic practices can help children build rapport with the agent thereby enhancing learning outcomes [29].

3 THE DESIGN OF “ROSITA READS WITH MY FAMILY”

We designed our bilingual conversational agent, Rosita, along with the e-book in which she is embedded, with the specific goal of promoting Latinx bilingual children’s school readiness. The three key design features of “Rosita Reads With My Family”, as detailed below, were based on the research literature highlighted in the previous section. First, we incorporated cultural practices deemed relevant to our target participants. The story we chose for developing the e-book is centered on Latinx food culture [23] and *familismo* [15]. In the story, Rosita’s *abuela* visits from Mexico and guides Rosita and her friend Elmo through the process of making guacamole and salsa. Rosita, her *abuela*, and Elmo write down the recipes, go grocery shopping, make the dishes together, and share the food with their friends. Second, we aimed to support bilingual reading and conversation. In addition to having a Mexican accent, the conversational agent empowering Rosita is capable of comprehending and carrying out dialogue in English, Spanish, and a mix of two. Families are also allowed to choose either Spanish or English as their preferred language for the printed text and narrated audio. Third, we aimed to promote parent-child joint engagement. Rosita facilitates the co-reading experience by asking two questions after each page. These question pairs are specifically designed to encourage children to reflect on and express their understanding of the story while also encouraging dialogue between the parent and the child.

3.1 Design of Rosita’s Conversation

The first question Rosita asks after each page is directed to the child (“child question”) and focuses on the narrative of the story,

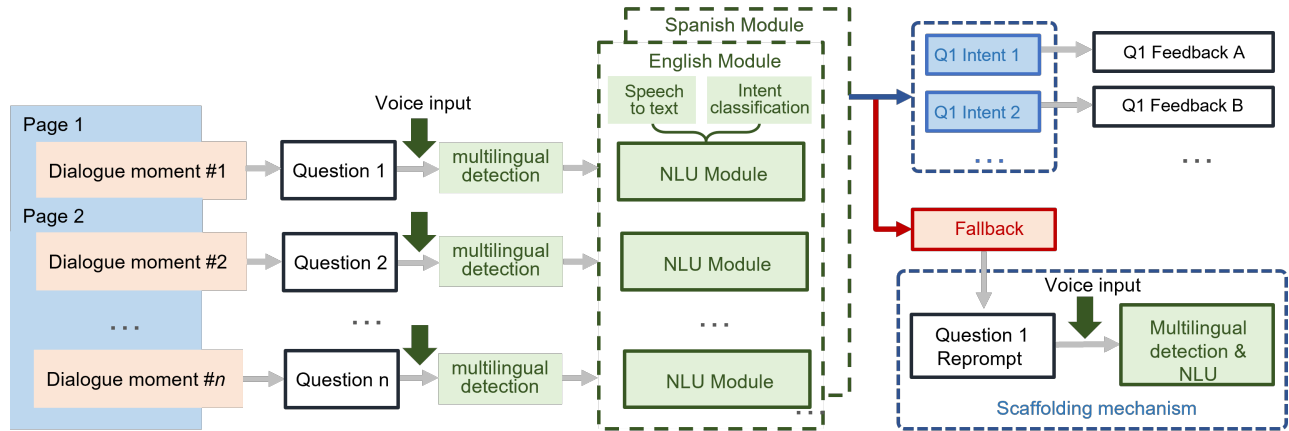


Figure 2: Natural language understanding process in “Rosita-child dialogue”

aiming to facilitate children’s comprehension. The second question is directed to both the parent and the child (“family question”) and is designed to expand on the immediately preceding child question by encouraging the child and parent to connect their personal experiences and common sense knowledge to the story. For instance, on one page, Rosita first asks a child question: “Hooray! We are going to make some yummy food! What food are we going to make together?” After the child’s answers, Rosita evaluates the response and provides feedback to the child, rephrasing and scaffolding the question as needed for children who initially answer incorrectly. Rosita then asks a family question extending the topic: “I love making guacamole with my Abuela! What food do you like to make in your family?” After posing the family questions, Rosita allows parents to guide their child in back-and-forth discussion on the topic and begins narrating the next page when the parent or child presses anywhere on the screen. This design has the benefit of allowing more flexibility for rich parent-child discussions while also encouraging parents to take a more active role in learning-focused dialogue during shared reading. A complete list of questions Rosita asks is displayed in Appendix A.

3.1.1 Procedure for Developing Rosita’s Conversation Script. The script for Rosita’s speech output was developed through an iterative process. We worked with 20 Latinx children aged three to six years old who were bilingual in English and Spanish. Each child listened to the story read by an experimenter and was asked both types of questions. These sessions were recorded and transcribed to analyze whether the questions were sufficiently clear and answerable and to make minor revisions as needed. We removed questions for which the majority of children did not have much to say, as well as any questions that seemed to confuse the children.

3.1.2 Building The Bilingual Conversational Agent Powering Rosita. For each child question, Rosita provides automatic responsive feedback based on the child’s answer. Using Google’s speech-to-text and DialogFlow API, Rosita analyzes these answers by performing end-to-end processing to first transcribe speech into text and then

classify the transcription by semantic intent in a process known as natural language understanding (NLU).

The NLU process, shown in Figure 2, was based on Google’s generic pre-trained language model and fine-tuned with utterances specific to the conversational moments in our e-books. This fine-tuning allows the agent to more precisely and accurately extract semantic intent from children’s responses. Given that children could respond to any particular question in a variety of ways, the agent was trained to associate more than one semantic intent with each conversational opportunity. For example, children’s possible answers to the question “Where can *Abuela* and I get all the ingredients?” might include keywords such as “market,” “fridge,” “farm,” or “outside.” These semantic intents in our NLU model were created based on predicted responses formulated by the research team and on actual utterances recorded during a field test with ten children.

