Self-Talk with Superhero Zip: Supporting Children's Socioemotional Learning with Conversational Agents

Yue Fu
Information School, University of Washington
Seattle, Washington, US
chrisfu@uw.edu

Mingrui Zhang
Meta Reality Labs
New York City, New York, US
z1m6r3@gmail.com

Lynn K Nguyen
School of Computer Science and Engineering, University of Washington
Seattle, Washington, US
lynnkn@uw.edu

Yifan Lin
Human-Centered Design and Engineering, University of Washington
Seattle, Washington, US
yifanl26@uw.edu

Rebecca Michelson
Human-Centered Design and Engineering, University of Washington
Seattle, Washington, US
rem23@uw.edu

Tala June Tayebi
Information School, University of Washington
Seattle, Washington, US
tayebit@uw.edu

Alexis Hiniker
Information School, University of Washington
Seattle, Washington, US
alexisr@uw.edu

ABSTRACT

Socioemotional competencies are fundamental for children's growth and success, and prior work shows that in some instances, technology can support children in acquiring these skills. Here, we examine whether children can learn to use a socioemotional strategy known as "self-talk" from a conversational agent (CA). To investigate this question, we designed and built "Self-Talk with Superhero Zip," an interactive CA experience, and deployed it for one week in ten family homes to pairs of siblings between the ages of five and ten (N = 20). We found that children could recall and accurately describe the lessons taught by the intervention, and we saw indications of children applying self-talk in daily life. Targeting sibling pairs rather than individual users proved to be a design challenge in its own right, and families suggested design ideas for supporting this context, such as UI to manage conversational flow and reduce competition, and visuals and embodied activities to encourage focus. The dual-user context coupled with the audio modality prompted "preinput huddles" in which children conversed in whispers before responding to the system. We contribute evidence that CAs can support children in learning to use self-talk as well as design guidance for creating multi-user conversational interfaces.

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CCS CONCEPTS

• **Human-Centered Computing**; • **Human-Computer Interaction (HCI)**;

KEYWORDS

socioemotional learning, conversational agents, self-talk

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1 INTRODUCTION

Socioemotional skills are a set of competencies for understanding oneself, expressing one's feelings, empathizing with others, and building meaningful interpersonal relationships [64]. Beginning in early childhood, children develop socioemotional skills through daily interactions and routines [55], and they continue to build these skills throughout their lives [48]. Socioemotional skills enable children to cultivate self-confidence [5], take on challenging tasks [50], foster relationships with others [78], and succeed in academic and non-academic settings [49]. Thus, developing these skills is a vital part of childhood, and supporting children's socioemotional learning (SEL) is a critical task. Prior research has shown that children can learn socioemotional skills from media and interactive technologies, including cooperative games [84], television [60], and social robots [17]. Prior work describes designing to support children's SEL as a promising line of HCI research [29, 66, 68].

Conversational agents (CAs) like the Amazon Echo, Siri, and Google Home may be effective tools for helping children build socioemotional competencies [46, 47]. People consciously and unconsciously react socially to these personified technologies, creating a context where users spontaneously draw on and practice their socioemotional skills. The rapid adoption of smart speakers and virtual assistants has brought CAs into many family homes [42], creating an opportunity for SEL experiences for CAs to reach millions of children. Prior work has found both that parents see potential for CAs to support socioemotional skills like active listening and turn-taking, but also that they are also wary of relying on technology to teach interpersonal skills [15, 29, 43]. Collectively, this work suggests that creating SEL experiences for CAs that families find acceptable is both a worthwhile goal and a challenging design problem.

Thus, the goal of this work was to design and evaluate one proof-of-concept CA system to teach a single socioemotional skill. After reviewing existing offline, evidence-based SEL interventions, we chose to investigate CAs' potential to teach the "positive self-talk" strategy for noticing, interpreting, and responding to emotions and events. "Self-talk" refers to the act of speaking to oneself, either out loud or (more commonly) as a voice inside one's own head [75]. It is a practice children and adults spontaneously engage in, often without even realizing it. *Positive* self-talk is the act of intentionally speaking to oneself in a constructive way, guiding oneself toward resilience, persistence, and character development, even in moments of adversity. Self-talk can predictively affect people's physical and cognitive performance [16, 41], ability to self-regulate [2], and problem-solving and social skills [25, 45]. Positive self-talk techniques have been incorporated into several SEL curricula [5, 77]. Thus, we asked:

- **RQ1:** Can a CA support children in learning to use positive self-talk?
- **RQ2:** How should such an intervention be designed for use in family homes?

To investigate these questions, we created "Self-Talk with Superhero Zip," an interactive, story-based CA experience. We designed our intervention for sibling pairs rather than individual users, because socioemotional interventions are most effective when taught and practiced collaboratively [51] and educational technologies are more likely to produce learning gains if they provide accurate feedback to learners [27]. One known shortcoming of existing CAs is that they rarely provide contingent feedback to their users [29, 58], thus we sought to create an environment that leveraged interpersonal conversation.

We deployed the system to pairs of siblings between the ages of five- and ten-years-old (inclusive) in ten family homes. Families participated in a one-week field deployment in which children engaged with five different CA-based interactive lessons. During the deployment, children recorded their responses to audio prompts from the system and families completed a daily survey documenting their experience with the system. We conducted whole-family interviews before and after the intervention to: 1) explore children's and parents' experiences, and 2) capture children's responses to pre- and post-intervention questions about responding to challenges.

Post-intervention, children were able to accurately define self-talk and the steps to employ it. Children described ways in which they envisioned themselves using self-talk in daily life, and by the end of the intervention, all of the children who initially described using negative self-talk when facing challenges ($N = 5$) described using positive self-talk instead. After living with the system, parents reported favorable views of the premise of using CAs for SEL, in contrast to prior work reporting parent wariness about the idea of using CAs in this context [29]. We contribute: 1) empirical evidence demonstrating that CAs can support children in adopting self-talk, 2) considerations for designing CAs for siblings, and 3) design suggestions from families for future CA technologies for SEL, such as incorporating physical and sensory experiences and adding UI to manage conversational flow.

2 RELATED WORK

2.1 Socioemotional Learning (SEL) and Technology

Socioemotional competencies are a set of fundamental skills categorized into the five categories of: 1) self-awareness 2) self-management 3) social-awareness 4) relationship skills, and 5) responsible decision-making [13]. Children begin developing these skills in early childhood [55] and continue to refine them throughout their lives [48]. Prior research shows that socioemotional skills acquired in preschool later enable academic success, improve mental health, reduce risk-taking behaviors, enhance adjustment, and improve peer relations and social competence [20, 22, 31, 59], making them critical to children's growth and success. As a result, researchers have created many non-digital SEL interventions to support children in developing these competencies through direct instruction, modeling, and practice [76].

Robots, media, games, and other interactive technologies can also support children's SEL [38, 53, 66, 71]. For example, prior work shows that technologies for SEL can support children's mental health [39], mediate interpersonal conflict [65], and augment positive mood [17]. Sesame Workshop, Disney Junior, and other media programs have incorporated SEL into their programs [52, 80]. Prior research show playing Pokemon Go can improve adolescents' social relationships [61], and online games can teach preschool children socioemotional competencies [52]. There is a growing interest in HCI community in supporting SEL and emotional regulation through technology [4, 17]. Slovak et al. report this trend and present a framework that includes theoretical, strategic, and practical guidelines to help interactive designers envision future technologies for emotional regulation [66].

Although there is abundant literature demonstrating that children can learn from CAs [14, 37, 40, 82], there is little work exploring whether and how they can support children's SEL. Because of the social and conversational nature of CAs, researchers have demonstrated they can support children's curiosity [1], support children's language learning, encourage self-reflection [40], and promote children's verbal communication and self-expression [14]. Prior research has noted that commercial CA experiences for SEL are limited [29]. The same study finds that parents see potential in using CAs to support children's prosocial behavior and calls for future studies to explore CA-supported SEL [29].

Thus, the goal of the current study was to design and deploy a CA experience to support children's SEL at home, given the importance of SEL, children's ability to learn from CAs, and the current lack of commercial offerings for this context.

2.2 Positive Self-Talk as a Socioemotional Tool

Theodorakis and colleagues define self-talk as "*what people say to themselves either out loud or as a small voice inside their head*" [75]. Self-talk modulates brain states concerning cognitive performance [41], and prior work shows that self-talk affects task performance by decreasing the occurrence of intrusive thoughts unrelated to task execution [33, 74]. Self-talk has been researched widely in the context of sports, and it is often used in sports to enhance players' performance [34, 35, 63, 74, 75].

Children's use of self-talk, also called private speech, plays an important role in shaping children's experience with social and cognitive phenomena [21]. Children use self-talk to regulate their behavior, facilitate complex cognitive functions, regulate task engagement, and cope with social challenges [2, 25]. As a result, positive self-talk can improve children's social and emotional competencies and problem-solving ability [45] and lead to inreased self-esteem, fewer irrational beliefs, and lower risk of depression [11].

