**Child-AI Creativity Support Tools: A Co-Design Study with Children**

BY

FRANCESCA FUSCO
B.S. Politecnico Di Torino, Torino, Italy, 2022

THESIS

Submitted as partial fulfillment of the requirements
for the degree of Master of Science in Computer Science
in the Graduate College of the
University of Illinois at Chicago, 2024

Chicago, Illinois

Defense Committee:

Nikita Soni, Chair and Advisor
Barbara Di Eugenio
Luigi De Russis, Politecnico di Torino

*To Nonna Colomba,*

*this is for you*

**ACKNOWLEDGMENTS**

I thank the children and adults in KidsTeam UW for their enthusiasm in participating in our design sessions, allowing us to obtain valuable insights every time. I thank Jason C. Yip from UW for believing in our project from the start and for his constructive feedback during our planning. I thank Caroline Pitt (UW) for her constant collaboration and help in the planning of the session and in their conduction, without which the study would not have been possible. I also thank Michele Newman (UW) for her enthusiasm in our project and the precious opinions she shared with us. All of the sessions were designed by us at UIC, but they wouldn't have been possible without the help and the enthusiasm of the children, researchers and students from the University of Washington.

I also want to express my gratitude to the ELICIT Lab team for their enthusiasm in hearing our weekly updates on the progress of the study and being there every step of the way. In particular, I want to thank Shanghao Li and Yamaan Nandolia for always helping me when I asked, and for sharing their experience and skills in research and writing.

Most of all, I want to thank Professor Nikita Soni, for her constant guidance and patience in the project. None of this would have happened if Professor Soni hadn't decided to make this idea a reality, believing in it from the start sharing her experience and competence in the field of Child Computer Interaction and Creativity Support Tools.

I also express my heartfelt gratitude to Jenna Stephens for her constant guidance, mentorship and encouragement in every step of this year at UIC.

## ACKNOWLEDGMENTS (Continued)

I am grateful to all the friends I met in Chicago for making this experience less frightening. Special thanks to Alessandro, Calliope, Martina, Simone, Filippo, and Marco for being kind to me when I was the most scared. I thank my roommates Federico, Giuseppe, and Mattia for not kicking me out of the house when I was hysterically crying since my deployments on AWS kept failing and for feeding me when I didn't want to get out of bed for a stupid heartbreak. Special thanks to Giuseppe for throwing away the picture of my ex that I had hanging on my wall, to Mattia for cooking pasta for me, and to Federico for forgoing chest day to make a cheesecake on Halloween. A heartfelt thanks goes to Turin, the dearest city in my life, which saved me, cuddled me, protected me, and nourished me like an elegant and caring mother. You will always have a special place in my heart.

Thanks to the GDA girls, especially Vittoria, Roberta, Michela, Elisabetta, and Elena, for making a house a home.

Thanks to the friends I made in these four wonderful years in Turin from day one: Catia, Alessandra, Fernanda, Federico, Michele G., Samuele, Riccardo, Daniele, Davide, Edoardo, Mattia, Sebastiano, Giulia, Kaliroi, Aurora and Federico.

Thanks to Simone for taking me home from the ER in the middle of the night, to Ludovica for the morning chats while we were going to university, to Enf for making me laugh in curious ways, to Michele F. for the evening ice-creams, and especially to my amo Alessio for being a wonderful socio and patient friend throughout my worst decisions. Thanks to Schiuma for being the kind, generous and sparkling person he is.

## ACKNOWLEDGMENTS (Continued)

Thanks to all of the people from HKN for inspiring me every day to expand my horizons, bringing me out of my comfort zone and believing in my projects, especially Serena, Edoardo, Rosario, Luca, Claudio, Alessia, Manuel, Francesca, Elena, Stefano, Francesco, Dario, and Matteo.

A special thanks goes to Elisa for being the best friend I could hope for, never judging me on my worst days, and always finding a way to make me laugh when I could not see the light at the end of the tunnel. I will always love you and be there for you.

A heartfelt thanks goes to Angelo: you have been here from day zero, and in one form or another, you have witnessed all of the phases and eras of my personality. I am so happy our lives have proceeded together all these years, and I hope it will be this way for a long time.

A special thanks goes to Davide, my mentor, friend, and favorite boss. You have always understood me, saw the best in me, and encouraged me and my ideas with an enthusiasm that I did not even think I deserved. Your determination, kindness, and smile will always inspire me to adventure in the world of adults. Thank you for leading me the way.

A heartfelt thank you goes to Filippo. Thank you for showing me that pure love and kindness still exist, because you exist, and your beautiful soul is full of it. I love you.

A very special thanks goes to Marco. Thank you for teaching me to breathe. *Testata.*

Last but not least, I thank my parents for supporting each one of my decisions and loving me in every form.

FF

## CONTRIBUTION OF AUTHORS

Francesca Fusco led study planning, development of design sessions, data analysis, and creation of the conceptual model presented in this thesis, with PI Nikita Soni's feedback. The study was conducted at UW KidsTeam, where UW researchers offered help with the execution of the co-design sessions. UW conducted the data collection, which was then shared with UIC. UIC and UW researchers plan to build on top of the data analysis presented in this thesis to answer additional research questions, refine the conceptual model, and submitting a research paper to a Human-Computer Interaction conference.

## TABLE OF CONTENTS


| CHAPTER | | | PAGE |
| --- | --- | --- | --- |
| 1 | **INTRODUCTION** | | 1 |
| 2 | **RELATED WORK** | | 7 |
| | 2.1 | Children and Creativity Support Tools | 7 |
| | 2.2 | Using Co-Design to elicit design ideas from children | 8 |
| | 2.3 | Children's engagement | 9 |
| | 2.4 | Intelligent Interfaces for Children | 10 |
| 3 | **METHODS** | | 12 |
| | 3.1 | Participants | 13 |
| | 3.2 | Study Creation | 14 |
| | 3.3 | Co-design Design sessions | 15 |
| | 3.3.1 | Design Session 1 - Familiarization with Intelligent Creativity Support Tools (DS1) | 16 |
| | 3.3.2 | Design Session 2 - Interaction and Feedback (DS2) | 17 |
| | 3.3.3 | Design Session 3 - Technical Automation (DS3) | 18 |
| | 3.3.4 | Design Session 4 - Conceptual Automation (DS4) | 21 |
| | 3.4 | Data Analysis | 23 |
| | 3.5 | Findings: The conceptual model of child-AI visual storytelling interface | 25 |
| | 3.6 | Themes | 26 |
| | 3.6.1 | Negotiation (T1) | 28 |
| | 3.7 | Division of work (T2) | 34 |
| | 3.7.1 | Input Interaction Methods (T3) | 45 |
| 4 | **DISCUSSIONS** | | 50 |
| | 4.1 | The output: Conceptual Diagram of Collaborative Child-AI Visual Storytelling Interface | 53 |
| | 4.2 | RQ1: What kind of interactions best suit children's needs and is well-received by them | 54 |
| | 4.3 | RQ2 and RQ3: What kind, if any, of technical and conceptual automation can assist children in their creative journey | 54 |
| | 4.4 | System Intelligence | 54 |
| | 4.4.1 | Memory | 55 |
| | 4.4.2 | Flexibility | 55 |
| | 4.5 | Control and Credit | 55 |
| | 4.6 | Privacy | 56 |

