Storytelling with *ALMA*: A Multisensory Approach to Enhance Kindergarteners' Emotion Regulation

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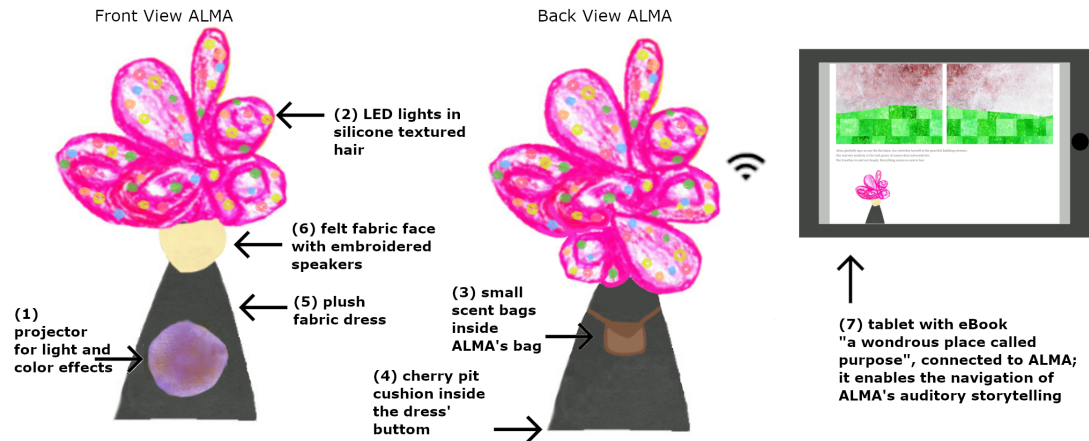
Fig. 1. Prototype Sketch ALMA

This work-in-progress presents ALMA, an innovative prototype for storytelling with a smart soft toy inspired by Snoezelen principles. Its objective is to improve children's emotion regulation while facilitating children's exploration of sensory perceptions, emotion labeling, and self-reflection. While current methods in Child-Computer Interaction (CCI) frequently emphasize individual aspects like storytelling or multisensory experiences, there is a gap in interactive storytelling incorporating soft toys that integrate multisensory and Snoezelen principles, despite the well-documented advantages of such integration. By leveraging the synergies between multisensory experiences and storytelling, ALMA seeks to foster children's emotion regulation and, therefore a holistic development.

Additional Key Words and Phrases: kindergarten children, multisensory, snoezelen, storytelling, soft toys, emotion regulation, CCI

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1 INTRODUCTION AND BACKGROUND

Emotion regulation, the ability of an individual to modulate an emotion or set of emotions[1], is crucial for children's mental health and higher-order cognitive processes (e.g., working memory, attention, and planning) [14]. Recognizing and labeling emotions is important for preschoolers [14], and connecting words to expressive cues [15] are essential for social interactions, fostering nuanced understanding and appropriate responses [17]. Individuals traditionally rely on personal determination and various techniques for managing emotions [28]. In the context of young children, smart soft toys offer a promising avenue for fostering children's emotional regulation, as their tangible characters can facilitate embodied emotional regulation. Through their hands, children actively engage with and experience the world, promoting the development of their understanding of dimensions and shapes [41]. Maria Montessori underscored the importance of sensory training during the ages of 3 to 6, aiming to foster both biological development and social adaptation, which precede the development of intellectual abilities in children [19]. Tangible materials provide children with an effective means to explore through touch and sensory experiences. Especially for young children, the use of tangible materials can be highly beneficial for conveying information even before they are able to express it verbally [23]. Often found in children's rooms, plush toys offer a soft surface with numerous interaction possibilities, serving as companions for comfort and protection [25]. They enable exploration through multiple senses, incorporating tactile elements beyond visual or auditory feedback. Designed with engaging aesthetics and customized features, these toys can provide a distinctive and captivating sensory experience [27]. Further, multisensory experiences can create an environment where children can engage in emotion regulation. This exploration is vital as early sensory experiences are pivotal in organizing cognitive structures and shaping sensory discrimination abilities [19, 33].