We also included a fallback intent that is triggered when a child’s utterance cannot be classified into any of the predefined intents or when the child does not respond to the question at all. When a fallback intent is triggered, the agent scaffolds the conversation by rephrasing the original question using more accessible language (e.g., changing from an open-ended question to a multiple-choice question, “Should *Abuela* go to the market or go to the farm?”). If the child’s response to the scaffolded question triggers the fallback intent again, the agent then provides neutral feedback and explains the correct answer to the child (e.g., “We are going to the market! A market is a place where we can buy avocados, tomatoes, lemons, and black beans – what we need for making guacamole!”). This fallback system is important for extending the conversation while preventing communication breakdowns and frustration.

To accommodate bilingual Hispanic families, we created NLU modules capable of processing both English and Spanish responses. First, we deployed a multilingual detection function that enabled the agent to detect whether an utterance was in Spanish or English, and then process this utterance using the appropriate NLU module. If a child or parent responds using both languages within a single utterance, the agent processes the utterance through both the English and Spanish NLU modules simultaneously and then

ID	Age	Gender	Home Language		Reading Frequency	
			Parent to Child	Child to Parent	Spanish Days per week, Time per day	English Days per week, Time per day
01	3	Female	Only Spanish	Only Spanish	75 min	1 day a week, 0-10 min
02	4	Male	Mostly Spanish	Mostly Spanish	1 day a week, 0-10 min	1 day a week, 0-10 min
03	6	Male	Equally Eng and Spa	Mostly English ¹	4 days a week, 20-30 min	5 days a week, 10-20 min
04	6	Male	Equally Eng and Spa	Equally Eng and Spa	3 days a week, 20-30 min	0 days a week
05	4	Male	Equally Eng and Spa	Equally Eng and Spa	7 days a week ²	7 days a week, 10-20 min
06	4	Female	Mostly Spanish	Mostly Spanish	4 days a week, 20-30 min	4 days a week, 0-10 min
07	3	Female	Mostly Spanish ¹	Mostly Spanish	5 days a week, 10-20 min	5 days a week, 0-10 min
08	6	Female	Mostly Spanish	Mostly English ¹	5 days a week, over 30 min	5 days a week, 20-30 min
09	4	Male	Mostly English	Only English	1 day a week, 0-10 min	3 days a week, 0-10 min
10	5	Male	Equally Eng and Spa	Equally Eng and Spa	0 days a week	1 day a week, 0-10 min
11	5	Male	Only Spanish	Only Spanish	3 days a week, 10-20 min	2 days a week, 0-10 min
12	4	Female	Mostly Spanish	Equally Eng and Spa	3 days a week, 10-20 min	2 days a week, 0-10 min
13	6	Female	Mostly English	Equally Eng and Spa	3 days a week, 10-20 min	3 days a week, 10-20 min
14	3	Female	Only Spanish	Only Spanish ¹	3 days a week, 10-20 min	4 days a week, 10-20 min
15	4	Male	Mostly Spanish	Mostly Spanish ¹	3 days a week, 10-20 min	3 days a week, 10-20 min
16	5	Male	Mostly Spanish	Mostly Spanish	3 days a week, 10-20 min	3 days a week, 10-20 min
17	3	Female	Mostly Spanish ¹	Mostly Spanish	3 days a week, 20-30 min	3 days a week, over 30 min
18	5	Male	Mostly English	Mostly English	1 day a week, 0-10 min	5 days a week, 20-30 min

Table 1: Demographics of user study participants.

¹ The parent did not report the home language, it was inferred from the language they used in the user study session. .

² The parent did not report the reading time per day.

responds based on the intent returned by whichever module most confidently classified the utterance.

3.2 Visual Design

The e-book is organized by pages with text and illustrations, similar to a conventional print book. During the conversation moments, Rosita appears in front of the page to ask the child and parent questions. When Rosita is speaking, her lips move to emulate natural speech, and after Rosita asks each question, she invites answers by blinking her eyes and slightly moving her body. These visual design elements have been vetted in our other studies and have proven effective in eliciting responses from children [51, 52].

4 USER STUDY

The development of “Rosita Reads With My Family” was an iterative process, and the user study presented here is focused on the most refined version. This study aimed to answer two primary questions:

- **RQ1:** What types of parent-child interactions and language usage patterns emerge during families’ reading sessions?
- **RQ2:** How do parents and children perceive co-reading with Rosita?

4.1 Participants

With the help of a non-profit community organization maintaining close relationships with a local school district serving predominantly Latinx children, we recruited 18 parent-child pairs who had not previously participated in any part of our research project. Each parent-child pair consisted of a parent and a child between the ages of 3-6 (mean = 4.44, SD = 1.10). All participants identified

themselves as Hispanic or Latinx. The demographic information of the participants is reported in Table 1. Each parent-child pair was compensated with \$25 along with a Sesame Street picture book for their time.

4.2 Study Procedure

The user study sessions took place at a community center in the neighborhood from where the participants were recruited. Before each session, the parent completed a demographic questionnaire. After an introduction to the study by the experimenter, the parent-child pair selected their preferred language and watched a 1-minute video introducing Rosita. The parent-child pair then read the “Rosita Reads With My Family” e-book and interacted with Rosita for an average of 25 minutes, after which we conducted a 20-minute semi-structured interview with each parent about their experience. A bilingual researcher carried out the interview either in English or Spanish, per each parent’s preference. Each user study session was video recorded and transcribed for analysis.