## TABLE OF CONTENTS (Continued)

**CHAPTER** **PAGE**


4.7 Co-design sessions . . . . . . . . . . 56
4.8 Limitations and future work . . . . . . . . . . 57

**5 CONCLUSION** . . . . . . . . . . 59

**APPENDIX** . . . . . . . . . . 60

**CITED LITERATURE** . . . . . . . . . . 63

**VITA** . . . . . . . . . . 67

## LIST OF TABLES


| TABLE | | PAGE |
|---|---|---|
| I | DEMOGRAPHICS OF THE CHILDREN OBTAINED VIA QUESTIONNAIRE | 13 |
| II | THE DESIGN SESSIONS THAT WERE CONDUCTED BY THE RESEARCHERS. EACH SESSION HAD A DIFFERENT RESEARCH GOAL AND ACTIVITY | 22 |
| III | THREE MAJOR THEMES OBTAINED BY ANALYZING THE DATA THROUGH AFFINITY DIAGRAMMING AND THEMATIC ANALYSIS. THE ANALYSIS IS STILL ONGOING | 27 |

# LIST OF FIGURES


| FIGURE | | PAGE |
|---|---|---|
| 1 | Output with IL = 0 | 19 |
| 2 | Output with IL = 48 | 20 |
| 3 | Screenshot of the Miro board used by the researchers | 24 |
| 4 | Conceptual diagram of child-AI visual storytelling interface, developed through thematic analysis and affinity diagramming | 25 |
| 5 | interface that uses movement and color for input | 28 |
| 6 | An example of negotiation using fine-tuning in prompt: a) "A dragon laying in a flower field"; b) "A gyrados lying in a flower field". Dragon was changed to gyrados | 30 |
| 7 | An example of fine-tuning through drawing: a) Jellyfish before fine-tuning; b) Jellyfish after fine-tuning | 32 |
| 8 | Mad Libs used as prototype during DS1, example of interface where the AI creates an outline in the plot of the story | 35 |
| 9 | Example of prototype for a drawing interface where the AI draws an outline and the child enriches it | 38 |
| 10 | Children drawing with an IL of 0 | 40 |
| 11 | Children increasing the IL | 40 |
| 12 | Screen of the iPad while C4 was drawing. She can only clearly see what she is drawing, hiding the tool's output | 41 |
| 13 | An example of division of work where child and AI are co-creators: a) Example of movement through drawing; b) Too much lead from the AI | 44 |
| 14 | a) An interface that implements a secret language through hand gestures; b) An example of multi-modality where children both draw and write on the canvas | 47 |
| 15 | Music notes as secret language. a) Written explanation; b) Note-letter correspondence | 48 |

# LIST OF ABBREVIATIONS

| | |
|---|---|
| UIC | University of Illinois at Chicago |
| UW | University of Washington |
| RQ | Research Question |
| IL | Imagination Level |

# SUMMARY

Creative expression plays an essential role in the development of cognitive skills. Creativity Support Tools (CSTs) such as child-AI visual storytelling where children can verbally narrate and figuratively draw and express their stories are increasingly used to scaffold and support children's creative expression, helping them overcome creativity decline or blocks such as the fourth-grade slump, a phenomenon where children's creativity declines by grade 4. However, child-AI visual storytelling interfaces are not always designed to align with children's mental models and expectations, nor do they fully accommodate their developing cognitive and motor skills. For example, generative AI interfaces such as DALL-E have been used as examples of Creativity Support Tools for visual art and storytelling for children, however, they are not always designed to accommodate children's needs and the diversity of their interactions in mind. The goal of this MS thesis is to understand children's mental models of child-AI visual storytelling tools, especially with regard to interaction methods and the level of automation support needed from AI to support children's creative storytelling expression. To answer our questions, we conducted four co-design sessions at the University of Washington's KidsTeam with 7 children aged 8-13. The sessions were hybrid and lasted 90 minutes each. The main goal of the session was to understand children's conceptual models related to how they might think of interacting with storytelling tools to express their ideas, and how they conceptualize distributing creating tasks between AI and themselves. We qualitatively analyzed data using thematic analysis to create a conceptual model of how children perceive creativity support tools and point out their preferences regarding the kind of interactions the interface can afford, main components of the model include: Negotiation, Division of Work, and Input Methods. Our work contributes a deeper understanding of children's conceptual model of child-AI creativity support tools for storytelling in terms of automation, feedback, and interaction and will help inform the design of future child-AI creativity tools.

# CHAPTER 1

# INTRODUCTION

Creative expression, which includes activities such as drawing, storytelling, and music, plays an essential role in developing cognitive skills [1] such as memory, flexible thinking or attention. Creative activities help children think outside the box and develop problem-solving capabilities. Visual storytelling, specifically, enhances children's literary skills and has been shown to encourage the development of critical thinking, story sequencing visualization and cognitive engagement [2]. In Agosto's study [2], the author worked with a class of 28 second-grade students. She first read some stories to them, and the children were later instructed to create some thank-you cards to send to the guest storyteller. By analyzing the cards, the researcher was able to highlight the four literacy benefits that are the consequences of oral storytelling: visualization, cognitive engagement, critical thinking, and story sequencing ability. Creativity Support Tools (CSTs) such as child-AI visual storytelling where children can verbally narrate and figuratively draw their stories are increasingly used to scaffold and support children's creative expression, helping them overcome blocks such as the fourth-grade slump, which is a decrease in children's creativity during fourth grade [1]. Chu [3] defines the fourth-grade slump as a precipitous decrease in creative engagement [4], and suggests that among the causes of this phenomenon might be children's increasing self-awareness [3]. The results of Chu et al.'s study indicated that the negative effects of self-awareness and self-evaluation on creative engagement could be mitigated by enhancing a positive attitude and self-efficacy regarding creative activities through storytelling, specifically, enactment-based animated authoring [3]. However, child-AI visual storytelling interfaces are not always designed with children's mental models and expectations in mind and accommodate their developing cognitive and motor skills which could impact the way the interface understands children's natural speech or drawing inputs. For example, generative AI interfaces such as DALL-E have been used for visual art and storytelling for children; Newman et al. [5], for instance, used DALL-E 2 for comic boarding and creative writing with children, generating a conceptual diagram of the functionalities of GenAI interfaces and children's awareness of these capabilities [5], highlighting how children needed adult's guidance to interact with the AI in a way that was satisfying for them. However, GenAI interfaces are not always designed to accommodate children's needs and the diversity of their interactions. Prior work by Shaw et al. [6] discussed how children's touchscreen interaction or drawing patterns are different than those of adults, and design guidelines and input recognizers designed for adults cannot be directly applied to children's interfaces. This could have implications for creative interfaces, as children often use gestures or drawings to express their ideas. Beyond touchscreen interactions, voice interfaces for children have emerged as a crucial area of study. Naranayan et al. [7] emphasize the importance of designing child-centered speech recognition algorithms since they express themselves and structure their thoughts differently than adults as a consequence of their ongoing development. This different way of giving speech input to interfaces can also influence how they express themselves creatively, and how AI might interpret and respond to it. Similarly, prior work by Soni et al. [8] highlighted the importance of tailoring other interface features such as simplicity, feedback mechanisms, and interaction flow to children when designing for them. Kim et al. [9] explored how existing voice assistants respond to children's speech input: they found out that voice assistants (such as Alexa) respond to children in a meaningful, contextually relevant way only half of the time [9]. A research literature review [10] surveying Human-Computer Interaction work within the space of creativity support tools found that out of 150 papers, only 12 focused on child-centered creativity support tools, warranting the need to support more work in this space, especially with the potential of AI in education and creativity gaining attention [11].