In this Work-in-Progress (WIP), we introduce ALMA, a smart soft toy for emotion regulation grounded on Snoezelen principles [2] that can serve as a meaningful and enjoyable educational tool, especially when incorporated into storytelling activities, offering multisensory and self-exploration experiences for young children. The Snoezelen concept, derived from Dutch terms meaning 'sniffing and dozing,' originated within Dutch facilities for individuals with intellectual disabilities [4, 7, 37]. This concept focuses on optimizing sensory experiences—light, sound, smells, tastes, and tactile sensations— aiming to reduce stress and anxiety, and engage users with various stimuli [7], while offering benefits such as relaxation, tranquility, and enhanced self-awareness [7]. By integrating the Snoezelen principles in our design of ALMA, we provide an interactive storytelling companion, that might support emotional regulation through tactile, auditory, and visual stimuli. Additionally, it could enhance the sense of security and familiarity, fostering a more supportive and inclusive learning environment for all children. Incorporating such toys into storytelling activities can enhance the experience, as storytelling fosters social skills, creativity, and emotional control [2]. Smart soft toys, though potentially beneficial, remain uncommon, expensive, and often inadequately customized for the specific needs of kindergarten children.

2 RELATED WORK

2.1 Tangibles, Smart Toys and Soft Toys

Toys are valuable educational tools, providing entertainment and contributing significantly to childhood development [1]. Smart toys are tangible playthings integrating technology for specific functions, enriching traditional toys and fostering meaningful interactive experiences for children [1, 31]. An effective smart toy integrates audio and visual

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[1]https://dictionary.apa.org/emotion-regulation
[2]https://www.snoezelen.info/

elements, is tailored to the appropriate age group, and considers children's cognitive characteristics [1]. Additionally, it should feature engaging content and appearance, presenting a 3-D, tactile structure to encourage hands-on interaction rather than relying solely on screens like computers or tablets [1]. However, comprehensive research on integrating smart toys into early educational settings is lacking. Thus, there is a need for studies to explore optimal integration methods for these toys in young children's learning environments [31].

Theofanopoulou et al. plush toy prototype [44] is a comforting companion for children that simulates an anxious creature, responding to touch with heartbeat vibrations that transition from frantic to calming purring [44]. Taylor et al. [43] foster language development through interactive play. Another innovation focuses on emotional development, exemplified by Breezy, a soft toy accompanied by an app and storybook designed to teach anger management techniques and promote emotional literacy in children [27]. Further, wearables like PlusMe, a panda-shaped device, offer touch-sensitive paws with customizable sensory outputs, fostering social engagement and interaction among children with special needs [39]. Also, WORM-E blends physical and digital elements to engage children in social and physical activities, providing an alternative to excessive smartphone usage while promoting cognitive development [25]. Lastly, SAM represents a fusion of sensory technology with traditional soft toys, offering extended autonomy and interactive capabilities to stimulate children's imagination and play [13]. These projects demonstrate the diverse range of features and functions that can be implemented in soft toys to support children's development.

2.2 Multisensory and Snoezelen Environments

Recent research underscores the educational value of sensory experiences, emphasizing physical engagement with learning materials and the role of multisensory environments in enhancing cognitive skills through technology-based learning [12]. Multisensory exercises have a favorable impact on users in terms of their mood, their balance of the bodily equilibrium, and in respect of their cognitive state, moreover, the connection between the senses may enhance the neuropsychological functions [30]. Snoezelen environments can include specially adapted rooms featuring interactive equipment like color projectors, fiber optics, water tubes with moving bubbles, relaxing music, aromatic elements, and tailored aids for specific populations [7]. These environments typically employ multisensory tools that offer diverse sensory experiences, including haptic events, light, sound, aromas, and even taste, aiming to stimulate users [45]. Snoezelen finds application in various contexts such as relaxation, therapy sessions, dementia care, and multisensory learning [45]. Studies have highlighted its role in enhancing positive communication [34].

2.3 Interactive Storytelling and Emotions

Storytelling fosters social skills, creativity, and emotional control [2]. It intertwines creativity and play, as children employ fantasy, symbolism, and divergent thinking to craft contexts, stories, and characters [24]. People of all ages engage in storytelling to make sense of their experiences [10]. Antunes et al. [2] propose tactile, auditory, and visual multisensory feedback, offering new avenues for stimulation, learning, and communication. The haptic sense, known for robustly communicating emotions [22], becomes pivotal in storytelling, transforming events into narratives, particularly when multisensory elements evoke appropriate emotional responses for the plot [21]. In interactive storytelling, previous research [2, 3, 20, 26, 42] explored digital, sound-based, and tangible elements, creating engaging multisensory environments. Hu et al. [26] highlight texture changes based on the protagonist's feelings. [20]'s Ahù employs projectors for visual storytelling and adds haptic feedback. Incorporating visual feedback through dynamic lights and diverse tactile elements enhances emotional evocation [2, 20, 26, 42]. Antunes et al. [2] utilize color and light dynamics in a multisensory prototype, conveying emotions with specific patterns.