5 RESULTS

5.1 Analysis Methods

5.1.1 Parent-child Interactions (RQ1). We coded all of our video recordings and their transcriptions to identify the conversation productivity, language use, and interaction style. Recall that Rosita asks two questions after each page. Each of these questions marked the beginning of a coding unit, and each coding unit included all parent or child utterances made in response to the question but prior to Rosita’s subsequent question. An utterance is defined here as a complete thought or idea contained within a word, phrase, or

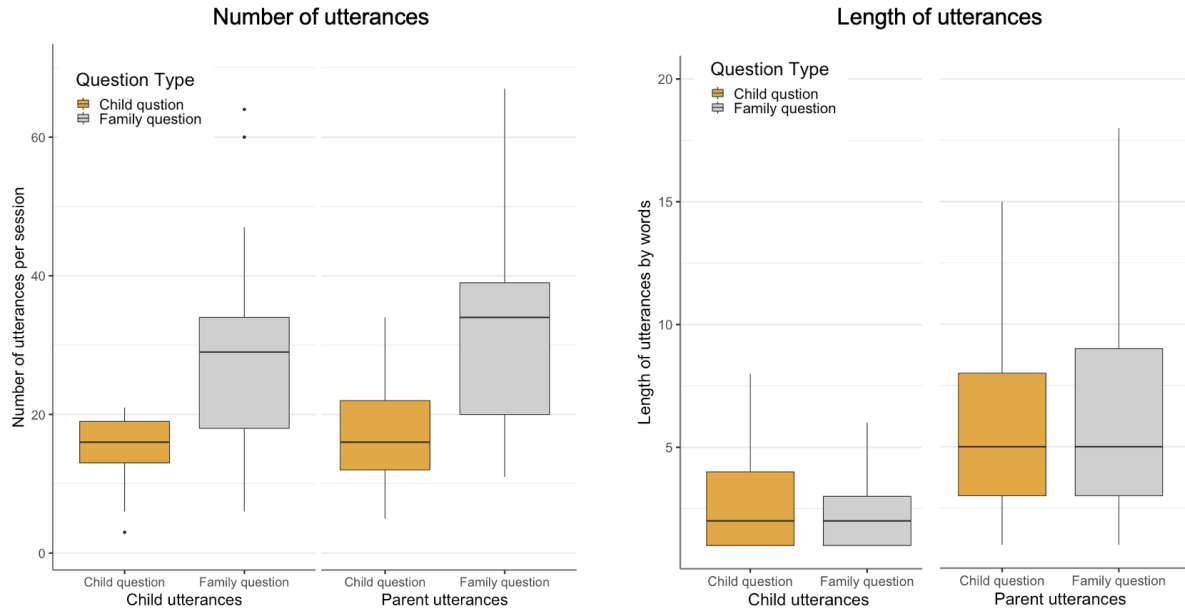


Figure 3: Conversation productivity

sentence. The three metrics we used to capture **conversation productivity** were (1) whether a child/parent verbally engaged in each unit, (2) the number of utterances, defined as a complete thought or idea in a word, phrase, or sentence, in each unit and (3) the word length of each utterance. For **bilingual choice**, we classified each utterance into three categories: English, Spanish, or code-switching between English and Spanish in one utterance. For **interaction style**, we used a four-category framework, based on Lin and colleagues [30], that indicates which participant drove the direction of the conversation. For each unit, we classified the interaction style into one of the following four categories: (1) *Rosita-driven*: Children answered directly to Rosita and parents did not engage verbally; (2) *Parent- and Rosita-co-driven*: Parents mainly supported their child’s interactions with Rosita by repeating Rosita’s questions or using directive language to encourage their child to respond to Rosita with additional information; (3) *Parent-driven*: Parents introduced new topics in their responses to children and/or asked follow-up questions that expanded beyond the original question; and (4) *Child-driven*: The child asked their parents or Rosita additional questions. This coding was performed by a trained research assistant and supervised by one of the authors of this paper. Thirty percent of the conversation units were randomly selected to be double-coded to establish reliability with a Cohen’s Kappa at 0.86.

We also conducted additional analyses of parent-child communication behaviors, following Heritage’s principles in conversation analysis [20] focusing on the organization of parent-child turn-taking, the progression of conversation sequences, and the strategies used by parents or children to maintain or expand the conversation flow. This allowed us to examine the nuances of parent-child communication in conversations classified under different interaction styles and language usage patterns. The coding process was

conducted by three authors of the paper, with weekly meetings held over a span of three months to discuss our findings.

5.1.2 Families’ Perceptions (RQ2). Our post-reading interviews asked parents about their opinions of Rosita’s questions and responses, how Rosita encouraged shared reading between the child and parent, the differences between using the e-book and their regular reading practices, the difficulties they encountered during the reading session, how they might use the e-book in their daily life, and their suggestions for system improvement.

Among all the parents, three completed the interview in English and the rest completed in Spanish. For the Spanish interviews, two bilingual Latinx researchers who carried out the interview translated them into English, and the translation was subsequently reviewed by other bilingual team members to ensure accuracy. Based on the transcription, two authors then conducted a thematic analysis [2], focusing on the users’ experiences, challenges, potential usage, and feedback. Each of the two authors independently analyzed the transcripts, identifying relevant extracts and categorizing them into initial codes. They then discussed their codes and worked together to cluster them into potential themes. To ensure the coherence and distinctiveness of the final themes, the authors carefully reviewed all extracts under each code and checked for any contradictions or overlaps. If necessary, they modified the themes by dividing them into separate themes or moving codes to different themes where they fit better. This process was repeated until all issues were resolved and a set of coherent, distinct themes was obtained.