Self-talk has been incorporated into several SEL curricula [5, 77]. However, little work has been conducted on how technology can support self-talk, which Hardy and Zourbanos call out as a promising topic for research [32]. In the current study, we investigate whether a CA-based intervention can teach self-talk, drawing on Burnett's four-part, evidence-based framework for employing self-talk [12]. This framework works through steps labeled: "H," "T," "F," and "D" (what **H**appens to you, what you **T**hink about it, how you **F**eel about it, and what you **D**o).

2.3 Joint Media Engagement

Joint media engagement (JME) is defined as people engaging with a media experience together. JME can apply to a wide range of modalities, such as television, mobile devices, and other technologies [24, 73]. Research notes children are more engaged during JME activities than during individual technology use, and parents and children support each other with cognitive, physical, technical, and affective techniques [24, 83]. Parents value the bonding that can occur during JME experiences, such as co-playing outdoor mobile games (Pokèmon Go) with their children [70]. JME between parents and children can positively impact parent-child relationships [81] and fosters children's learning [73].

In addition, JME also occurs among siblings and friends. Prior research shows JME among siblings can promote collaboration and facilitate children's understanding of media content [6]. One study researching children's collaborative processes while playing Minecraft shows that children's prior social ties, game experience, and responsiveness to other players all influence their joint attention, thus affecting their in-game collaboration [18]. Go et al. outline sibling game play as a unique design context and describe the design considerations for this space [30].

Research has laid out the conditions and processes that lead to productive JME, namely 1) mutual engagement, 2) dialogic inquiry, 3) co-creation, 4) boundary crossing, 5) intention to develop, and 6) focus on content, not control [73]. Prior research has pointed out the need to supply tools to scaffold parents' engagement for children's SEL, such as interactive prompts, cues, and activities [67]. Our study draws on this foundation for guidance in the design of an interactive technology intended for co-use by siblings in family homes.

3 SYSTEM DESIGN

3.1 Design Process

To create the system used in this study, the research team first curated existing socioemotional curricula, with each team member independently identifying existing frameworks and sharing these interventions with the group. These included the RULER framework [62], Harvard's EASEL resource [23], the Strong Kids Curriculum [72], the Second Step Curriculum [10], the Kindness Curriculum [26], the Strong Start Curriculum [79], the CASEL framework [13] and others. In total, the team reviewed 11 evidence-based curricula for SEL and discussed each as a group. For each framework, we discussed its aims and components, its suitability for the CA form factor, the feasibility of implementing its components in a digital context, the strength of evidence backing the framework, and the alignment with design principles from the formative work our team had conducted (prior interviews with families).

Drawing on this collection of interventions, the team met weekly over six weeks to iteratively design candidate prototypes. We divided the socioemotional competencies targeted by these frameworks into two categories: the outward-facing subcomponents of decision making, social awareness, and relationship skills, and the inward-facing subcomponents of self-awareness and self-management. To facilitate divergent thinking, the team then pursued two different design approaches in parallel. One team iteratively designed a prototype targeting outward-facing subcomponents and the other designed a prototype targeting the inward-facing ones. Each week, each group shared design concepts and provided critique to the other team. Design work included sketching, script drafting, structuring dialogic prompts, and translating intervention components into digital interfaces. Each week, each team produced a paper prototype of increasing fidelity, with one group developing a storyline about a wizard named Willa and a structure of branching multiple-choice questions that the user answers to help heroine Willa tackle various interpersonal challenges and draw on existing SEL interventions.

The other team developed a storyline about a superhero named Zip who helps children help themselves through socioemotional interventions. The use of the superhero theme was inspired by a classroom-based exercise developed by Harvard's EASEL lab in which teachers encourage children to imagine a tiny superhero on their shoulder providing coaching input [23]. Throughout our prototype, the superhero explains SEL concepts, gives examples, and asks the child user to imagine applying these skills in their own life and using these skills to help others. The team decided to use storytelling to teach SEL lessons because metaphors and stories serve as particularly attractive instruments to improve young people's information-processing abilities and assist them in changing behavior [28, 44, 54]. Clinicians with a cognitive-behavioral focus have welcomed them into their therapeutic approaches [9]. Both

prototypes we designed incorporated a mix of interaction styles to test, including quizzes, reflection prompts, modeling, storytelling, repetition, and feedback. During weekly critiques, the team refined this mix of interactions and narrative into two cohesive prototypes.

After designing these two prototypes, we conducted two participatory design workshops with seven children between the ages of 7 and 11, one for each prototype. For each session, we created pre-recorded audio files to serve as the system output and two researchers collaboratively ran a wizard-of-oz usage session, with one researcher facilitating and the other acting as the wizard. After children tried the prototype, we asked them to share their likes, dislikes, and ideas to improve the storylines or interaction. With children's feedback, we generated a new design that combined interactive elements from each prototype, isolated the "self-talk" intervention as our target skill to teach, and further developed the superhero storyline. As part of this collaborative iteration and in response to feedback from our workshops, the team also decided to focus on designing for siblings and friends. Many of the SEL interventions we examined rely on interpersonal interaction and feedback, and prior work shows that current CAs have limited ability to provide contingent feedback to users [29]. By designing the interaction for siblings or close friends, we sought to create a CA that can delegate discussion, promote engagement, and leave opportunities for the users to discuss lessons.

We tested the updated version of our paper prototype with two siblings, who provided primarily positive feedback after using a wizard-of-oz version of the system. The siblings suggested additional storyline ideas like talking animals, magic, and supervillain characters. We incorporated these ideas into our final prototype design, and expanded the experience into five sessions, intended to be experienced over the course of one week.

3.2 Self-Talk with Superhero Zip

Ultimately, we designed and implemented a voice-based interactive web application called "Self-Talk with Superhero Zip." The app's core intervention follows the four-part framework for employing self-talk described in Section 2.2. By developing a web application instead of using a third-party service like Amazon Alexa Developer Console [3], we had more flexibility to control the interaction and data collection. We implemented the web app using Google's Speech-to-Text API to capture and recognize audio, ReactJS for front-end developement, and NodeJS for back-end development. Users' responses to prompts from the system were uploaded to AWS S3 cloud storage as audio recordings.

Upon opening the web application, the users (in our deployment, the two users were always siblings) are asked to log in with their assigned username (see Figure 1a). After logging in, the application plays a brief welcome message. Then it asks one of the users to say, "I am ready to start day [x]" and press a button with a pulsing microphone icon when they are ready to continue. Pressing the button takes the users to a screen indicating who is speaking (either the system or the pair of users) and begins to play the day's story (see Figure 1b). The system then asks the users to discuss prompts with each other and answer questions; the system records their audio responses.

Each day's interaction includes five components. All sessions except the first follow the same structure, illustrated below. Each session is designed to take approximately 10-15 minutes to complete.

(1) **Recap:** After launching the day's session, the application summarizes the SEL lessons from the prior day and prompts children to answer the take-home question they were given at the end of the prior session.

(2) **Question of the day:** The application asks the users a specific question related to the day's storyline and learning goal, previewing the topic and situating the lesson.

(3) **Story and learning activities:** The application tells a dramatic superhero story that teaches SEL lessons and incorporates self-talk as a plot point. The "Superhero" serves as the supportive self-talk promoter encouraging kids to think constructively in different challenging contexts including facing failure and managing frustration. The story also includes a supervillain character who promotes negative self-talk as a foil to the superhero. Users are prompted to answer two kinds of questions during story: storyline questions and SEL questions.

(4) **Reflection questions:** The application provides a summary of the day's lesson. Users are asked to reflect on the day's lesson by discussing with each other. Users are given structured prompts probing past experiences that connect to those in the story and asked to discuss how they might apply self-talk in the future.

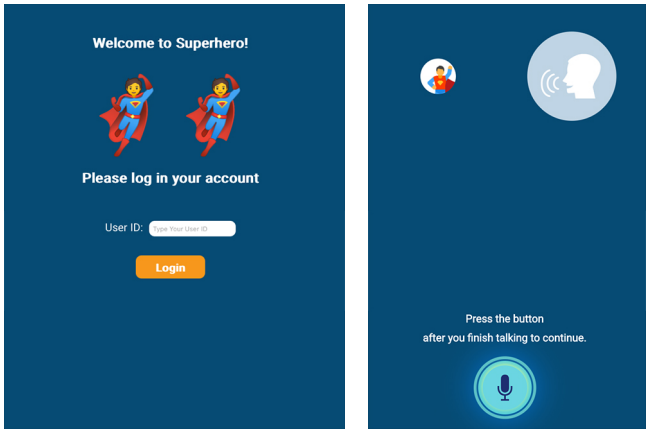
(5) **Take-home question:** The application leaves the users with one take-home question and asks them to think about it. The application reminds them that they will be asked this question during the next session.

4 METHOD

4.1 Participants

Ten families completed all procedures and were included in our final sample (see Appendix A). We first sent recruiting material to families who had participated in a prior study in our lab investigating the design of CAs for the home; four families from this group enrolled in the current study. We then recruited participants from a database of families from the larger metropolitan area surrounding our research institution who had previously expressed interest in participating in research, yielding another six families.