Some of the critical questions that need to be addressed when designing AI-based visual storytelling tools for children concerning interactions include: what means of interaction are most natural to children regarding their creative expression, especially in the field of visual storytelling? Additionally, it is important to study children's conceptual models of automation or help needed from AI, especially in a creative context. Chu et al. [3] showed how children's creative output is influenced by their perceived self-efficacy and self-awareness. AI interfaces can help in this by providing conceptual and technical automation that can support the child in developing creative outputs. Technical automation consists of helping the user with technical aspects such as coloring, fixing lines to make them straight, and so on. We explore these aspects since drawing and representing a story visually is the aspect that characterizes visual storytelling, and drawing includes technical aspects such as the ones listed above. Conceptual automation assists in generating and refining ideas and giving inspiration [12]. We also want to explore if and to what extent children users appreciate this kind of help, and how they perceive it. Prior work has started to explore the design space of child AI creativity support tools.

Zhang et al. [13] and Zhang et al. [1] have developed Bio Sketchbook and StoryDrawer, respectively, that assist children in their learning process and visual creativity through drawing. The StoryDrawer platform enables collaborative storytelling through two main strategies. The first strategy involves generating a sketch based on the child's dictation, while the second strategy involves creating sketches to inspire the child based on the context of the rest of the drawing. On the other hand, Bio Sketchbook aims to enhance children's learning of biodiversity. It is an interactive drawing tool that guides children in observing the environment by helping them recognize different species of plants, providing magnification for details, generating outlines based on pictures taken by the child, and offering botanical information based on the context. Both studies concluded that the strategies performed by those tools, which involve scaffolding the child in their autonomous process, improved children's retention of information for Bio Sketchbook and increased their creative output in the case of StoryDrawer. However, previous research did not explore how children perceive collaborating with AI for storytelling, including when they do or do not need help. Our work builds on this by examining the types of interactions children believe storytelling tools should support and how they envision collaboration dynamics with AI, both in terms of technical and conceptual assistance, for creative visual storytelling.

The main research questions of this thesis are:

1. RQ1: How do children think of interacting with child-AI visual storytelling interfaces?
2. RQ2: What kind (if any) of technical automation can assist children during visual storytelling?

3. RQ3: What kind (if any) of conceptual automation can assist children during visual storytelling?

To answer these research questions, we conducted four co-design sessions with 7 children aged 8-13 at KidsTeam UW [14], an already-existing intergenerational co-design group that operates at the University of Washington (henceforth denoted as UW). Each session aimed to elicit a different insight on one of the following matters related to children's creativity tools: interaction, feedback, error reaction, and technical and conceptual automation. Each session aimed to elicit a different insight on one of the following matters related to children's creativity tools: interaction, feedback, error reaction, and technical and conceptual automation.

The sessions were hybrid and lasted 90 minutes. The study data, including video, audio recordings, and creativity artifacts created by children were thematically analyzed using affinity diagramming, a technique which is often used to analyze large amounts of data by organizing it in themes and patterns. Based on our analysis, we contribute a conceptual model of how children's expectations from child-AI visual storytelling interfaces, with three key themes: negotiation, division of work, and input methods.

This thesis contributes to the current state of the art in the following ways: In their study on IUIs [15], Woodward et al. developed a conceptual diagram to examine how children perceive Intelligent Tools and how they interact with them. Our work builds on this by concentrating on how children perceive collaborating with AI-based storytelling interfaces, beyond focusing on how children perceive AI. Another close work to our research is that by Newman et al. [5], who developed a three-layer explanatory model for Child-Generative AI Creative Interactions. This model encompasses the system's functionalities and the child's recognition of its capabilities [5]. Our goal was to observe how child users prefer to interact with the tool, negotiate desired outputs, and collaborate in the creation process.

The main contributions of our study include: a conceptual model of AI storytelling tools for children, incorporating different ways children think of collaborating with AI when doing creative storytelling tasks. Our conceptual model emphasizes children's preferences regarding automation: they did not want AI to take over or completely alter their creative ideas. However, they did not express concerns with AI adding light details to their creations, as long as the core idea or structure remained intact. We discuss design implications for future child-AI storytelling interfaces based on our findings. Our conceptual model can inform the designers of future creativity interfaces for children so that their needs and expectations in terms of automation, feedback, error reaction, and interaction are taken into account in the development of future creativity support tools that accommodate children's needs and mental models.

# CHAPTER 2

# RELATED WORK

## 2.1 Children and Creativity Support Tools

Previous works have explored the suitability of existing creativity tools for children and even developed prototype tools directed to younger users. Zhang et al. [1] created StoryDrawer, which is a collaborative tool designed to assist kids between the ages of 6 and 10 in creating visual stories. [1]. The tool presented two collaborative strategies to support children's cognitive mechanisms by leveraging AI [1]. Strategy 1 involved turning children's descriptions into drawings in real time, while Strategy 2 created abstract sketches that were conceptually similar to the stories already in existence. They concluded that the two strategies, together with a voice agent, engaged children and helped them produce creative and elaborate outcomes [1]. Yadava et al. [16] explored how children of different ages use drawing apps. They found that children aged two and three prefer simplicity, glowing colors, and background music synchronized with their movements. Four-to six-year-old children could use the eraser feature of the creativity app. Children aged seven and eight could use brushes of different thicknesses, filling functionalities, and undo features. Children aged nine and ten could also use "redo" and "zoom." The oldest children (aged eleven and twelve) could also use different-sized erasers [16] . Han et al. [17] explored the opportunities and limitations of existing generative AI tools such as Stable Diffusion, ChatGPT, and MidJourney for educational purposes such as the creative expression of children [17]. They interviewed nine adult participants from diverse backgrounds to understand their opinions on using AI technologies for children [17]. The main concerns were related to security and the hindering of children's ability to make independent decisions. However, the back-and-forth fashioned interaction was praised [17]. The main concern regarding current AI art generators' educational potential is their limited open-ended exploration options [17]. However, these studies were either with adults or evaluated the fully developed prototype after the fact with children. In our work, we have employed a co-design approach where the goal is to develop a systematic understanding of children's conceptual models by involving them as designers rather than just evaluating the creative interfaces. One of our goals is to explore the appropriate level of automation (conceptual or technical) to include in creative storytelling interfaces designed for children. We aim to support children's actions and enhance their creative output without overdoing it, ensuring that AI-based assistance does not discourage their creative expression.