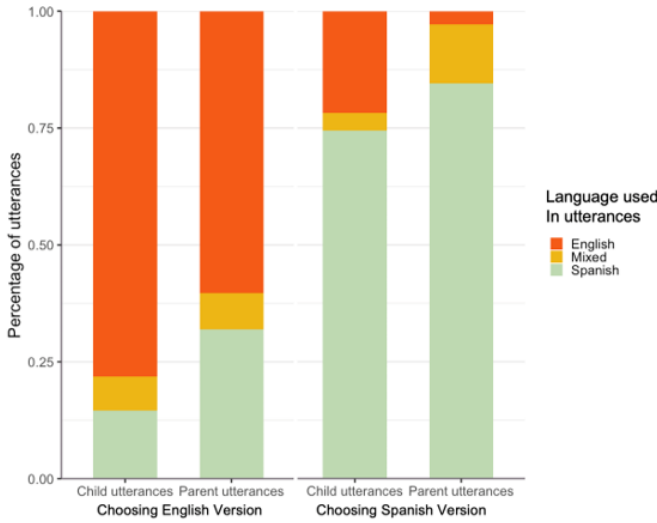


Figure 4: Bilingual Choice

5.2 How Did Children and Parents Interact with Rosita?

All but one of the 18 pairs of participants completed the reading session successfully, with an average duration of 22 minutes. The exception occurred due to the child having a bad mood upon arrival due to a reason unrelated to our study, as indicated by the parent. The child did not sit at the table where the experimental laptop was placed, while their parent used the e-book and interacted with Rosita alone. We excluded data from this parent-child pair from our interaction analysis.

5.2.1 Conversation Productivity. On average, children verbally engaged in 80% of the conversation units, while parents were active in 91% of the units. When examining family and child questions separately, we found that parents' involvement was higher during family questions, as expected. Both children and parents produced similar numbers of utterances, although these quantities were higher during family question units compared to child question units. In other words, participants' conversations in response to family questions contained more back-and-forth dialogue. In terms of length, however, we found that parents produced longer utterances, with an average of around 7.5 words, while children's utterances averaged around 2.6 words. This pattern was consistent across both family and child questions, with the difference likely being at least partially due to children's still developing language proficiency. Figure 3 displays the number and length of parent-child utterances.

5.2.2 Bilingual Choice. Of the 18 parent-child pairs that participated in the study, 13 chose to read the e-book in Spanish, while the remaining 5 read in English. As expected, those who read in English tended to respond to Rosita's questions in English more often, while those who read in Spanish tended to use more Spanish. Children generally spoke more English than their parents. However, we observed a significant amount of code-switching between English and Spanish among all participants, regardless of their chosen language (Figure 4). For example, children who read the Spanish

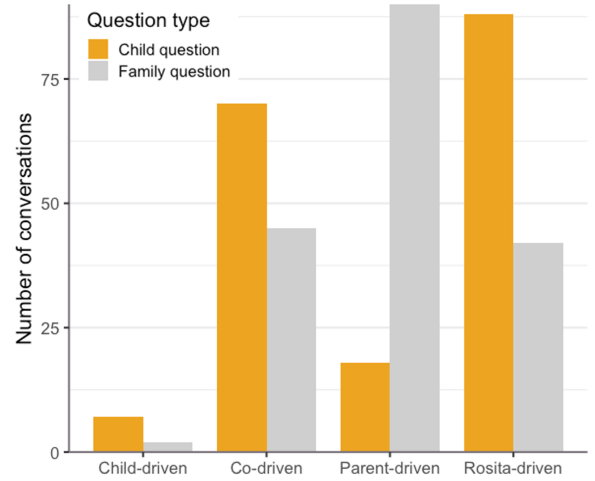


Figure 5: Interaction style

e-book spoke English during 22% of their utterances, while children who read the English e-book spoke Spanish during 18%. One exception was that parents rarely spoke English if they had chosen to read in Spanish; in these cases, only 2% of their utterances were in English.

5.2.3 Interaction Styles. We then examined the conversation styles children and their parents used while reading the e-book (Figure 5). Rosita-driven conversations, which are characterized by direct engagement with children through story-oriented verbal exchanges, were the most common, constituting 35.8% of all conversation units. Rosita-parent co-driven conversations, in which parents facilitated their child's response to Rosita's questions, made up 32.0% of the units, while parent-driven conversations accounted for 29.8%. Child-driven conversations were relatively rare, comprising only 2.5% of units. When we examined the interaction styles by question type, we found that the responses to child questions and family questions exhibited different patterns (Figure 5). The vast majority of dialogue in responses to child questions was Rosita-driven. In contrast, the vast majority of responses to family questions were parent-driven. Analysis suggested that there was a significant effect of question types on parent-child interaction styles ($(\chi)^2 = 72.55$, $df = 3$, $p < 0.0001$).

An analysis of the conversation transcripts and video recordings revealed more details about the specific characteristics of each interaction style.

First, Rosita-driven interaction was characterized by children actively and independently responding to Rosita's questions. Although parents did not participate verbally, they were attentive to their child's responses and often acknowledged them with gestures such as smiling or nodding. Additionally, all children used body language—including pointing, eye contact, gestures, smiling, nodding, and head-shaking—as a way of responding. For instance, when Rosita asked the children what Rosita's grandmother had told her and Elmo to do before cooking, six children answered "handwashing" while acting out the motion.