An inclusion criterion for families was having at least two children between the ages of five- and ten-years-old (inclusive). In a screening survey, we asked about families' demographics, including children's age, ethnicity, language spoken at home, CAs used at home, and parents' education. The average age of child participants was 7.5 years (sd = 1.4), and our final sample included seven girls, 12 boys, and one non-binary child. Despite explicitly reaching out to families from a variety of racial backgrounds, all families except one in our final data set self-reported their race as white. Participant demographics are shown in Table 1. Each family received an Amazon gift card worth US$100 as a thank-you for their participation.



(a) Login **(b) Interacting with the app**

Figure 1: Interface for the web app, "Self-Talk with Superhero Zip."

4.2 Procedures and Apparatus

Initial Interview and Pre-Intervention Assessment. Families participated in an initial intake interview, followed by a five-session deployment spread over one week, followed by an exit interview. Five researchers were assigned to interview 1-3 families individually. We conducted our initial interviews online with two siblings and one parent from each family. During the initial interview, we introduced the web application Self-Talk with Superhero Zip and showed families how to use it. We then asked each child to describe a challenging situation they had faced in the past. We asked them what they might say to themselves if they faced this same challenge in the future, giving them a set of examples for inspiration that included both supportive and negative self-talk (see Appendix B interview protocol part three). We recorded their responses for comparison with their response during the exit interview. At the end of the initial interview, we told the parents they could choose to join the interaction with their children or not. We assigned each participant family a fruit name as their login ID username and used the same name to identify them across this paper. The initial interview was designed to take approximately 15–20 minutes. All interviews were audio-recorded and transcribed.

Deployment. Over the course of one week, participants then completed the deployment study in five separate sessions on five different days of their choosing. During the first day's lesson, we introduced the four steps of self-talk which were reinforced throughout the deployment and repeated again in the last day's lesson. When the system prompted siblings to discuss or answer a question, their responses were audio recorded by the system. After each day's interaction, participants were asked to complete a short audio survey using Phonic.ai [57]. The survey included a Likert-style question that asked how much they liked the interaction ranging from 1 (strongly like) to 5 (strongly dislike). Then we asked children questions about what they liked or disliked about today's interaction, what they thought about the self-talk used in the story, and if they saw connections between the story and their life. Children recorded their audio answers online.

Exit Interview and Post-Intervention Assessment. After the intervention, each family completed an online exit interview. The interview protocol included four parts. We first asked children about their interaction experience with the web application, including questions like, "*Can you tell me what you thought about how the web app worked?*" and "*Would you recommend your friends to try it for five days? Why or why not?*" We then asked children about their socioemotional learning, including questions like, "*What lessons do you remember from the past interaction?*" and "*Do you think self-talk can help you in your life?*". Third, we resurfaced the challenge that each child had mentioned in the initial interview as something that had been hard to face. We once again asked them what they would say to themselves if they faced this challenge in the future, and we showed them the same set of examples as in the initial interview. Finally, we asked the parent for their impressions of the systems (see Appendix B for the interview protocol). Interviews were semi-structured and followed the participant's lead. The exit interview was designed to take 20 to 30 minutes. All interviews were audio-recorded and transcribed.

4.3 Data Analysis

We collected three types of data for each family: 1) audio recordings of children's interactions with the system (r), 2) daily survey data (s), and 3) interview data from two interviews (i). We distinguish these three datasets using suffixes. For example, "apple-i" refers interview data collected from the family with the participant ID "apple."

To analyze the data, transcripts were divided across four team members. Researchers individually reviewed transcripts and listened to the interaction and survey audio recordings. Researchers individually identified notable quotes and developed open codes. We discussed and clarified each code, re-read and listened to each transcript, and clustered codes into themes using the qualitative analysis software delve [19]. After several rounds of coding, discussion, and refining codes among the team, one researcher revisited all three datasets and gathered examples from each theme.

5 RESULTS

5.1 Indicators of Learning to Use Self-Talk from a CA

5.1.1 Understanding Self-Talk Concepts. We saw several indicators that through the intervention, participants learned the concept of self-talk and internalized the practice of using it. For example, we asked children to explain what self-talk was to their parents during the exit interview, and 8 out of 10 families' children participants could explain the concept accurately and with confidence. They explained self-talk by saying things like, "*self-talk is like talking to yourself in a confident way to help yourself go through rough things*" (lemon-i), "*it's when you talk to yourself in a positive way to help you do the hard stuff and not give up*" (blueberry-i), and "*self-talk is something when you feel bad, uh, you can talk to yourself to make you feel better. It's like, like 'just try again,' encouraging yourself*" (avocado-i).

During the exit interview, we also asked children to describe the steps of self-talk (i.e., the "Happens-Thoughts-Feelings-Do" framework described in Section 4.2), although, in three instances, the researchers failed to ask this question. Of the sibling pairs who were asked this question, all but one remembered and explained the framework steps correctly to the researchers. However, one pair had difficulty remembering what the letter "T" stood for.

5.1.2 Applying Self-Talk in Context. Both during and after the intervention, children described many different contexts and situations where they might apply the self-talk strategies they learned from the system. For example, they suggested leveraging self-talk for managing strong emotions (cherry-s, cherry-i), replacing negative thoughts of self-blame (cherry-s), asking for help (blueberry-r), managing sibling relationships (blueberry-s, lemon-s), or coping with an injury (apple-i). Throughout the intervention, the system sporadically asked children to reflect on self-talk and its applicability to their lives, and children responded with examples and ideas for how they might employ it. For example, one participant responded to a prompt asking how they use self-talk by saying:

> "*I've said, 'Hey, you feel angry, but you can't let your anger take over and start being mean. You have to be kind to yourself and say, "I'm angry, mad or sad or frustrated."' I'm going to take a breath out of my mouth. After one minute, then I'm going to talk to the person that hurt me or made me mad or angry and say, 'you made me this feeling.' And I'm saying, 'Can you stop maybe next time? Can you not do that to me? I feel disappointed.' And that's what I would say*" (cherry-r).

In other instances throughout the intervention, children said things like, "*Usually when I do self-talk, it helps me contain myself when I'm mad at someone and I'm like, that's okay. I can do it the best I can*" (grape-r), and "*When I use self-talk, I would [say], 'I can do this and don't get mad because it's probably just an accident and it's my sister's turn… if I needed to, I can do this. It's okay. I will self-talk*" (plum-r). These examples and others illustrate the children's emerging understanding of self-talk and sense of when and how to employ it.

In exit interviews and survey reflections, several children mentioned that they had used self-talk in their daily life after interacting with the system and would continue to use self-talk in the future.

> **Parent:** "*Last night she was feeling really down and negative about—*"
> **Child:** "*I was kinda crying.*"
> **Parent:** [To child] "*You were crying.*"
> **Parent:** "*And she said 'I am—I was doing a lot of negative self-talk. And then I did these things and I was able to come back and finish up the evening and calm down.' So it was kind of fun cause it was a good launching point or talking point.*"

For example, one child said that he would use self-talk to deal with conflicts with his friends, saying, "*When I get mad at my friends I kinda wanna attack him if he does something really, really annoying. But I [can] calm myself down [with] self-talk*" (blueberry-i). Parents also reported children using self-talk at home. For example, one parent-child pair (cherry-i) described their child using self-talk to control their strong emotions, saying:

Similarly, other children said things like, "*I think the self-talk was inspiring for kids who were listening and doing this study. It inspired me to give myself a lot of self-talk and ask for help*" (pineapple-s). Another one said, "*I learned that self-talk is an important thing and you should use it. You should use it a lot*" (plum-i). Thus, we saw a consistent pattern of children claiming to see value in self-talk by the end of the intervention and several supporting examples of them beginning to put it into practice.

5.1.3 Shifts in Children's Perceptions. Finally, we compared children's pre- and post-intervention responses to the interview question asking them what they would say to themselves when faced with a specific (child-defined) challenge. Sixteen children answered questions. Before the intervention, five described negative statements they would tell themselves, such as, "*I'm so nervous*" (grape-i), or explained that they would not know what to tell themselves, saying things like "*I don't know*" (apple-i). After the intervention, all five children's answers changed to supportive self-talk. For example, when asked during the initial interview to describe a situation they find challenging, participant lemon explained that math and close-reading tests are difficult saying, "*Doing math was hard, but the most thing that I hated and was super hard was close reading. You have to read a book and you have to do some work to show what it means*" (lemon-i). When asked in the pre-intervention interview what she would say to herself if she faced the challenge in the future, she answered, "*I am nervous*" (lemon-i). After the intervention, when researchers asked again what she would say to herself when facing the same challenge, she replied that she would say to herself, "*I have done these before. I can do this one*" (lemon-i).

Similarly, participant grape said when he was in first grade, he had difficulty making friends, and when probed by the interviewer in the pre-intervention interview about what he would say to himself if he found himself worried about making friends in the future, he replied, "*I'd say, 'I'm so nervous, because if you didn't have any friends, it might be hard to get other friends'*" (grape-i). After the intervention, when asked again, he described a mix of statements that now included supportive ones, saying, "*I think I sometimes I'd say just be calm. There's no way I can do it and then I'm going to work it out*" (grape-i)." Thus, looking across children's descriptions of the

intervention concepts, reflections on connections between the intervention and their daily life, and changes in their responses before and after engaging with the intervention, we saw several indicators that participants understood the concepts, came to see value in them, and began to integrate them into their view of themselves and the world.