2.4   Emotion Regulation

Emotion regulation, a vital aspect of emotional competence [14], is crucial for a healthy childhood development, aiding when emotional experiences diverge from expectations [14]. Understanding emotions fosters empathetic connections and supports prosocial behavior [17]. The World Health Organization highlights key skills for youth well-being, including decision-making, critical thinking, communication, self-awareness, and coping with stress [38]. Caregivers can nurture emotional competence through detailed feedback and engaging multisensory experiences [5]. Emotion labeling, linking words to emotions [15], enhances social interactions, aiding in interpreting others' emotions and guiding appropriate responses [15]. Emotion regulation, identified as the third crucial component of emotional competence [14], plays an important role in the healthy development of children's minds. It comes into play when the intensity, duration, or other aspects of emotional experiences deviate from alignment with the child's or social partners' goals and expectations [14]. Understanding emotions holds the key to empathetic connections and establishes the foundation for engaging in prosocial behavior [17]. The World Health Organization [38] underscores a core set of skills promoting the health and well-being of young people. These skills encompass decision-making, critical and creative thinking, communication and interpersonal relationships, self-awareness and empathy, and coping with stress and emotion. Emotion regulation is at the core of emotional competence, involving an individual's ability to regulate and estimate their own emotions and behavior. To nurture nuanced self-perception, caregivers can provide detailed feedback, actively listen to children, and create multisensory environments with engaging play-and-learn experiences [5].

2.4.1   Emotion Labeling and Social Interaction. Emotion labeling, the ability to connect words and verbal meaning to expressive emotional cues of emotion [15], is a crucial tool in social interactions. Understanding emotion facilitates the nuanced interplay between emotion and cognition [15] and contributes to complex dynamics. Children's perception of emotions empowers them to accurately interpret others' emotional states, serving as a catalyst for appropriate emotional responses during social engagements.

2.4.2   Emotional Intelligence. Understanding emotions holds the key to empathetic connections and establishes the foundation for engaging in prosocial behavior [17]. Citing [14–17], Mayer et al. [35] suggests that enhanced emotional intelligence in children and adolescents is linked to improved social relations and reduced social deviance. These correlations manifest in self-reports, family assessments, and teacher observations within and beyond the school setting.

3   ALMA: A SNOEZELEN STORYTELLING SOFT TOY TO PROMOTE EMOTION REGULATION

ALMA is based on the book "A Wondrous Place Called Purpose"[3] and its protagonist "Alma", which was the model for this prototype. Also, Alma means "soul" in Portuguese.

3.1   Goals

With ALMA we aim to explore how to design a soft toy and a multisensory Snoezelen environment integrating storytelling to foster children's emotion regulation. Our contribution would be two-fold: (1) a soft toy prototype that consists of seven main components (description below) representing a portable mini multisensory Snoezelen environment, (2) a new age-appropriate multisensory approach for emotion regulation education primarily targeted for kindergarteners.

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[3]https://katharinabuckmayer.com/index.php/a-wondrous-place-called-purpose/

3.2 Design Approach

Kaur et. al [32] propose user-centered design (UCD) as a commonly employed approach for designing interfaces tailored for children, aiming to ensure a positive user experience. UCD engages users indirectly in software design, with the designer retaining control over the process. This method is ideal for preschool children as it offers them a predetermined framework, providing structure while allowing room for creativity. It enables them to develop new ideas and enhance, complement, or replace features and aesthetic elements of prototypes while maintaining a sense of freedom in play.

3.3 ALMA's Main Components

Our work is greatly inspired by the concepts from [39], [20] and [26]. The initial prototype (Figure 1) will consist of seven main components: (1) A compact projector embedded in the dress of the soft toy, projecting colors and movements corresponding to the narrative of the storybook; (2) LED light in the plush toy's silicon hair that changes color based on the storybook's plot or the feelings and dynamics of conversations; (3) scent-bags in ALMA's backpack to underline the different emotional states, (4) a thermal cherry pit cushion placed inside the buttom of ALMA's dress that can be removed to be heated in a microwave allowing children to place the soft toy on their stomach and feel its heat, (5) divers fabrics and textures to give an haptic experience while holding the soft toy, (6) soft speakers to promote the audio story embroidered in the head of the soft toy, and (7) a tablet that is connected to ALMA that displays the storybook "A Wondrous Place Called Purpose"[4], while ALMA serves as an auditory and tangible companion to the storyline.