### 2.2 Using Co-Design to elicit design ideas from children

According to Van Doorn (2016), children are experts in "being a child," and their experiences, context, desires, and needs should be considered valuable input for the design process [18]. However, when it comes to children's as subjects in studies, the approaches that are commonly used for adults (e.g., direct interviews and focus groups) do not always produce useful insights [15]. Woodward et al. [15] conducted four co-design sessions with children aged 5-12 to elicit how children think about and understand Intelligent User Interfaces. They found that direct interviews, in the case of children subjects, do not generate data as rich as Participatory

Design does [15]. As per Newman et al. [5], Participatory Design involves collaboration between designers and users to jointly create new technology [5] by directly involving users in the design process through generative techniques [19]. Participants are able to express and manifest their thoughts and ideas through co-design by creating tangible objects. By giving children the role of design partners, researchers can better understand their needs, expectations, and conceptual models, obtaining more insightful information that we would obtain by using methods that imply an asymmetric relationship between designer and user and a capacity to express one's ideas that young children might not have obtained yet, such as interviews and focus groups. Hence, we conducted co-design sessions using participatory design techniques such as Big Paper, Comic Boarding, and Bags of Stuff (described later) to elicit useful insights into how children conceptualize child-AI creativity storytelling interfaces.

### 2.3 Children's engagement

Recent research has focused on developing strategies to effectively involve children in co-design activities and to motivate their active participation. It is crucial for researchers to gather valuable and meaningful insights. Traditional methods like direct interviews, which are designed for adults, may not always provide useful information because children's developing literary skills can make it challenging for them to fully articulate their thoughts during interviews. Mazzone et al. [20] performed three different design activities with children to understand the efficacy of co-design activities in generating design ideas and involving children in the design process. The sessions' outcome was a framework for increasing children's engagement in design activities. Using multiple channels for children to express their ideas and providing an initial prompt to trigger the activity seemed to play a positive role in the subjects' engagement [20]. Therefore, we will use different generative techniques and discussion prompts to keep children engaged. We have also elaborated some original guidelines to better motivate children in taking part to the activity, based on our challenges and successes during the design activities.

### 2.4 Intelligent Interfaces for Children

Children generally interact better with tools that present human characteristics and are conversational. Woodward et al. [15] stressed the importance of intelligence and human-like characteristics in their conceptual model of how children perceive Intelligent User Interfaces. It seemed important for children to interact with an interface that can maintain a conversation and elicit, recognize, and accurately respond to emotion [15]. This stress on the system's intelligence is reported in studies regarding many different types of interfaces. For example, Woodward et al. [21] came up with the same conclusion in their study about AR headsets for children. They found that children expect highly intelligent systems that can also consider context [21]. Our study aims to identify how this necessity adapts to creativity support tools for storytelling. Regarding creativity tools directed to children, some level of help has been shown to support children's creative output and learning process. Zhang et al. [13] introduced an interactive drawing tool called Bio Sketchbook, which was designed to help children observe the natural biodiversity of plants. They found that the tool improved the recording and retention of information, enhanced the children's engagement with nature, and encouraged them to interact with plants in a versatile manner such as sketching and note-taking [13]. Zhang et al. [1] created StoryDrawer, a collaborative tool designed to enhance visual storytelling for children between the ages of 6 and 10. The primary aim was to address the decrease in creativity often observed in fourth-grade children, known as the "Fourth-Grade Slump". Their study findings indicated that the implementation of StoryDrawer aided children in generating imaginative and detailed concepts, ultimately leading to enhanced creative outputs [1]. Davis et al. (2006) developed a Cognitive Theory of Creativity Support and encouraged the creation Creativity Support Tools (CSTs) that offer a flexible scaffolding to transfer certain skills from more experienced individuals to intelligent tools in order to assist novices [12]. In our work, we want to further explore how to determine the level and kind of technical and conceptual automation that best suits children's storytelling experiences.

# CHAPTER 3

# METHODS

We conducted 4 co-design sessions, during which we encouraged participants (ages 8-13) to interact with and design creativity support tools, focusing on interaction modalities and automation. We worked with an already-existing co-design group of children (referred to, from now on, as *KidsTeam UW* or *KidsTeam*). *KidsTeam* is an inter-generational research group that brings together both adults and children to collaborate on the development of new technology. In *KidsTeam*, children are not viewed as mere testers or informants but as valuable design partners. The group meets a maximum of twice a week during the school year and has contributed to numerous industry and academic projects [14]. The reasons for which we chose an already-existing group of children instead of recruiting our own are the following: (1) The children composing the group were already familiar with multiple design techniques; (2) Children had already previously interacted with AI tools in other studies conducted by *KidsTeam* [5, 15].

Each design session lasted 90 minutes, and each one explored a different research goal of our study:

- Design Session 1: Familiarization with Intelligent Creativity Support Tools: design your own Creativity Support Tool (Bags of Stuff, Big Paper)
- Design Session 2: Interaction and Feedback: modify the previous designs with particular stress on interaction modalities (Bags of Stuff, Big Paper)

TABLE I: DEMOGRAPHICS OF THE CHILDREN OBTAINED VIA QUESTIONNAIRE

| Participant ID | Age | Ethnicity |
|---|---|---|
| 202 | 9 | Asian; black or African American |
| 999 | 9 | Asian American |
| 888 | 8 | Asian American |
| 143 | 13 | White; Asian; Roman |
| 493 | 9 | White; African American |
| 666 | 8 | White; Asian |
| 113 | 11 | White; Asian |

- Design Session 3: Technical automation: interact with some drawing tools that present different kinds of technical automation, and discuss likes and dislikes
- Design Session 4: Conceptual automation: perform visual storytelling using the different levels of conceptual automation offered by an existing tool, and discuss the likes and dislikes of each experience

### 3.1 Participants

The participants were all members of the already-existing intergenerational co-design group *KidsTeam UW*, which consists of child participants and adult researchers. For years, this group has explored how adults and children can collaborate in the design of new technologies.

*KidsTeam UW* includes 7 children ages 8 to 13 years old [average = 9.6, median = 9]. 4 of the children identified as females, while 2 identified as males. One of the children did not answer the demographic question. This age group is consistent with previous research on how children perceive computer interfaces, and their needs regarding that [15–17, 21, 22]. There have been episodes where the oldest child (13 years old, female) acted as a mediator between the adults and her younger group mates, encouraging them to participate in the activity with enthusiasm. During Design Session 3, she encouraged her teammates to participate in the activity enthusiastically. For instance, she took over the most technically difficult parts of drawing, such as drawing the dragon, while leaving her younger teammate, C1, to draw the flowers in the background. However, she also participated in the activities like the other children and provided design inputs.