5.1.4 Parents' Optimism about Using CAs for SEL. After witnessing their children's use of the system, most parents reported seeing CAs as a form factor with potential to support children's SEL. One parent explained:

> "*I just think it's really nice to talk about strategies for positive self-talk or calming down any of those things… So I think it's always nice to have that brainstorming before you're in those moments of dysregulation… so I find it really useful to have an app or something that can be interactive and provide a launching point for those day-to-day challenges*" (cherry-i).

In parents' reflections, they saw the system as an effective SEL teaching tool, saying things like, "*They were not really familiar with the idea of self-talk. And so I'm sure that while they do it, it is a new concept for them of putting those feelings into words in their heads*" (apple-s). Parents anticipated that engaging with the CA experience would scaffold children's metacognition and self-reflection, "*it was good for them to remember times in the past, which might not be something that they normally do when they're having it like a, a dilemma. They might not think back, well what did I do one time? So that was really good*" (avocado-i). They also anticipated that the experience would help children think from other people's perspectives, saying things like, "*these were examples of feelings that the kids would have in this same situation. Um, so they could kind of, you know, for the most part, put themselves in the story and, uh, feel what the characters were feeling*" (peach-i).

Parents also mentioned that their family adopted the self-talk intervention outside of the context of the study. As one parent explained: "*Well, I do think the self-talk lesson worked well… there was some talk in our household around self-talk throughout the period, particularly when there were frustrations. Usually when it was used, one would say to the other, usually, the one that was not upset would say to the one that was upset, 'use your self-talk,' that kind of thing*" (plum-i). Similarly, another parent described, "*One thing that was kind of cool, you guys remember when we were reading that book from the library and a lot of the same lessons popped up and we were like, oh my gosh, that sounds just Zip and Hex. Do you remember?*" (grape-i). Parents' reflections were consistent with usage data indicating potential for children to learn to use self-talk through the CA form factor and connect this practice to their daily life.

5.2 The Family as a Design Context

5.2.1 Sibling Interactions. When posing a question to children, the system often asked the user to discuss their reply with their sibling before answering. The recordings of these interactions reveal siblings prompting each other to reply, helping each other to come up with an answer to the question, and engaging in turn-taking. Siblings asked each other questions like, "*what's your reason [for why people should not be afraid of asking for help]?*" (mango-r), and "*what did you like and dislike about today's activities?*" (plum-s). Siblings engaged in conversational back-and-forth, saying things like (pineapple-r):

Older child:	"*So what did you think?*"
Younger child:	"*I thought I'd feel really mad and frustrated, but I'd take a breath and I breathe in and I try again. What'd you do?*"
Older child:	"*I would ask someone for help, but if they wouldn't, I would [pause] just calm myself and then try again*"

Usually, the older sibling explained the question and helped the younger one. For example, in one family (pineapple), when the younger child forgot the question in the middle of speaking, he asked the older one in a whisper, "*what was the question?*" The older one reminded him by saying, "*why we should not be afraid to ask for help?*" The younger one then continued answering the question. In the exit interview, another older sibling confirmed his role in helping his sister by saying, "*[younger child] was mostly asking me what the question was and I was like, 'it was like this'*" (plum-i). Parents reported that they valued this discussion between siblings, saying things like, "*They get more answers from each other… getting ideas off of each other is helpful*" (blueberry-i).

Five of the ten sibling pairs regularly prompted each other using a very quiet voice in the background and discussed together in whispers before replying. They then spoke loudly as they responded to the device. For example, the older child in one family (cherry) prompted the younger child by saying, "*it's your turn.*" After some unintelligible background talk and a long pause, the younger one responded to the system, "*even listening to this let me [want] to work on being kinder to my brother, too*" (cherry-r).

However, at times, sibling interactions were less smooth. In some instances, siblings focused on outdoing each other, argued over turn-taking, or distracted each other from the task at hand. One parent recalled that "*the competition to be the first one to talk… kind of was a distraction, I think, from what otherwise could have been good discussion*" (plum-i). And in other instances, children's interactions with the system were dominated by their own negotiation. Parents told the research team that children "*struggled with the conversation part… cause they really wanted to take their own turn*" (cherry-i) and "*they might argue or fight over who did this part or said this part*" (avocado-i).

Siblings also did not always stay on topic while engaging with the system. At times, they were distracted by each other and their surroundings. As one sibling pair told the interface, "*Okay, but sorry about our last answer. Yeah, we didn't hear it. We were talking about something, but we were listening to the thing though. We just didn't hear the question*" (mango-r). Thus, the audio modality and multi-user interface in many instances prompted collaboration and joint engagement. But in other moments, the interface failed to provide sufficient support for mitigating conflict and distraction.

5.2.2 Parent Facilitation. When families began the deployment, we told parents they could participate as much or as little as they liked. Six out of ten parents opted to participate at least occasionally in their children's interactions with the system. When parents were

involved in the interaction, children's answers had higher quality and depth (consistent with prior work on co-engagement in other digital contexts [69, 73]).

Some parents noticed they felt children needed their help when interacting with CAs. As one parent mentioned, "*I found it felt like they needed help from me to kinda and ask a little bit more and to get them going a little bit… they weren't like, 'Oh I have something to share about this.' Took a little bit of prompting on my part as well*" (apple-i). Other parents reported that they stepped in because they felt it would enhance siblings' interactions with each other. When asked if they thought the sibling discussions were useful, one parent explained, "*I feel like it's trying to think of times where they do have a good independent discussion. Oftentimes it's very adult-facilitated. So how do you encourage them to have that independently? Usually, I would say when they're in a situation where they have to solve a problem, or they're put on the spot, they're more apt to rely on one another.*" (plum-i).

Recording data showcased these moments of parent facilitation. Several parents stepped in to encourage children to elaborate on their initial statements or to encourage turn-taking. For example, parents said things like, "*Can you tell more about that? Why did you feel good?*" (apple-r) and "*what do they stand for?*" (pineapple-r). If children struggled to articulate an answer, in some cases parents then went on to scaffold possible responses saying things like, "*[to child 2:] can you think of something you would say to yourself in this situation? If…[child 1] was angry with you, cause you broke it, what is something you could tell yourself?*" (apple 1-5).

This prompting usually led to richer responses, but in some instances, was still met with a dead end. For example:

Parent: "*How did you feel after you asked for help?*"
Child: "*Good.*"
Parent: "*Can you tell me more about that? Why did you feel good?*"
Child: "*Because I felt good.*"
Parent: "*How do you feel after you ask for help and get help?*"
Child: "*I can't remember.*"

In addition to prompting children, parents also occasionally offered input or explanation. For example, one parent explained the word "persistent" (pineapple-r) in a question, and another explained the word "lack" (apple-r).

Lastly, parents nudged children to stay on task when they lost focus or got distracted. For example, when the parent noticed one of the children got distracted, the parent directed the question to the child, "*what about you [child's name]? [child replied:] what was it, mama?*" (grape-r). Then the parent repeated the question which lead the child to refocus on the interaction. In another instance, the parent stepped in to say, "*You guys pay attention to the question. What was the question right here? Hey, what was the question? Should we go back?*" when the siblings became embroiled in an argument while using the system (cherry-r).

However, parents did not need to provide consistent support, and in 40% of families, parents did not intervene at all. Most parents who did provide some facilitation also said things in their exit interview like, "*It was pretty easy for the kids to use after they did day one. They knew the drill and knew how to answer and push… as a parent, it's always nice when an app or engagement can both be useful, but also something that's simple to use*" (cherry-i).

5.3 Participant Design Suggestions

5.3.1 Using Storytelling. Children consistently said that the stories were their favorite part of the CA experience, and parents agreed with this assessment, saying things like, "*it actually has some type of like, storytelling and it's not like a lesson, it's like a natural story*" (mango-i, parent). Children mentioned liking the exciting superhero theme, story characters such as superheroes and supervillains, and both the imaginative and relatable parts of the storyline. For example, one child said, "*I liked about today's activity was how there were lots of things like a magic quill, how they can turn into goblins when they're mad made me super happy*" (lemon-s). Another mentioned he could relate to the story by saying, "*we could hear a story that's familiar to us. That makes sense, because our Legos got destroyed by our little sisters a lot*" (grape-s) (a plot point of the day's story was a younger child destroying her older sister's Lego creations).

In addition, both parents and children like the application because it is easy to use and novel for SEL. They mentioned, "*it was so easy they could do it by themselves*" (mango-i), and "*it's a good program for kids…I had never heard of, like, self-affirmations through a computer game before. That was pretty cool*" (mango-i). Participants' consistent reports of the ease, enjoyment, and value of stories told by the system suggest a natural fit with this modality.