3.3.1 Light Projection and Visuals. ALMA incorporates the idea of using a projector to create an ambient atmosphere, projecting lights and colors onto walls and floors inspired by [20] and Tranquil Turtle[5]. A small projector will be placed into ALMA's dress, visible on the front. [39] emphasizes the significance of sensory and visual aspects in a comforting object, while [26] proposes utilizing LED rings. Building on these concepts, LED lights will be incorporated into ALMA's hair, altering it according to the story's dynamic and the emotions portrayed. We will also investigate predictable color-emotion responses [18] to map colors to emotions based on children's interactions with the prototypes. Lastly, in line with the suggestion of [11], the visual elements of the prototype will exhibit characteristics such as cuteness, liveliness, or exoticism to captivate children's interest.

3.3.2 Scent and Aroma. Inspired by [26], which incorporates dynamic textures, scent, audio, and light, aiming to provide a versatile platform for children's engagement and emotional understanding, we will include various atmospheric scents to enhance the storytelling experience. Initially, these scents will be manually added, with options like lavender and lemon balm provided in small bags that can be inserted into ALMA's backpack.

3.3.3 Sensorials and Haptics. Sensation, encompassing both factual and emotional aspects, is often interpreted as enjoyable or unpleasant experiences [8]. ALMA's haptics aims to provide diverse and enjoyable sensory patterns [39], with interactive behaviors triggering outputs like colored lights, sounds, and vibrations upon touch. To enhance enjoyment, and since a stimulus that warms the skin to a lukewarm temperature is considered pleasant [9], the prototype will incorporate a removable and microwave-heatable cherry pit cushion to provide thermal sensations. Silicone hair will enclose LED lights that offer additional tactile exploration.

3.3.4 Fabrics. ALMA adheres to [39]'s guidelines, focusing on creating comfort and fostering emotional attachment through soft plushy material. We will utilize different fabrics, such as felt for the face and plush for the dress, emphasizing

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[4]https://katharinabuckmayer.com/index.php/a-wondrous-place-called-purpose/
[5]https://cloudb.com/en-europe/collections/tranquil-turtle

visual appeal and texture to aid tactile perception. Embroidery will be added to the dress using LilyPad Arduino, enabling the integration of electronic components like LEDs with textile arts [6, 40].

3.3.5   Soft Speaker, Audio Story and Tablet Book. [36] propose embedded Soft Speakers embroidered into textiles in their work. Based on that idea, a speaker for the audio-played story will be stitched into the inside of the ALMA's head, which can be visible as its eyes. Through ALMA's eBook, users will have access to a tablet that allows for traditional eBook reading and offers auditory storytelling experiences facilitated by ALMA. With the tablet the story can be navigated.

4   FUTURE RESEARCH AND CONCLUSION

ALMA opens multiple research applications and interaction scenarios for emotion regulation: from individual free-play and pretend-play to group emotional sharing and co-reading. For instance, children can use ALMA during the free-play time to explore its multisensory features while attending to their senses (beyond vision) [29]. The tactile and olfactory features can facilitate children's direct manipulation through an embodied, engaging experience [43]. Engaging with ALMA in play can also foster empathy and the development of personal relationships, as children may care for the stuffed animal in a manner typical of role-playing. It can function as a regular doll, allowing children to explore, discover, and process experiences through pretend play. ALMA can also be used as a relaxation companion by providing carefully designed low-arousal experiences for individual use [39].

We propose two main applications to leverage ALMA's potential: (1) Co-reading and (2) Emotional sharing. Co-reading with children is key to fostering emotional and interpersonal development. ALMA can be used with a book (either physical or digital). Educators/parents can read while children illustrate emotional reactions through ALMA, opening space for interpretation, interactivity, and play. In the case of a digital book, it opens opportunities to augment ALMA of some agency on expressing emotions or even narrative parts of the story. Children can be prompted to recognize and label ALMA's emotions as the storyline guides them through the protagonist's emotional journey, depicted with age-appropriate metaphors and multisensory experiences.

For emotional sharing applications, ALMA can be used as a playful and expressive tool to communicate emotions. If done in a group, it can be a useful tool for fostering emotional regulation skills such as self-awareness, mutual awareness, affective (cognitive and associative) empathy, as well as building trust and self-confidence among children. This might occur during free play or structured activities like the morning circle time, where each child shares experiences by enacting them through a proxy (i.e., ALMA).

In conclusion, ALMA aims to facilitate children's exploration of sensory perceptions, emotion labeling, and self-reflection, promoting experiences suitable for collective and individual use. Additionally, it augments traditional storytelling activities by providing an engaging multisensory experience. Overall, ALMA can contribute to children's emotional regulation and support augmented storytelling approaches through a novel multisensory medium.

5   SELECTION AND PARTICIPATION OF CHILDREN

No children participated in this study.

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