Our participants reported using text-to-image tools such as DALL-E at most once or twice a month. Our research received approval from the Institutional Review Boards of both UIC and UW, and all the names that we will use from now on are pseudonyms.

### 3.2 Study Creation

PI Soni and I collaborated on designing sessions and activities for the children based on our research questions, regularly seeking feedback from the UW research group managers to help frame questions that could be easy for children to understand and respond to. Their feedback was especially useful for ideating the questions of the day and for ensuring that our design activities took into account children's experiences with previous AI-related studies. For instance, in the preparatory meetings for Session 3, which would focus on interaction and feedback, we were encouraged to create a "question of the day" to prompt children to think creatively and "outside of the box". Since they had already interacted with GenAI interfaces in a previous project, we didn't want them to limit their answers to what they were already familiar with, such as text and touch. We eventually created the following question: “What is the weirdest way you can think of communicating with a computer?”.

### 3.3 Co-design Design sessions

We conducted four design sessions, each lasting 90 minutes. The sessions took place over six weeks, with a maximum of one session per week. Each of the sessions was divided into the following four parts: *Snack Time* (15 minutes): social time; *Circle Time* (15 minutes): warm-up activities and prompt questions related to the topic of the day; *Design Session Time* (45 minutes): children are divided into small groups and complete the activity, either a design activity or an interaction with one or more existing tools; *Discussion Time* (15 minutes): the group is reconstituted and likes, dislikes, general feedback, and design ideas are discussed together. We structured the sessions so that children could become familiar with the concept of Creativity Support Tools (we used the term “AI Partner for Creativity Support” in the sessions) before participating in the sessions related to the more complex research questions.

During Design Session Time, children were divided into groups. The groups were different each time, so that everyone had the chance to work with different people each session. Each group was made of two or three children and two or three adult researchers. It could happen that one or two children in each group participated online on Zoom. Specifically, two children were online during Design Session 1, one child was online during Design Session 2 and two children were online during Design Session 3.

The strategy that appeared to keep the children engaged and motivated during the activity had two key elements:

1. The adults interacted with the children as equals.

2. The adults did not act as authority figures assigning tasks. Instead, both children and adults participated in the activities as if they were playing together. If the children lost focus, the adults did not force them to continue working. Instead, they allowed the children to take a break and do something else until they were ready to resume the activity on their own.

All sessions were audio and video recorded; the adult facilitators collected field notes and pictures of the design artifacts and shared them with the UIC researchers over secure servers. The study was approved by both UIC and UW IRBs. Children and their parents assented and consented, respectively, to take part in the study as a part of blanket IRB approved by the UW's larger *KidsTeam* Study, which explores how adults and children can collaborate for the creation of new technology for children.

Here follows a detailed description of each design session.

### 3.3.1 Design Session 1 - Familiarization with Intelligent Creativity Support Tools (DS1)

Design goal: scope setting and initial design of a creativity AI partner.

During Snack Time, children were asked to fill a demographic survey (see Appendix). We then proceeded with a *question of the day*: "How do you interact with technology?". After giving each child time to share their answer, the group was introduced to the concept of "AI tools for creativity", described as "AI tools that help you draw, write stories, make music and all sorts of creative things". A quick video of a child interacting with *StoryDrawer* was then played. While the demo was playing, a researcher explained how the child was using a storytelling tool that could understand children's speech and drawings. After this introductory phase, a researcher from UW explained the design activity of the day, in which children had to use the *Bags of Stuff* design technique to create a prototype of their own CST. *Bags of Stuff* is a low-tech prototyping method where participants use large bags filled with craft materials to create prototypes in groups. Researchers anticipated it was just the first of a couple of sessions in which children would have worked on their prototype. Therefore, they were encouraged to think broadly about a creativity tool, what they would have liked it to do, and how they would have wanted it to communicate with them. The group was then divided into subgroups of 4-5 (2 adults and 2-3 children each), and each subgroup was provided with a *Bag of Stuff* and blank papers to work on their prototype.

After the Design Session Time, the whole group was reconstituted, and each subgroup explained the prototype(s) they had developed.

### 3.3.2 Design Session 2 - Interaction and Feedback (DS2)

Design goal: elicit what kind of interactions, feedback, and error reactions children expect from a storytelling creativity support tool.

On the second day, we elicited how children would want to communicate their stories to an AI storytelling interface. During Circle Time, we asked the question of the day to prepare the children for the activity that would follow. The question was, "What is the weirdest way you can think of communicating with a computer?" The goal was to encourage the children to think outside the box instead of coming up with alternatives they are merely familiar with, such as touch, drag-and-drop, and other popular direct interaction methods. This time, the activity consisted of *acting out* (meaning, demonstrating) how they would like to interact with a storytelling interface. Indeed, we were afraid that with traditional prototyping, they would have focused on UI aspects rather than providing us with data related to interaction methods. For the design activity, children were divided into four groups, each with at least one adult facilitator. Each group was provided with a bag of stuff and some blank sheets of paper.

The facilitator asked the children to choose one story component among those presented during *Circle time*: character, action, and setting. Then, children were asked to demonstrate how they would communicate that component to a computer. Children were encouraged to think outside the box and come up with creative alternatives. During *Discussion Time*, each group demonstrated the interactions they ideated.

### 3.3.3 Design Session 3 - Technical Automation (DS3)

Design goal: elicit what level and kind of technical automation children desire for the creativity tools they interact with.

With the third session, we aimed to identify what kind of technical automation children need with the drawing aspect of storytelling. During Circle Time, we asked the question of the day to prepare the children for the following activity: "How would you like the computer to help you communicate your ideas through drawing?" We provided some examples, such as "fixing straight lines" and "color-filling." Children were divided into four groups for the activity, each with at least one adult facilitator. Each group was provided with a tablet. The activity consisted of interacting with a free online tool called "Pikaso Freep!ck" (Figure 1 and Figure 2 below), which presents an interface split into two panels; on the left-hand side, children could draw a subject. The software would use AI and an optionally provided prompt to enrich the starting drawing, which would appear in the right-hand side. A sliding bar from 0 to 100 allows the customization of the "Imagination Level" (IL), which controls the extent to which the AI modifies the drawing and inserts its own ideas in it.