5.3.2 Supporting Physicality. Families also saw the audio modality of the CA as being compatible with physical and sensory experiences. Parents suggested integrating other activities that require children to move and use their bodies. For example, one parent mentioned:

> "*Like [child 1] was saying, we do the breathing, and we also have one that I think comes from a book called 'A Spot of Anger.' So that was [moving] the tip of the finger to the middle of the palm. But that could be something to incorporate into the stories as well. Incorporate the self-talk strategies with an example of what that looks like*" (cherry-i).

Children also suggested physical activities such as taking deep breaths to help them to calm down. One child said, "*I got through [math problems] by just looking up and breathing in and out*" (pineapple-i). Children and parents alike felt that augmenting the conversational interface with physical activities would enhance children's learning and engagement.

5.3.3 Managing Conversational Flow. Both parents and children mentioned that children had insufficient time to think through their responses, because the system automatically began recording immediately after posing each question. One parent mentioned, "*They also sometimes needed to think about their responses, and I think they would get nervous when the recording button would come on*" (avocado-i). And another said, "*you can kind of prepare your thoughts before. Yeah. And then you get to decide when you're recording*" (pineapple-i). These accounts from parents were consistent

with children's common behavior of talking quietly in the background before loudly responding to the CA. Families felt that providing UI that supports children in pausing and thinking and trying out different answers may lead to better reflections and learning.

As described above, siblings often enhanced each other's responses, but at times, undermined them as well, and parents occasionally stepped in to manage turn-taking and prompt discussion between siblings. For instance, one parent explained, "*I think because they were struggling to take turns is the biggest [problem]. I just felt like I needed to be intermediate.* " (plum-i). Thus, families also envisioned additional design support for managing conversational flow among users. They explained that, at times, children "*were just kind of answering the question to you one at a time*" and suggested the design team augment the system with "*some, I don't know, something, some solution*" to add structure for "*more engagement between them*" (grape-i).

5.3.4 Supporting Focused Attention. One of the interaction challenges that surfaced in recording data and in interviews was distractibility and loss of focus. Both parents and children suggested supporting children's focus by adding visual features such as color, animation, moving objects, and videos to illustrate stories, saying things like, "*I think there could have been more engagement if there was some visual to go along, even if it was a little comic strip or something. It wouldn't have to be a full animation, but something to go along with the story*" (cherry-i). Children also agreed that visual elements can promote engagement by saying, "*if there were pictures on it, then I would probably stay more connected to the screen*" (pineapple-i).

Alongside the visual elements, some other parents and children proposed adding more interactivity, such as clicking and dragging things around. They said something like, "*I think unfortunately kids are so used to visuals and tunes and that sort of thing…so [they want to] find things to poke at or play with on the computer*" (plum-i). Another parent said, "*I wonder if there were like little activities embedded that they would like to click or like didn't have to verbally react but like could, could interact with it*" (pineapple-i).

Some parents suggested having questions or on-screen dialogue bubbles to anchor children's attention and improve understanding. For example, one parent said, "*I think since the kids are older, maybe if the questions were also printed on the screen, they could read it too after listening to it so they could think about it a little bit before they push record*" (blueberry-i), and another mentioned, "*[If] there's also some like, uh, terminology and like vocabulary that they didn't know. If there would be some way to like, hey, you know, 'click on this to get an explanation of this word'*" (apple-i).

6 DISCUSSION

Socioemotional skills determine how well children can adjust to their environment, build relationships, and achieve success in life. Our results show one proof-of-concept of a CA supporting children in learning one socioemotional skill. Here, we discuss the ways in which these findings extend our understanding of how technology might support SEL and the design considerations that emerged when we deployed a voice-based system into the intimate, multi-user context of a family home.

6.1 The Possibility of Supporting SEL at Home with CAs

We saw a number of proximal indicators suggesting that children came to understand and use the self-talk intervention embedded in our CA experience. Children could accurately recall and describe what self-talk is, why it is valuable, and the specific steps to use it introduced by the intervention. Despite moments of distraction and sibling conflict throughout the deployment experience, we heard stories from children and their parents of children spontaneously using self-talk as a socioemotional strategy in daily life outside the intervention. By the end of the intervention, all children who had initially said they would use negative self-talk when faced with a challenge shifted their response and described supportive, constructive things they would say to themselves with faced with the same challenge. These short-term data points suggest potential for longer-term outcomes, although future work remains to understand the extent to which children internalize this strategy over time and how to design effective longitudinal supports.

We chose to teach self-talk in particular because of its alignment with CAs' audio-based interaction modality. Prior work shows that many of the most effective SEL lessons involve verbal strategies in small groups [51], supporting the idea that CAs are well-suited to narrative and conversational SEL interventions that can be deployed at home. Our findings illustrate how this can work for one narrowly scoped intervention (learning self-talk through the "HTFD" framework) and suggest that CAs could be effective tools for teaching other skills, such as responsible decision-making, self-awareness, and self-management, through narrative and interactive dialogue. Unsurprisingly, participants' feedback focused, in part, on the quality of the content and the experience we created, with children describing their enthusiasm for the stories and characters. This points to the importance of embedding interventions in high-quality content.

Prior work has shown that, when speculating about hypothetical systems, parents are wary of integrating CAs into the home generally [43]. Further, they worry in particular that CAs for SEL will fail to account for families' values and intrude into parents' relationships with their children [29]. However, we found that after observing their children's use of our system, parents were universally optimistic about the idea of using CAs in this context and saw potential for such a system to augment their child's learning and align with family life. This suggests that parents' resistance may be reflective of the values and interactions embedded in current systems, and designers have the power to create alternatives that are more sensitive to families' needs and concerns.

Finally, prior work reports that reinforcing school-based SEL interventions at home is challenging and rarely successful [56] and that the use of technology may be a promising way to help address this issue [67, 69]. Our system illustrates one example of how a formal socioemotional lesson might be extended systematically but informally into family life, bridging the known learning gap between school and home.

6.2 Learning with and without Parents

Consistent with prior work in other digital contexts [60, 73], we found that parent involvement enhanced children's responses and

reinforced the designed learning objectives. However, prior work also reports that, for parents, keeping children occupied while parents attend to other tasks is a key use case [7, 8, 36]. This creates tension between the design goal of fostering co-engagement (and thereby supporting children's development), and the design goal of fostering independent child usage (and thereby supporting parents' need to attend to the competing demands of family life).

Here, we found that parents could be incidentally involved in children's use of the system, as the ambient audio projected into the home broadcast the interaction and enables bystanders to follow along. Several parents provided just-in-time scaffolding for their children, for example, by defining words the system used or asking their child to elaborate on their answer when their response was particularly shallow. But many of the same parents also praised the system saying it was easy for children to use independently. We saw that the voice modality gave parents incidental exposure to the experience and allowed them to provide occasional support without requiring their constant presence. Thus, our findings: 1) suggest that the voice-based form factor has unique promise for resolving the design tension of encouraging but not requiring parent support, 2) highlight that public usage affords this intermittent parent involvement, and 3) suggest a need for future work to evaluate the effectiveness of technology-based SEL interventions with: continuous, intermittent, and no parent support.

6.3 Designing for Siblings as Target Users

One design challenge we faced was making a sibling pair—rather than an individual—our target user. We encountered both systematic needs (e.g., support for turn-taking), benefits (e.g., older siblings' ability to support younger siblings in understanding complex concepts), and challenges (e.g., siblings' familiarity with each other leading to squabbles and distractions). This suggests the potential for a "sibling-centered design" framework that accounts for these considerations in a principled way.

One phenomenon we encountered repeatedly was children's tendency to speak in hushed tones with each other before responding to the system. This arose as a combined function of: 1) the fact that we designed the interaction for a dyad rather than an individual, and 2) the fact that the voice modality of the system used the same communication channel as the one siblings would naturally use to collaborate. We refer to this mitigation strategy by our users as the "*pre-input huddle*" and suggest designers of voice-based systems account for this behavior and the needs that motivate it. For example, after prompting input, a system might wait for a wake word before listening for a response, or it might attempt to distinguish between hushed and louder input and respond only to input with the louder volume.

Finally, we saw that children were willing to engage with the intervention together as a pair, and in many cases, prompted each other and built on each other's ideas. Prior work shows that socioemotional learning is most successful when conducted in social settings through interventions that scaffold collaboration and cooperation [51]. This poses a challenges for teaching SEL through CAs, given that CAs' conversational abilities are limited [58], and these systems are unable to provide the social and contingent feedback to users that is necessary for SEL [29]. Our results suggest that designing for siblings is a promising way of overcoming this challenge, as it leverages the system's ability to direct conversation while shifting the responsibility for providing constructive feedback and collaboration to the human users.

6.4 Limitations and Future Work

One important limitation of this work is that we do not know if children will continue applying self-talk skills in their daily lives in the long run. Our intervention spanned only one week, and we did not systematically examine changes in their behavior outside of the intervention context. A second key limitation is the potential for social desirability bias to have affected children's responses, leading them to speak more positively than they would otherwise about self-talk and its connections to their daily life. The claims we can make are also limited by our small sample size, although our objective is not to offer results with broad generalizability, but rather to provide design insights with transferability. Future work remains to examine the effectiveness of this intervention over time and its influence on children's socioemotional competence in naturalistic settings. In future research, the scope of socioemotional skills could be broadened beyond self-talk to encompass other relevant SEL topics and contexts. While our study focused on sibling pairs, it would be worthwhile to investigate the dynamics of socioemotional skill development in alternative relational settings, such as friendships or parent-child interactions. This expansion would serve to enhance our understanding of CAs as a potential tool to support children's SEL across various interpersonal relationships.