Second, in Rosita-parent co-driven interaction, parents often joined the conversation to assist their children when they did not respond, responded non-verbally, or otherwise indicated difficulty responding through non-verbal cues. All participating parents used a common technique of repeating the question verbatim to prompt their child. In addition to this strategy, parents also provided hints and clues, reminded their child to look at relevant images, and generated multiple options for their children to choose from. For instance, when asked to recall the food that Rosita was making with avocado, a child had difficulty providing the correct answer (guacamole). In this case, the parent intervened by offering two options to choose from:

Rosita: (to the child) *Look! I am mashing an avocado in the bowl. What food am I making?*

Child: (silence)

Parent: (to the child) *Avocado. Are they making guacamole or salsa?*

Child: *Salsa.*

Third, parent-driven interactions were characterized by parents making connections with their daily routines by mentioning specific foods, shared memories, and other familiar elements in their responses. For instance, when Rosita asked about their family's favorite food, one parent prompted their child by saying, "*What do we eat? We eat lots of beans, right?*" Another parent used a shared memory, reminding their child of a trip to the grocery market and asking, "*What's everything we put into the trolley we carry to the market?*" The child excitedly listed items such as fruit, pie, and soda, after which the parent and child shared a brief exchange about the child's love for sweets. Additionally, parents' responses sometimes expanded to related topics, such as in the example below (translated from Spanish, original quote in Appendix):

Rosita: (to parent and child) *Another question for the family. I love making guacamole with my grandma. What food do you like to make in your family?*

Child: (to parent) *Pizza.*

Parent: *Do you like pizza?*

Child: *Yes.*

Parent: *How is pizza made? What are the ingredients?*

Child: *Flour.*

Parent: *Flour. And what do you add to it? What else do you love on your pizza?*

Child: *Pepperoni.*

Parent: *Pepperoni.*

We also observed that parents provided guidance to their children by encouraging them to practice Spanish vocabulary words. For example, when Rosita asked the child about the taste of the food, the child responded with "delicious" in English. In response, the parent prompted the child to use the Spanish word *delicioso*, which had also been used earlier in the story.

Fourth, child-driven interactions occurred most frequently when the child was confused by the "child questions" or during "family questions," when the child was trying to engage their parents in the topic being discussed. For example, when Rosita asked a child to recall what Elmo did with a lemon (with the correct answer being "squirting lemon juice on the paper"), the child turned to their parent and asked, "*What is done on the paper?*" After the parent pointed

to the lemon in the illustration, the child replied to Rosita with the correct answer. In another instance during a family question, a child told their parent their favorite food and then asked the parent the same question:

Rosita: (to parent and child) *I love guacamole and Elmo loves salsa. They are delicious. What's your family's favorite food?*

Child: (to parent and Rosita) *Fruit.*

Parent: *What do you like?*

Child: *Spaghetti.*

Parent: *Spaghetti again?*

Child: *Yeah, but what do you like?*

Parent: *I like rice and beans.*

Child: *Rice and beans? I thought you like Mexican food.*

Parent: *Yeah, that's Mexican food. How about tacos?*

Do you like tacos?

Child: *I love tacos.*

Parent: *Yummy.*

5.3 How Did Parents Perceive Rosita?

The interviews revealed that parents were generally positive about the design of "Rosita Reads With My Family" and had constructive insights for further improving the overall system (Figure 6).

Parents felt that Rosita's questions for children facilitated children's story comprehension. Half of the parents commented on the value of Rosita's questions in helping children understand the story. Parents thought that Rosita's questions were "*specific to the pictures*" (P17) as they "*specified what they were actually doing in the book*" (P14). Moreover, Rosita's questions "*forced the child to see what they were doing*" (P17) and "*reaffirmed the story so that you understood what the topic is or what they're going to do*" (P09). Moreover, eight parents spoke highly of the quality of Rosita's questions. They regarded Rosita's questions as "*straight to the point*" (P18), "*good and concrete*" (P06), "*well-formulated*" (P12), and "*perfect for [their child's] age*" (P14). These findings align with the results from prior research which indicated that conversational agents can support children's story comprehension by serving as their reading partners [49].

Parents felt that Rosita's family questions could help provide opportunities for them to bond with their child. All of the parents acknowledged that Rosita's family questions triggered some form of verbal exchange between them and their child. For example, P18 thought that Rosita's family questions encouraged her and her child to share their life experiences with each other and talk about "*everything that's going on*". Likewise, P06 appreciated the opportunity to engage in the conversation with their children as "*it is very important to connect with the children.*" Additionally, P16 thought positively about the family questions because "*it depends on how the child and the mom interact, so the mom will have to ask him more details, and more conversations.*" Moreover, Rosita's family questions also helped parents learn "*what children want to do*", thus building and improving connections between the parent and the child (P17). These types of feedback support the idea that parent-child co-reading with Rosita brings benefits that go beyond improving the child's reading comprehension.