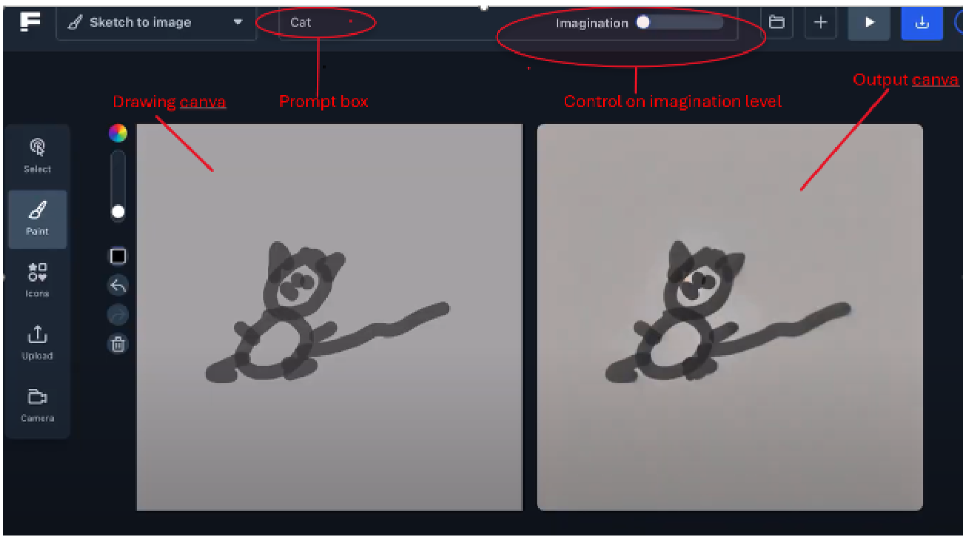



Figure 1: Output with IL = 0

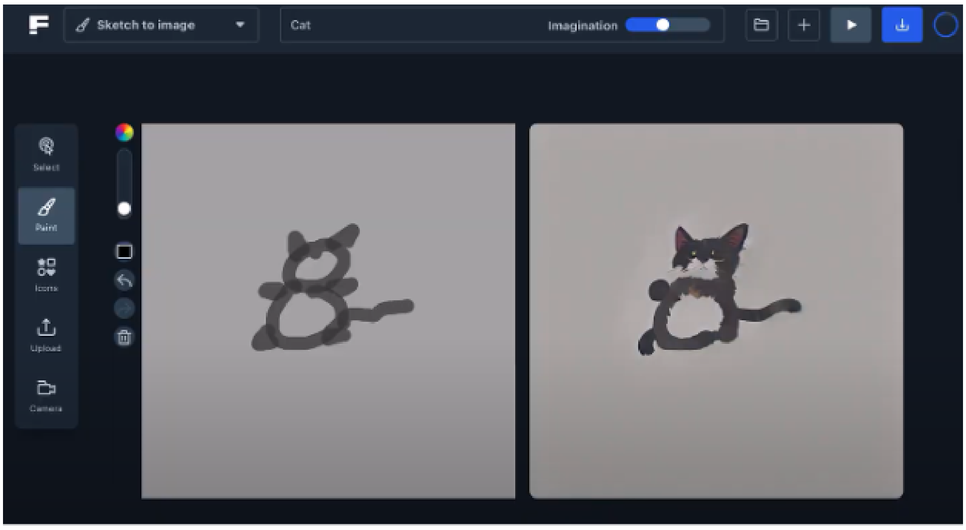



Figure 2: Output with IL = 48

Children were asked to choose a prompt between a given set ("*A baby lion eating an apple*", "*A bee flying on a flower*" and "*A dragon sleeping in a field of flowers*") or come up with their own, and they then used Pikaso, experimenting with different levels of Imagination. During the activity, they were asked some prompt questions: "*How was the drawing experience?*", "*What would you have liked to receive help from the computer?*", "*What are you not satisfied with your drawing?*", "*What would you have liked to receive help with from the computer?*". During *Discussion Time*, children were asked to express their likes and dislikes about how the interface tried to help, what they would modify, and which Imagination level they believed was best.

### 3.3.4 Design Session 4 - Conceptual Automation (DS4)

Design goal: elicit what level and kind of conceptual automation children desire for the creativity tools they interact with.

The goal of the last session was to identify what kind of conceptual automation children need with the drawing aspect of storytelling. During Circle Time, we asked the question of the day to prepare the children for the following activity: "What is the hardest part of creating a story? Which parts of the story creations would you like the AI to help you with?" We provided some examples so that the subjects could understand the context better. Children were divided into four groups for the activity, each with at least one adult facilitator. Each group was provided with a tablet. The activity consisted of interacting again with "Pikaso Freep!ck" after choosing a prompt, this time as follows: in the first part of the Design session time, they were instructed to use an imagination level between 0 and 30, while in the second part of the activity, we asked them to use a value between 30 and 70. During the activity, they were asked prompt questions such as "How would you program these different levels of imagination if you were the programmers?". This question might seem too technical for a young child. However, in the first session, this group of children demonstrated a degree of familiarity with concepts like programming and AI models since they received some very broad explanations during the other projects they took part in. Therefore, we decided to better engage them by putting the question in a way that made them perceive they were treated like equals, so that they would be more motivated to participate. Furthermore, by framing the question in this specific manner rather than using a more broad "*What changes would you make?*", we were able to avoid receiving vague responses

TABLE II: THE DESIGN SESSIONS THAT WERE CONDUCTED BY THE RESEARCHERS. EACH SESSION HAD A DIFFERENT RESEARCH GOAL AND ACTIVITY

| Design Session # | Research Goal | Question of the day | Design activity |
|---|---|---|---|
| 1 | Familiarization with Intelligent Creativity Support Tools | "How do you interact with technology?" | Prototyping |
| 2 | Interaction and feedback | "What is the weirdest way you can think of communicating with a computer?" | Act out |
| 3 | Technical automation | "How would you like the computer to help you in communicating your ideas through drawing?" | Usage of Freep!ck Pikaso |
| 4 | Conceptual automation | "What parts of telling a story do you find hardest? Which parts of the story creation would you like the AI to help you with?" | Usage of Freep!ck Pikaso |

such as "*I would re-program it*" or "*I would change the model*", which had occurred in previous studies according to the UW researchers we consulted. During *Discussion Time*, we asked again what the hardest part of creating a story was and whether they preferred a tool that directly changes pictures or suggests changes. Moreover, children were asked how they would modify the tool.

### 3.4 Data Analysis

I transcribed and wrote memos of the design sessions videos, the screen recordings, the pictures of the prototypes, and the questionnaires of the four design sessions. Excluding snack time, we had around 720 minutes of video recordings. Transcriptions were executed word by word, whereas memos were created by listening to 15-minute intervals of the recordings and writing down anything that the researcher considered relevant based on our research questions. Memos included: a date and an identifier, a summary, reflections, connections, and any design implication [23]. During memo writing, I also looked at the notes taken by the facilitators during the sessions, the screen recordings of the iPads, and the pictures of the artifacts. All the data was used for Affinity Diagramming to uncover themes of children's conceptual models concerning interaction and collaboration with child-AI creativity storytelling tools. Affinity diagramming is an inductive method often used to analyze big moles of data. This method has already been used by other CCI researchers in the past when analyzing the output data of co-design sessions with children [5, 15, 21]. Thematic analysis is a method that allows to analyze of qualitative data like transcripts, by organizing them into themes and patterns [24]. It involves grouping similar or related data into clusters. The clusters are reviewed iteratively by one or more people until they stabilize. I copied each concept from the note and statement from the transcriptions on a sticky note and iteratively grouped related and similar notes until the clusters were stable enough to assign themes to them. I then identified a common theme for each group of notes along with my advisor, Soni, and highlighted the connections between them. We used Miro, an online whiteboard that allows virtual group collaboration for this process (Figure 3).