7 CONCLUSION

Through a one-week field deployment of a CA-based web application in ten family homes, we found that sibling pairs learned the concept of self-talk and, most importantly, showed indications of applying this socioemotional strategy in their daily lives. One quarter of participants described using negative self-talk in a pre-intervention session asking about their experiences with past challenges; by the post-intervention follow-up, all children described using positive self-talk when facing these challenges.

Contrary to prior work, we found that parents were supportive of the idea of using CAs for SEL and found the system valuable, although some parents also found it necessary to mediate their children's interactions with the system. We further contribute design considerations for supporting SEL with CAs at home, including documenting sibling behaviors (such as competing, prompting each other, and engaging in pre-input huddles where users whisper privately before speaking to the audio-based system) and sharing families' suggestions for future designs (including physical and sensory experiences and UI to manage conversational flow).

SELECTION AND PARTICIPATION OF CHILDREN

Our working design system was tested on children participating in the KidsTeam at the University of Washington. We conducted two online design and testing sessions, followed by discussions after each session to collect the children's design recommendations. Study participants were recruited through a database maintained

by the authors' institution, where parents interested in scientific research can sign up to learn about future study opportunities for themselves or their children. Parents were provided with an information sheet with details of the research. We told parents they could discontinue the study at any time and for any reason and secured consent before beginning any procedures. We then began our first interview by securing the children's assent. During the assent process, we explained the research procedure, which includes a 5-day interaction with a CA-based technology, a diary survey after each day's interaction, and an exit interview with both parents and children. These procedures were approved by our institutional review board.

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REFERENCES

[1] Mehdi Alaimi, Edith Law, Kevin Daniel Pantasdo, Pierre-Yves Oudeyer, and Hélène Sauzeon. 2020. Pedagogical Agents for Fostering Question-Asking Skills in Children. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–13.

[2] Ben Alderson-Day and Charles Fernyhough. 2015. Inner Speech: Development, Cognitive Functions, Phenomenology, and Neurobiology. *Psychol. Bull.* 141, 5 (Sept. 2015), 931–965.

[3] Amazon. 2023. Amazon Alexa Console - Amazon Alexa Official Site. https://developer.amazon.com/alexa/console/ask, Accessed on 01/25/2023.

[4] Alissa N Antle, Leslie Chesick, Aaron Levisohn, Srilekha Kirshnamachari Sridharan, and Perry Tan. 2015. Using neurofeedback to teach self-regulation to children living in poverty. In *Proceedings of the 14th International Conference on Interaction Design and Children* (Boston, Massachusetts) *(IDC '15)*. Association for Computing Machinery, New York, NY, USA, 119–128.

[5] Daniela Maree Ashdown and Michael E Bernard. 2012. Can Explicit Instruction in Social and Emotional Learning Skills Benefit the Social-Emotional Development, Well-being, and Academic Achievement of Young Children? *Early Childhood Education Journal* 39, 6 (Jan. 2012), 397–405.

[6] Rafael Ballagas, Thérèse E Dugan, Glenda Revelle, Koichi Mori, Maria Sandberg, Janet Go, Emily Reardon, and Mirjana Spasojevic. 2013. Electric agents: fostering sibling joint media engagement through interactive television and augmented reality. In *Proceedings of the 2013 conference on Computer supported cooperative work* (San Antonio, Texas, USA) *(CSCW '13)*. Association for Computing Machinery, New York, NY, USA, 225–236.

[7] Yehuda Bar Lev, Nelly Elias, and Sharona T Levy. 2018. Development of infants' media habits in the age of digital parenting : A longitudinal study of Jonathan, from the age of 6 to 27 months. (2018), 103–112.

[8] Ine Beyens and Steven Eggermont. 2014. Putting Young Children in Front of the Television: Antecedents and Outcomes of Parents' Use of Television as a Babysitter. *Commun. Q.* 62, 1 (Jan. 2014), 57–74.

[9] Paul Blenkiron. 2005. Stories and Analogies in Cognitive Behaviour Therapy: A Clinical Review. *Behav. Cogn. Psychother.* 33, 1 (Jan. 2005), 45–59.

[10] Jenna Buckle. 2023. 6 Effective Interventions for Social-Emotional Learning. https://www.panoramaed.com/blog/effective-interventions-for-social-emotional-learning, Accessed on 01/25/2023.

[11] Paul C Burnett. 1994. Self-talk in upper elementary school children: Its relationship with irrational beliefs, self-esteem, and depression. *J. Ration. Emot. Cogn. Behav. Ther.* 12, 3 (Sept. 1994), 181–188.

[12] Paul C Burnett. 1997. Self-esteem and self-talk enhancement in upper primary school children. , 4 pages.

[13] CASEL. 2020. CASEL'S SEL Framework. https://casel.org/casel-sel-framework-11-2020/, Last accessed on 2023-01-20.

[14] Fabio Catania, Micol Spitale, Giulia Cosentino, and Franca Garzotto. 2021. Conversational Agents to Promote Children's Verbal Communication Skills. In *Chatbot Research and Design*. Springer International Publishing, 158–172.

[15] Ying-Yu Chen, Ziyue Li, Daniela Rosner, and Alexis Hiniker. 2019. Understanding parents' perspectives on mealtime technology. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 3, 1 (2019), 1–19.

[16] S Chroni. 1997. Effective verbal cues make the skier's and coach's lives easier. *American Ski Coach* (1997).

[17] Molly K Crossman, Alan E Kazdin, and Elizabeth R Kitt. 2018. The influence of a socially assistive robot on mood, anxiety, and arousal in children. *Prof. Psychol. Res. Pr.* 49, 1 (Feb. 2018), 48–56.

[18] Katie Davis, Julian A Boss, and Perry Meas. 2018. Playing in the Virtual Sandbox: Students' Collaborative Practices in Minecraft. *International Journal of Game-Based Learning (IJGBL)* 8, 3 (2018), 56–76.

[19] Delvetool. 2023. Software Tool to Analyze Qualitative Data | Delve. https://delvetool.com/,Accessed on 01/24/2023.

[20] Susanne A Denham and Chavaughn Brown. 2010. "Plays Nice With Others": Social–Emotional Learning and Academic Success. *Early Educ. Dev.* 21, 5 (Oct. 2010), 652–680.

[21] R M Diaz, L E Berk, and R Diaz. 2014. *Private speech: From social interaction to self-regulation.* Psychology Press, London, England.

[22] Joseph A Durlak, Roger P Weissberg, Allison B Dymnicki, Rebecca D Taylor, and Kriston B Schellinger. 2011. The impact of enhancing students' social and emotional learning: a meta-analysis of school-based universal interventions. *Child Dev.* 82, 1 (Jan. 2011), 405–432.

[23] Easel Lab at Harvard. 2020. SEL Exercises for School & Home. https://static1.squarespace.com/static/58bddd12e58c6278e8a670e2/t/5f512e62e7500041623170e0/1599155810309/sel-exercises-dwld.pdf, Last accessed on 2023-01-20.

[24] Carrie A Ewin, Andrea E Reupert, Louise A McLean, and Christopher J Ewin. 2021. The impact of joint media engagement on parent–child interactions: A systematic review. *Hum. Behav. Emerg. Technol.* 3, 2 (April 2021), 230–254.

[25] Róisín M Flanagan and Jennifer E Symonds. 2022. Children's self-talk in naturalistic classroom settings in middle childhood: A systematic literature review. *Educational Research Review* 35 (Feb. 2022), 100432.

[26] Lisa Flook and Laura Pinger. 2023. Lessons from Creating a Kindness Curriculum. https://centerhealthyminds.org/join-the-movement/lessons-from-creating-a-kindness-curriculum,Accessed: 2023-1-25.

[27] Manuel Förster, Constantin Weiser, and Andreas Maur. 2018. How feedback provided by voluntary electronic quizzes affects learning outcomes of university students in large classes. *Comput. Educ.* 121 (June 2018), 100–114.

[28] Robert D Friedberg and Laura H Wilt. 2010. Metaphors and Stories in Cognitive Behavioral Therapy with Children. *J. Ration. Emot. Cogn. Behav. Ther.* 28, 2 (June 2010), 100–113.

[29] Yue Fu, Rebecca Michelson, Yifan Lin, Lynn K Nguyen, Tala June Tayebi, and Alexis Hiniker. 2022. Social Emotional Learning with Conversational Agents: Reviewing Current Designs and Probing Parents' Ideas for Future Ones. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 6, 2 (July 2022), 1–23.

[30] Janet Go, Rafael Ballagas, and Mirjana Spasojevic. 2012. Brothers and sisters at play: exploring game play with siblings. In *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work* (Seattle, Washington, USA) *(CSCW '12)*. Association for Computing Machinery, New York, NY, USA, 739–748.