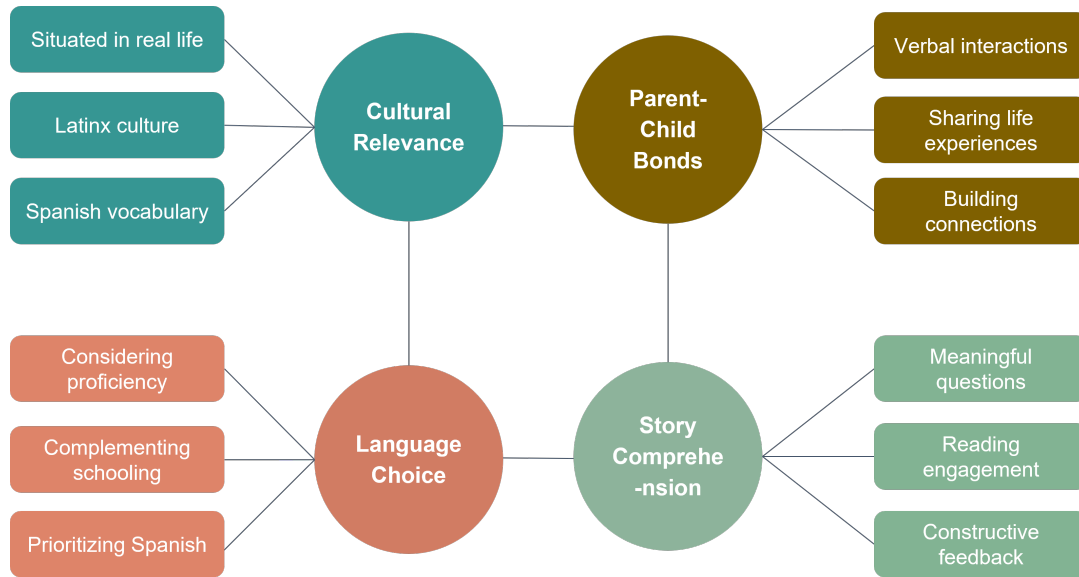


Figure 6: Thematic analysis of parent interview

Parents valued the cultural relevance of the story. The nine parents who commented on the content of the story all mentioned that the story was closely related to their daily life. For instance, P17 stated, “it’s something that happened in real life, and seeing what [Rosita’s abuela] says here is the same thing my mom does.” P10 regarded the part where “the abuela visited the characters and they did fun things together” as her favorite part of the story. P04 said that she liked “how it can be applied in real life.” Parents also appreciated how the story helped children learn Spanish vocabulary and Latinx culture by including “Mexican names” (P15), “Mexican foods” (P16), and “family vocabulary” in Spanish (P17). Additionally, “the story is teaching Mexican culture along with American culture,” encouraging children to “start interacting with both nations” (P15). These findings were consistent with the literature that culturally responsive technology design connects children to their family traditions, helps them value their heritage culture, and cultivates cultural identities [19].

Parents considered children’s language preferences while intentionally prioritizing children’s Spanish language development. Parents often took their children’s language proficiency into account. They chose their children’s “primary language” (P01), “what they speak the most at home” (P08), or what they felt “more comfortable with” (P15). Moreover, eight parents further explained that they wanted to expose their child to more Spanish content, with one reason being that their child’s school emphasized English learning over Spanish. For example, P04 said that when their child is in school, “they only speak pure English, so I taught my children Spanish from the time they were born until they enter the school where they learn English.” P08 shared a similar stance: “there are many places that don’t teach you Spanish in the schools, they focus more on English.” These findings revealed that parents valued and desired Spanish content for their children due to a lack of emphasis on Spanish learning opportunities in mainstream curricula.

Parents suggested that the dialogue be more adaptive to individual children’s language proficiency and attention span. In the current version of “Rosita Reads With My Family,” all readers received the same child and family questions, although how Rosita replied to the participants was contingent upon a child’s response. However, some parents pointed out that the frequency and content of the questions might not be suitable for their child. For example, P11 mentioned that their child became distracted as there were “too many family questions.” Moreover, Rosita’s questions were not “straightforward” enough for their four-year-old (P15).

Parents alluded to some usability issues during the user study, despite the general attitude regarding the usability of “Rosita Reads With My Family” being positive. The most common issue was the inaccurate speech recognition, which sometimes misinterpreted or failed to register a child’s spoken responses. As P18 said, “(My child’s) voice was very low, she (Rosita) didn’t hear him.”

6 DISCUSSION

This project involved the implementation of a conversational agent to encourage and support shared reading practices between parents and children. We found that children actively responded to Rosita’s questions, and Rosita’s family questions sparked discussions between parents and children about their daily life as it related to the story. Interviews with the parents revealed their appreciation for the way our conversational agent stimulated parent-child dialogue during the reading.

6.1 Using AI to Support Shared Storybook Reading

“Rosita Reads With My Family” was intended to replicate the benefits of existing conversational agents that carried out one-on-one interactions with children [49] but also encouraging the parent and child to engage in conversation that goes beyond the reading

material itself. Our analysis revealed that parents' communication behaviors conformed with the goals of these types of questions despite the parents receiving minimal instruction for using this e-book. Our child questions were of the "known-answer" type, commonly used by teachers [28] and parents across cultural groups [42] to confirm whether children have understood specific information. These types of questions encouraged parents in our study to scaffold the question for their children when necessary. Furthermore, our more open-ended family questions prompted parents to make the conversation more personal and free-flowing by tying it to their daily lives. Overall, our findings suggest that this type of conversational AI-powered learning media provides an enriching learning experience while promoting parents' awareness of and ability to engage in dialogic reading with their children.

While we observed promising results with our e-book, a small number of parents appeared to struggle with engaging their children in rich dialogue. These parents simply repeated Rosita's questions to their children and pushed for more detailed responses, usually resulting in children providing single-word answers. Thus, future designs of conversational agents may need to provide more scaffolding for parents, such as offering follow-up questions based on the content of parent-child discussions to help extend their conversations. Additionally, this pattern may be due to the "natural ambiguity" of the roles that parents and children experience when interacting with a conversational agent, as previously observed in another study [30]. Future designs could address this issue by providing clearer direction on the parents' expected roles during the co-reading process.