Professor Soni helped me with the analysis process to ensure a satisfactory level of reliability. The analysis spanned a month. I created initial groupings based on the design sessions data on Miro Board and shared the link with PI Soni. PI Soni and I met over several meetings to discuss each theme. During these meetings, we reviewed each sticky note within a theme to ensure consensus on the assigned group. Based on these discussion meetings, themes were revised to create the final conceptual model reported in the thesis. The reported model helps us answer the research questions for the thesis. We plan to continue to analyze the data with UW team members to answer additional questions and extend the conceptual model. We went through this process iteratively 5 times over the course of a month. To analyze the anonymized demographic data, we used Google Sheets.

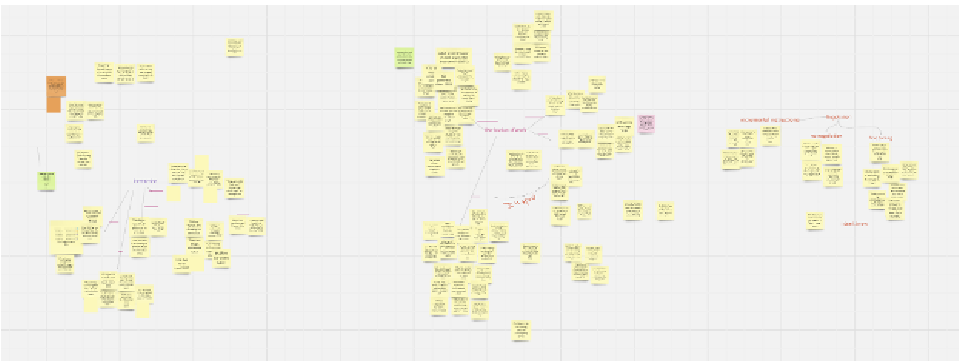


Figure 3: Screenshot of the Miro board used by the researchers

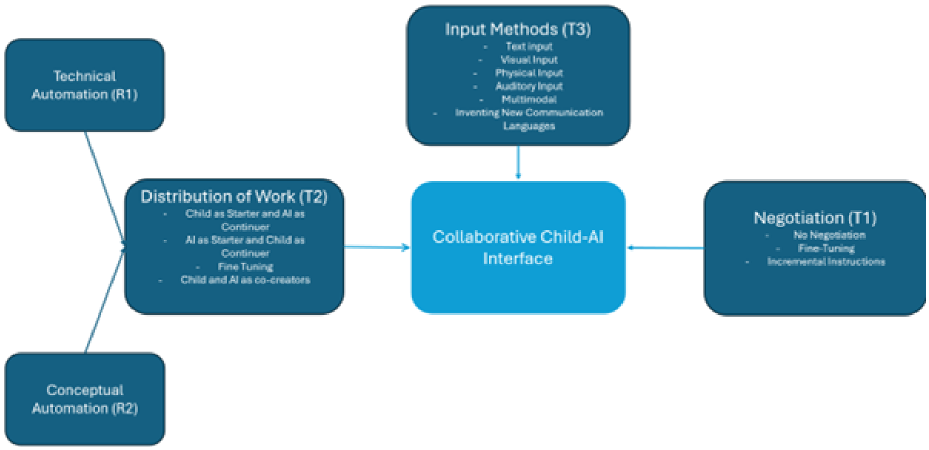



Figure 4: Conceptual diagram of child-AI visual storytelling interface, developed through thematic analysis and affinity diagramming

### 3.5 Findings: The conceptual model of child-AI visual storytelling interface

Through affinity diagramming, we identified three high-level themes: Negotiation, Distribution of Work, and *Input Methods* (Figure 4). These themes also capture how children conceptualize **negotiating (T1)** with AI when the output is not aligned with what they expected, **division of work or** distributed creativity, that is dividing storytelling work among themselves and AI, where they need or might not need help (**T2**). In our data analysis, we further divided of work into **technical** help from AI (**T2-R1**) and **conceptual** idea help from AI (**T2-R2**). Lastly, we discuss **input interaction methods** that children expected the AI interface to support and understand (**T3**).

### 3.6 Themes

We will explore the three primary themes and their associated sub-themes, using examples derived from the design sessions.

TABLE III: THREE MAJOR THEMES OBTAINED BY ANALYZING THE DATA THROUGH AFFINITY DIAGRAMMING AND THEMATIC ANALYSIS. THE ANALYSIS IS STILL ONGOING

| Theme | Definition | Implications and Design Guidelines |
|---|---|---|
| Negotiation | Children used different methods to negotiate with the AI to get the correct output. | Children expect CSTs to support different kinds of follow-up to undesired outputs. They also expect the system to be stateful. |
| Distribution of Work | How children automate some of the creative tasks | In terms of work distribution, children conceptualized working with AI-based storytelling interfaces in a variety of roles, ranging from fine-tuner to co-creator. However, overall, we saw children expecting AI to not completely override children's ideas and creations. |
| Interaction Modalities | Interaction methods describe how children give input to the interface when they are using a tool that aims at helping them with storytelling. | Children conceptualized communication with AI using different input methods (e.g., text for content and whole-body input to the movement of story characters). They also conceptualized having a private codified language with an interface that only the child and AI would understand. |

### 3.6.1 Negotiation (T1)

Children used different methods to *negotiate* with the AI to get the desired output. These strategies can be categorized into three groups: *no negotiation*, *fine-tuning*, and *incremental instructions*.