[31] Nancy G Guerra and Catherine P Bradshaw. 2008. Linking the prevention of problem behaviors and positive youth development: core competencies for positive youth development and risk prevention. *New Dir. Child Adolesc. Dev.* 2008, 122 (2008), 1–17.

[32] J Hardy and N Zourbanos. 2016. Self-talk in sport: where are we now? *Routledge international handbook of sport* (2016).

[33] Antonis Hatzigeorgiadis, Yannis Theodorakis, and Nikos Zourbanos. 2004. Self-Talk in the Swimming Pool: The Effects of Self-Talk on Thought Content and Performance on Water-Polo Tasks. *J. Appl. Sport Psychol.* 16, 2 (April 2004), 138–150.

[34] Antonis Hatzigeorgiadis, Nikos Zourbanos, Evangelos Galanis, and Yiannis Theodorakis. 2011. Self-Talk and Sports Performance: A Meta-Analysis. *Perspect. Psychol. Sci.* 6, 4 (July 2011), 348–356.

[35] Antonis Hatzigeorgiadis, Nikos Zourbanos, Sofia Mpoumpaki, and Yannis Theodorakis. 2009. Mechanisms underlying the self-talk–performance relationship: The effects of motivational self-talk on self-confidence and anxiety. *Psychol. Sport Exerc.* 10, 1 (Jan. 2009), 186–192.

[36] Alexis Hiniker, Hyewon Suh, Sabina Cao, and Julie A Kientz. 2016. Screen Time Tantrums: How Families Manage Screen Media Experiences for Toddlers and Preschoolers. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (San Jose, California, USA) *(CHI '16)*. Association for Computing Machinery, New York, NY, USA, 648–660.

[37] Alexis Hiniker, Amelia Wang, Jonathan Tran, Mingrui Ray Zhang, Jenny Radesky, Kiley Sobel, and Sungsoo Ray Hong. 2021. Can conversational agents change the way children talk to people?. In *Interaction Design and Children* (Athens Greece). ACM, New York, NY, USA.

[38] Pirita Ihamäki and K Heljakka. 2020. Social and emotional learning with a robot dog: technology, empathy and playful learning in kindergarten. In *9th annual arts, humanities, social sciences and education conference*. researchgate.net, 6–8.

[39] Katarzyna Kabacińska, Tony J Prescott, and Julie M Robillard. 2021. Socially Assistive Robots as Mental Health Interventions for Children: A Scoping Review. *International Journal of Social Robotics* 13, 5 (Aug. 2021), 919–935.

[40] Alice Kerry, Richard Ellis, and Susan Bull. 2009. Conversational Agents in E-Learning. In *Applications and Innovations in Intelligent Systems XVI*. Springer London, 169–182.

[41] Junhyung Kim, Joon Hee Kwon, Joohan Kim, Eun Joo Kim, Hesun Erin Kim, Sunghyon Kyeong, and Jae-Jin Kim. 2021. The effects of positive or negative self-talk on the alteration of brain functional connectivity by performing cognitive tasks. *Sci. Rep.* 11, 1 (July 2021), 14873.

[42] Bret" "Kinsella. 2022. Voice Assistant Adoption Clustering Around 50% of the Population. https://casel.org/casel-sel-framework-11-2020/, Last accessed on 2023-01-20.

[43] Natalia Kucirkova and Alexis Hiniker. 2023. Parents' ontological beliefs regarding the use of conversational agents at home: resisting the neoliberal discourse. *Learning, Media and Technology* (2023), 1–16.

[44] Kevin T Kuehlwein. 2000. Enhancing Creativity in Cognitive Therapy. *J. Cogn. Psychother.* 14, 2 (Jan. 2000), 175–187.

[45] Scott Weng Fai Lee. 2011. Exploring seven- to eight-year-olds' use of self-talk strategies. *Early Child Dev. Care* 181, 6 (July 2011), 847–856.

[46] Birgit Lugrin, Catherine Pelachaud, and David Traum (Eds.). 2021. *The Handbook on Socially Interactive Agents: 20 years of Research on Embodied Conversational Agents, Intelligent Virtual Agents, and Social Robotics Volume 1: Methods, Behavior, Cognition* (1 ed.). Vol. 37. Association for Computing Machinery, New York, NY, USA.

[47] Birgit Lugrin, Catherine Pelachaud, and David Traum (Eds.). 2022. *The Handbook on Socially Interactive Agents: 20 years of Research on Embodied Conversational Agents, Intelligent Virtual Agents, and Social Robotics Volume 2: Interactivity, Platforms, Application* (1 ed.). Vol. 48. Association for Computing Machinery, New York, NY, USA.

[48] Tina Malti and Gil G Noam. 2016. Social-emotional development: From theory to practice. *Eur. J. Dev. Psychol.* 13, 6 (Nov. 2016), 652–665.

[49] Julia L Mendez, Paul McDermott, and John Fantuzzo. 2002. Identifying and promoting social competence with African American preschool children: Developmental and contextual considerations. , 111–123 pages.

[50] National Research Council, Institute of Medicine, Board on Children, Youth, and Families, and Committee on Integrating the Science of Early Childhood Development. 2000. *From Neurons to Neighborhoods: The Science of Early Childhood Development*. National Academies Press.

[51] Siew Chin Ng and Rebecca Bull. 2018. Facilitating Social Emotional Learning in Kindergarten Classrooms: Situational Factors and Teachers' Strategies. *International Journal of Early Childhood* 50, 3 (Nov. 2018), 335–352.

[52] Mariya Nikolayev, Kevin Clark, and Stephanie M Reich. 2016. Chapter 10 - Social-Emotional Learning Opportunities in Online Games for Preschoolers. In *Emotions, Technology, and Digital Games*, Sharon Y Tettegah and Wenhao David Huang (Eds.). Academic Press, San Diego, 211–229.

[53] Geraldine V Oades-Sese, Abigail Cahill, Jedediah Wilfred Papas Allen, Wai-Ling Rubic, and Noor Mahmood. 2021. Effectiveness of Sesame Workshop's Little Children, Big Challenges: A digital media SEL intervention for preschool classrooms. *Psychol. Sch.* 58, 10 (Oct. 2021), 2041–2067.

[54] Michael W Otto. 2000. Stories and metaphors in cognitive-behavior therapy. *Cogn. Behav. Pract.* 7, 2 (March 2000), 166–172.

[55] Kristine M Pahl and Paula M Barrett. 2007. The Development of Social–Emotional Competence in Preschool-Aged Children: An Introduction to the Fun FRIENDS Program. *Journal of Psychologists and Counsellors in Schools* 17, 1 (July 2007), 81–90.

[56] Evanthia N Patrikakou and Amy R Anderson. 2005. *School-family Partnerships for Children's Success*. Teachers College Press.

[57] Phonics. 2023. Phonic - The Complete Toolkit for Unmoderated Research. https://www.phonic.ai/, Accessed on 01/25/2023.

[58] Martin Porcheron, Joel E Fischer, Stuart Reeves, and Sarah Sharples. 2018. Voice Interfaces in Everyday Life. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–12.

[59] Raquel Raimundo, Alexandra Marques-Pinto, and Maria Luísa Lima. 2013. The effects of a social-emotional learning program on elementary school children: The role of pupils' characteristics. *Psychol. Sch.* 50, 2 (Feb. 2013), 165–180.

[60] Eric E Rasmussen, Autumn Shafer, Malinda J Colwell, Shawna White, Narissra Punyanunt-Carter, Rebecca L Densley, and Holly Wright. 2016. Relation between active mediation, exposure to Daniel Tiger's Neighborhood, and US preschoolers' social and emotional development. *J. Child. Media* 10, 4 (Oct. 2016), 443–461.

[61] Alberto Ruiz-Ariza, Rafael Antonio Casuso, Sara Suarez-Manzano, and Emilio J Martínez-López. 2018. Effect of augmented reality game Pokémon GO on cognitive performance and emotional intelligence in adolescent young. *Comput. Educ.* 116 (Jan. 2018), 49–63.

[62] Rulerapproach. 2023. Evidence for RULER – RULER Approach. https://www.rulerapproach.org/about/what-is-the-evidence/, Accessed on 01/25/2023.

[63] Francisco J Santos-Rosa, Carlos Montero-Carretero, Luis Arturo Gómez-Landero, Miquel Torregrossa, and Eduardo Cervelló. 2022. Positive and negative spontaneous self-talk and performance in gymnastics: The role of contextual, personal and situational factors. *PLoS One* 17, 3 (March 2022), e0265809.

[64] Craig R Seal, Stefanie E Naumann, Amy N Scott, and Joanna Royce-Davis. 2011. Social emotional development: A new model of student learning in higher education. *Research in Higher Education Journal* 10 (2011), 1.

[65] Solace Shen, Petr Slovak, and Malte F Jung. 2018. Stop. I see a conflict happening. In *Proceedings of the 2018 ACM/IEEE International Conference on Human-Robot Interaction* (Chicago IL USA). ACM, New York, NY, USA.