6.2 Designing For Linguistic Minority Communities

The design of "Rosita Reads With My Family" considered the bilingual and bi-cultural backgrounds of our users, which is important for promoting joint engagement during reading. Parents whose first language is not English may encounter challenges when reading an English story with their children due to limited English proficiency [7]. Research suggests that it is more beneficial for parents to read or talk to their children in the language they are most comfortable with. At the same time, it is also important to consider the value of early exposure to English and families' desire to cultivate children's bilingual fluency. To address these considerations, "Rosita Reads With My Family" allowed families to choose their preferred language and incorporated a fully bilingual conversational agent capable of comprehending spoken input in English and Spanish. Our user study indicated that this design seemed to be in line with the linguistic flexibility of our participants, who had diverse language backgrounds and preferences, and the participants appreciated the bilingual feature, particularly when there was a strong preference for a particular language.

However, our user study also revealed that parents and children within the same family may have different language preferences, and they may need to negotiate and compromise with each other. In some cases, the child preferred reading in English but the parents preferred Spanish, as they were not proficient in English. In these situations, the families usually ended up choosing the Spanish version, but the children continued to respond to Rosita or talk

to their parents in English. While these families still had smooth translanguaging interaction experiences thanks to Rosita's bilingual capabilities, these scenarios prompted us to consider how to provide support for parents who wish to engage in reading in a language they are less proficient with. One potential solution could be to allow the conversational agent to narrate the story in the language preferred by the child (e.g., English) while displaying discussion prompts for the family questions in the parent's preferred language (e.g., Spanish) to facilitate interaction in both languages. This would allow family members to read and interact in the language they are most comfortable with while still promoting joint engagement and linguistic richness. Additional research, such as that conducted by Yang and colleagues [54], could further explore the role of bilingual conversational agents in supporting multilingual families' reading experiences.

6.3 Future Directions

There are several directions for future work to both improve the design and provide more empirical evidence how AI may support parent-child joint reading.

One direction for future research is to compare the benefits of using conversational agents to engage children alone with the benefits of engaging parents in the reading process. There are numerous studies suggesting that parent involvement can lead to children being exposed to richer language and experiencing higher levels of engagement (e.g., [49]). It is reasonable to expect that parent-child co-reading would have additional benefits compared to children reading independently. Future studies could use a randomized controlled trial to compare these two approaches and examine the effects on children's language exposure and engagement.

Another future direction is to understand how children from different age groups interact with "Rosita Reads With My Family" and how the system can be modified to meet their diverse needs. As reported in the results from the post-study interviews, parents identified several areas where the e-book could be improved to better meet the needs of their child, particularly with regard to the frequency and content of the questions. Given that parents have clear preferences for the types of interactive strategies that are suitable for their child, it may be helpful to allow parents greater flexibility to adapt the system to their child's needs. For example, future systems might offer a list of child and family questions that parents can choose from to customize the reading experience for their child.

During our study of parent-child pairs engaging with the e-book, we encountered instances where accompanying siblings were also interested in participating in the readings. Thus, future research should investigate how "Rosita Reads With My Family" could accommodate more users, such as one parent and multiple siblings. The interactive dynamics in these scenarios are likely to be more complex, as there will be more parties involved in the conversation. We already noticed that parents using our current system sometimes had difficulty transitioning from a supportive role during child questions to an active role during family questions. To accommodate the participation of more than two users, it is important to design the dialogue flow so that each user can participate smoothly.

7 CONCLUSION

This study presents “Rosita Reads With My Family,” an e-book incorporating a bilingual conversational agent designed to support parent-child interactions and address the unique school readiness needs of Latinx bilingual children. Rosita is tailored to address the cultural and linguistic needs of Latinx bilingual children and is intended to involve parents in the reading. Our user study suggested that the bilingual agent fulfilled its intended goals by both encouraging children’s verbal engagement in response to reading comprehension questions and facilitating parent-child dialogue on more personal topics directly related to the story. Our study offers a compelling case of conversational technologies being embedded in children’s specific social and cultural contexts in ways that are known to promote their bilingual development.

ACKNOWLEDGMENTS

We thank the Joan Ganz Cooney Center at Sesame Workshop for collaboration on this research. We thank the Santa Ana Early Learning Initiative (SAELI) for assisting with participant recruitment. We also thank the families and children who participated in this study.

PARTICIPATION AND SELECTION OF CHILDREN

This study was approved by the Institutional Review Board of the University of California, Irvine. The recruitment of participants was conducted by the Santa Ana Early Learning Initiative, a non-profit organization that has a close relationship with the school district serving local students. Participants were selected based on the inclusion and exclusion criteria, which included being identified as Latinx/Hispanic and being between the ages of three and six years old. Eighteen parent-child pairs were recruited through this method, informed of the study procedures in detail by a bilingual researcher, and presented with a Study Information Sheet. All 18 parent-child pairs consented to participate in the study and were informed that they could discontinue at any time. Upon completion of the study, participants received \$25 in cash and a Sesame Street picture book worth \$5 as compensation for their time.

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8 APPENDICES

8.1 Conversational Script for Rosita

Page	E/S	Child Question	Family Question
1	English	Wow, look at that! Elmo and I are in the picture! Why are we so excited?	Haha. Here comes the question: Who do you like to visit in your family?
	Spanish	¡Wow, mira eso! ¡Elmo y yo estamos en la foto! ¿Por qué estamos tan emocionados?	Ja ja. Aquí viene la pregunta: ¿A quién te gusta visitar en tu familia?
2	English	Yay, Elmo met my Abuela today! What are we going to do together?	Now, a family question! I love cooking with my family! What do you like to do together in your family?
	Spanish	¡Bravo! ¡Elmo conoció a mi Abuela hoy! ¿Qué vamos a hacer juntos?	¡Ahora, una pregunta para la familia! Me encanta cocinar con mi familia! ¿Qué les gusta hacer juntos en tu familia?
3	English	Hooray! We are going to make some yummy food! What food are we going to make together?	Another family question! I love making guacamole with my Abuela! What food do you like to make in your family?
	Spanish	¡Bravo! ¡Vamos a hacer una comida rica! ¿Qué comida vamos a hacer juntos?	¡Otra pregunta para la familia! ¡Me encanta hacer guacamole con mi Abuela! ¿Qué comida te gusta hacer en tu familia?
4	English	Look! Elmo and I are drawing a colorful shopping list. Why do you think we need a shopping list?	Now, a family question! Elmo and I are using crayons to draw our shopping list! What do you like to draw?
	Spanish	¡Mira! Elmo y yo estamos dibujando una lista de compras muy llena de color. ¿Por qué crees que necesitamos una lista de compras?	¡Ahora, una pregunta para la familia! ¡Elmo y yo estamos usando crayones para dibujar nuestra lista de compras! ¿A ti qué te gusta dibujar?
5	English	Hahaha, look at Elmo! What funny thing did Elmo do?	Look! Elmo is doing something funny! What funny thing did you do in your family?
	Spanish	Jajaja, mira a Elmo! ¿Qué cosa cómica hizo Elmo?	¡Mira! ¡Elmo está haciendo algo cómico! ¿Qué cosa cómica haces en tu familia?
6	English	We bought all the ingredients for making guacamole and salsa! What did we buy at the market?	Now, a family question! Do you like going to the market together with your family? What foods do you usually buy at the market?
	Spanish	¡Ah, compramos todos los ingredientes para hacer guacamole y salsa! ¿Qué compramos en el mercado?	¡Ahora, una pregunta para la familia! ¿Te gusta ir al mercado con tu familia? ¿Cuáles comidas usualmente compran en el mercado?
7	English	Haha, we are ready to make salsa and guacamole! Oh wait, what does grandma ask us to do before we start cooking?	Now, a family question! Elmo and I always wash our hands before we cook or eat! What are the steps in handwashing?
	Spanish	¡Jaja, estamos listos para hacer salsa y guacamole! Oh, espera, ¿qué nos pide abuela que hagamos antes de empezar a cocinar?	¡Ahora, una pregunta para la familia! ¡Elmo y yo siempre nos lavamos las manos antes de cocinar o comer! ¿Cuáles son los pasos para lavarnos las manos?
8	English	Look! I am mashing an avocado in the bowl. What food am I making?	Now, a family question! I'm using a green avocado to make guacamole! Do you know any other fruits or vegetables that are green? Do you like to eat them?
	Spanish	¡Mira! Estoy machucando un aguacate en un plato hondo. ¿Qué comida estoy preparando?	¡Ahora, una pregunta para la familia! ¡Estoy usando un aguacate verde para preparar guacamole! ¿Conoces otras frutas o verduras que son verdes? ¿Te gustan?
9	English	Look! Elmo is making salsa! What ingredient is Elmo using to make salsa?	Another family question! Elmo is using tomatoes to make salsa! What else can you put tomatoes in? Do you like to eat that?
	Spanish	¡Mira, Elmo está preparando salsa! ¿Qué ingrediente está usando Elmo para preparar salsa?	¡Ahora, una pregunta para la familia! ¡Elmo está usando tomates para preparar salsa! ¿En qué otras comidas se usan los tomates? ¿Te gusta comer eso?
10	English	Yay! The guacamole and salsa are ready! How do they taste?	Now, a family question! I love guacamole and Elmo loves salsa. They are delicious! What's your family's favorite food?
	Spanish	¡Bravo! ¡El guacamole y la salsa están listos! ¿Cómo saben las salsas?	¡Ahora, una pregunta para la familia! A mí me encanta el guacamole y a Elmo le encanta la salsa picante. ¿Cuál es la comida favorita de tu familia?
11	English	Look, my amigos are all smiling! Why are they so happy?	Another family question! Elmo and I shared the food with our amigos at the fiesta! What do you like to do at parties with your family?
	Spanish	¡Mira, mis amigos están sonriendo! ¿Por qué están tan felices?	¡Otra pregunta para la familia! Elmo y yo compartimos la comida con nuestros amigos en la fiesta. ¿Qué te gusta hacer en las fiestas con tu familia?

8.2 Parent-driven Conversation Excerpt

Rosita: (to parent and child) *Sí, vamos a hacer guacamole. Me encanta el guacamole. Y también vamos a hacer salsa. A Elmo le encanta la salsa picante. Empecemos. Muévele. Otra pregunta para la familia. Me encanta hacer guacamole con mi abuela. ¿Qué comida te gusta hacer en tu familia?*

Child: (to parent) *Una pizza.*

Parent: *Una pizza te gusta?*

Child: *Si.*

Parent: *¿Cómo se hace la pizza? Cuáles son sus ingredientes?*

Child: *Harina.*

Parent: *Harina. ¿Y qué le echas con esto? ¿Y qué más? De que te encanta la pizza?*

Child: *Pepperoni.*

Parent: *Pepperoni.*