[66] Petr Slovak, Alissa N Antle, Nikki Theofanopoulou, Claudia Daudén Roquet, James J Gross, and Katherine Isbister. 2022. Designing for emotion regulation interventions: an agenda for HCI theory and research. (March 2022). arXiv:2204.00118 [cs.HC]

[67] Petr Slovák and Geraldine Fitzpatrick. 2015. Teaching and Developing Social and Emotional Skills with Technology. *ACM Trans. Comput.-Hum. Interact.* 22, 4 (June 2015), 1–34.

[68] Petr Slovák, Ran Gilad-Bachrach, and Geraldine Fitzpatrick. 2015. Designing Social and Emotional Skills Training: The Challenges and Opportunities for Technology Support. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (Seoul, Republic of Korea) *(CHI '15)*. Association for Computing Machinery, New York, NY, USA, 2797–2800.

[69] Petr Slovák, Kael Rowan, Christopher Frauenberger, Ran Gilad-Bachrach, Mia Doces, Brian Smith, Rachel Kamb, and Geraldine Fitzpatrick. 2016. Scaffolding the scaffolding: Supporting children's social-emotional learning at home. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing* (San Francisco, California, USA) *(CSCW '16)*. Association for Computing Machinery, New York, NY, USA, 1751–1765.

[70] Kiley Sobel, Arpita Bhattacharya, Alexis Hiniker, Jin Ha Lee, Julie A Kientz, and Jason C Yip. 2017. It wasn't really about the Pokémon: Parents' Perspectives on a Location-Based Mobile Game. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (Denver, Colorado, USA) *(CHI '17)*. Association for Computing Machinery, New York, NY, USA, 1483–1496.

[71] Abigale Stangl, Joanna Weidler-Lewis, Carlye Lauff, Emily Price, and Eric Fauble. 2017. The SEL Transition Wheel: Designing for Early Childhood Social Emotional Learning. In *Proceedings of the 2017 Conference on Interaction Design and Children* (Stanford, California, USA) *(IDC '17)*. Association for Computing Machinery, New York, NY, USA, 334–339.

[72] StrongKids. 2023. Home - Merrell's Strong Kids. https://strongkidsresources.com/, Accessed on 01/25/2023.

[73] L Takeuchi and R Stevens. 2011. *The new coviewing: Designing for learning through joint media engagement*. The Joan Ganz Cooney Center at Sesame Workshop.

[74] Y Theodorakis, S Chroni, K Laparidis, V Bebetsos, and I Douma. 2001. Self-talk in a basketball-shooting task. *Percept. Mot. Skills* 92, 1 (Feb. 2001), 309–315.

[75] Yannis Theodorakis, Robert Weinberg, Petros Natsis, Irini Douma, and Panagiotis Kazakas. 2000. The Effects of Motivational versus Instructional Self-Talk on Improving Motor Performance. *Sport Psychol.* 14, 3 (Sept. 2000), 253–271.

[76] Sarah K Ura, Sara M Castro-Olivo, and Ana d'Abreu. 2020. Outcome Measurement of School-Based SEL Intervention Follow-Up Studies. *Assess. Eff. Interv.* 46, 1 (Dec. 2020), 76–81.

[77] Marieke van Woerkom. 2020. Self-Care: Self-Talk for Elementary School". https://www.morningsidecenter.org/teachable-moment/lessons/self-care-self-talk-elementary-school/, Last accessed on 2023-01-19.

[78] Maria von Salisch, Janice Zeman, Nadine Luepschen, and Rimma Kanevski. 2013. Prospective relations between adolescents' social-emotional competencies and their friendships. *Soc. Dev.* (Nov. 2013).

[79] Sara A Whitcomb, Danielle M Parisi Damico, Hill Walker, Dianna Carrizales-Engelmann, Laura L Feuerborn, Barbara A Gueldner, and Oanh K Tran. 2016. *Merrell's Strong Start–Pre-K : A Social and Emotional Learning Curriculum, Second Edition*. Brookes Publishing, Baltimore, UNITED STATES.

[80] Barbara J Wilson. 2008. Media and children's aggression, fear, and altruism. *Future Child.* 18, 1 (2008), 87–118.

[81] Qian-Wen Xie, Celia H Y Chan, Qingying Ji, and Cecilia L W Chan. 2018. Psychosocial Effects of Parent-Child Book Reading Interventions: A Meta-analysis. *Pediatrics* 141, 4 (April 2018).

[82] Ying Xu. 2020. Using conversational agents to foster young children's science learning from screen media.

[83] Nicola Yelland and Jennifer Masters. 2007. Rethinking scaffolding in the information age. *Comput. Educ.* 48, 3 (April 2007), 362–382.

[84] Annuska Zolyomi and Marc Schmalz. 2017. Mining for Social Skills: Minecraft in Home and Therapy for Neurodiverse Youth. (2017).

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Table 1: Participant Demographics. Age, gender, and race are reported for the child; the highest level of educational attainment is reported for the parent who was interviewed. The languages listed are those spoken in the home.

Assigned ID	Child1 Age, Gener	Child2 Age, Gender	Race	Family CAs	Language	Highest Level of Education
mango	9,M	7,F	White	Siri, Alexa	English	Bachelor's degree
apple	9,M	7,M	White	Siri, Alexa, Google Assistant	English	Associate degree
pineapple	9,F	7,Non-binary	White	Siri, Alexa	English	Doctorate degree
blueberry	9,M	7,M	White	Siri, Google Assistant	English	Bachelor's degree
avocado	8,M	6,M	White	Siri, Alexa, Google Assistant	English	Master's degree
plum	8,M	6,F	White	Siri	English	Bachelor's degree
peach	6,M	5,F	White	Siri, Google Assistant	English	Bachelor's degree
grape	9,M	7,M	White	Siri, Alexa	English	Master's degree
cherry	7,M	7,F	White	Alexa	English	Master's degree
lemon	10,F	8,F	Black or African American	Siri, Alexa, Google Assistant	English	Technical/vocational training

A APPENDIX A: PARTICIPANT TABLE

B APPENDIX B: EXIT INTERVIEW PROTOCOL

Part One: Interaction Experience

- Can you just tell me what you thought about how the web app worked? What did you like about the interaction? What did you dislike about the interaction?
- What did you think about the discussions you had with your sibling(s) when you were using the web app? How did you feel about having those conversations?
- Would you recommend your friends to try it for 5 days? (Why or why not?)
- If you were the designer of this app, what would you do to make it different or more appealing to your friends?

Part Two: Socioemotional Learning and Self-talk

- What do you think about the stories you heard?
- What lessons do you remember from the past interaction?
- In the story, we talked about self-talk. What is self-talk? Can you explain to your parent what it is?
- Do you remember the four self-talk steps our superhero Zip taught other kids to use in the story?
- Do you think self-talk can help you in your life?
- Have you tried to use self-talk in the past several days after you heard the Superhero story?
- Do you think self-talk can help you in the future?

Part Three: Children's Challenge Revisited [We asked if children faced any challenges in life and what they would say to themselves if they face the challenge again during our initial interview. We showed the same image prompt as we showed in the exit interview (see Figure 2).]

- You told me before that one of your challenge at school is … [refer back to the initial interview], What would you say to yourself if you faced this challenge again? I am going to show you a picture of some things you might say to yourself. You can choose the answer that is closest to what you think you would say to yourself. (see Figure 2)

Part Four: Parents' Impressions

- How do you feel about the interaction? What do you like and what do you dislike?
- How do you feel about the interaction? What do you like and what do you dislike?
- What aspect do you think it works well? How would you change it to work better for your children?
- What do you think about your children's discussion with each other during the time they use the technology? Do you think using technology together can help or not help them build relationships?

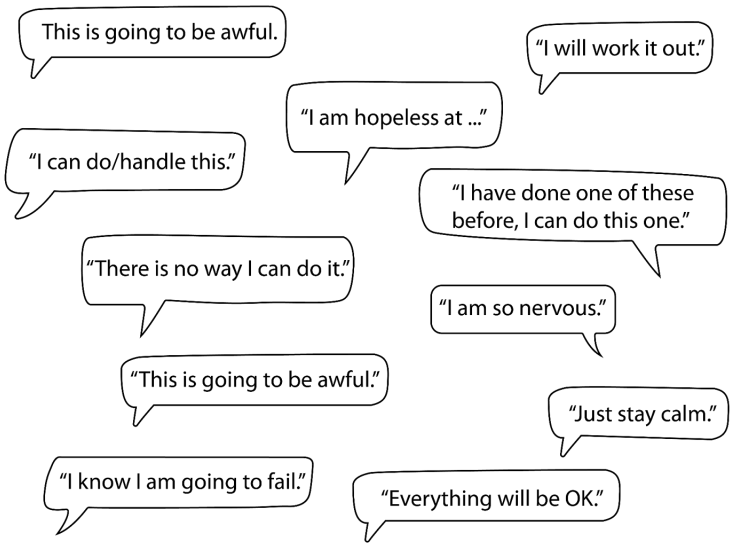

Figure 2: A set of examples for inspiration that includes both supportive and negative self-talk. During the initial interview, children were asked to share what they might tell themselves when confronted with life's challenges. This question was revisited in the exit interview following the implementation of the technology.