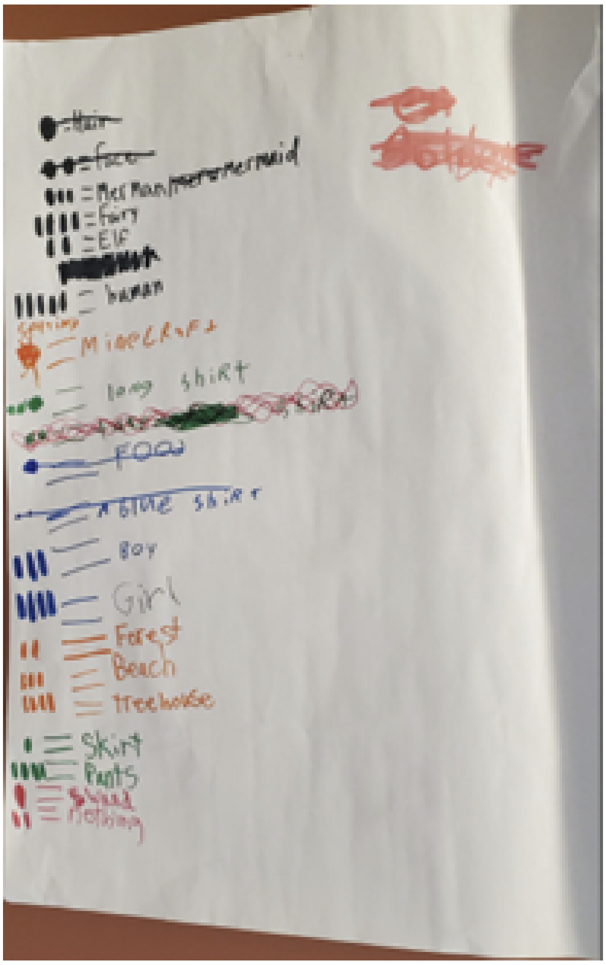



Figure 5: interface that uses movement and color for input

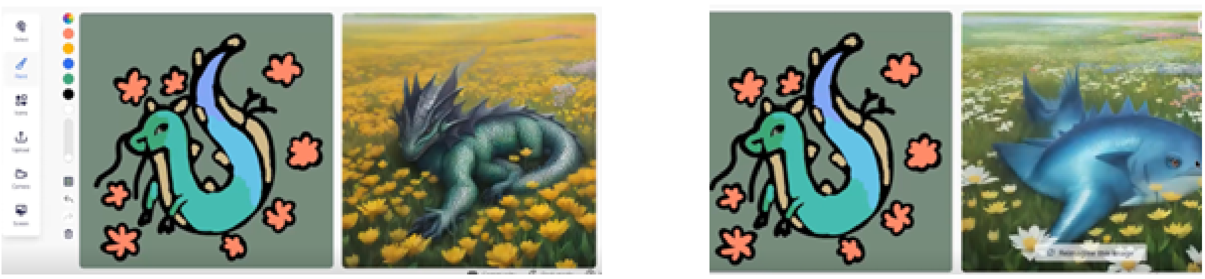
**No negotiation (T1-S1)** This category includes strategies that require minimal action from the user We consider something requiring minimal action when it involves a very limited number of steps, such as refreshing. No negotiation appeared as a strategy in three different groups. For example, we report the interface prototypes by C1 and C10 during Design Session 2. The interface had colors and movement as input means (Figure 5). For instance, tapping a blue object three times meant "*boy*", while two taps on orange means "*Forest*". By combining different numbers of taps and colors, the user is able to create a story. In case of problems with the output (meaning an undesired result), the strategy suggested by the child designers was the reload of the page, as explained in detail in the paragraphs that follow.

*No negotiation: Global reset.* With global reset we mean the re-creation, from the start, of the whole output. When asked by the researcher ) how the user can fix problems in the output, C1 answered, "*You just reload the page, [. . . ] you can just, like, try again, and it'll probably work*". This is an example of a global reset, where the child restarts the whole process (e.g., reloading a browser page such as that of Pikaso Freep!ck) hoping for a better result in the new output. This is an example of *no negotiation*, as the child puts minimal effort in the attempt to correct the undesired output.

*No negotiation: Local object reset.* This indicates the regeneration of only a portion of what was produced by the system ***a portion of the output***, which could be a story component (e.g., a character, the setting, or a prop) or a part of the drawing. C14 adopted the strategy of no negotiation in the interface he ideated during Session 2. His prototype could understand a story communicated through verbal input and animate it by creating a movie. C14's story was about

"*A fun day. In which two people go shopping in the fast food capital of the nation*". In case one of the elements of the movie-like rendering was incorrect, his proposed strategy was to redo the scene and restart the animation: "*You can click a button, and it will generate the same scene again*". However, it is an example of local reset since he added that "*It won't [change] the whole thing, it will only make a slight change*", meaning that the interface would only change a detail of the animation each time the page is reloaded, such as a prop or a piece of clothing.

In conclusion, we noticed that after an undesired output occurs, some children desire a small number of steps in negotiating a desired output. This preference is something to take into consideration in the design of any tool targeted to children, as it might show that some child users are willing to sacrifice a more granular control on the output for the sake of efficacy.

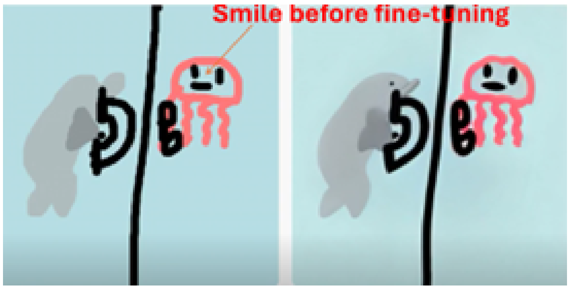


a b

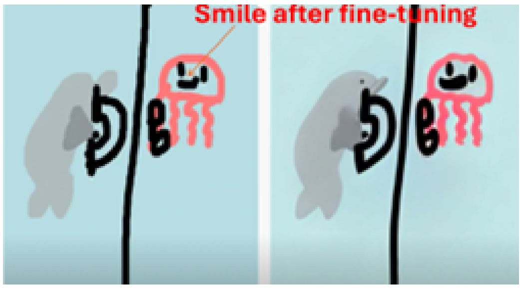
Figure 6: An example of negotiation using fine-tuning in prompt: a) "A dragon laying in a flower field"; b) "A gyrados lying in a flower field". Dragon was changed to gyrados

**Fine-tuning (T1-S2).** Fine-tuning consists in the making of small adjustments to obtain a desired result, and was recorded as a strategy across five different groups. . Indeed, this strategy consisted of children making minor changes to the input (*tuning*) until the desired output was obtained. An example of textual fine-tuning is the one adopted by C1 and C6 during Design Session 3. The group was drawing a comic-style dragon on a field of flowers (left-hand side image), but the AI kept generating a "realistic"-style dragon. Their strategy was editing the prompt gradually, adding or changing some words each time, to obtain the goal output. The initial prompt was "*A dragon lying in a flower field*". They then changed it into "*A **gyrados (meaning: a flying dragon-like Pokémon)** lying in a flower field*" (editing), hoping it would generate a cartoon-style representation of a water dragon. When this attempt failed (Figure 6), they opted for "*A **cartoon** dragon lying in a flower field*" (adding). They then tried "*A **Pokémon** dragon lying in a flower field", which was then changed to "A dragon lying in a flower field in Pokémon style*". Fine-tuning was also used by children in drawing. For example, by bolding the parts of the drawing the AI was not taking into consideration. This happened, for instance, when Group 1 drew, during Session 4, a dolphin swimming around with a shark and a jellyfish. Since the AI wasn't interpreting the jellyfish's expression as a happy one, they insisted on the smile until the AI included it in the output (Figure 7).

A takeaway we can draw from this modality is the following. When children communicate with a system, every part of the input has its specific value and should not be overseen by the AI, as shown by the specificity of their modifications to the prompts and drawings when unsatisfied with the resulting output.




a




b

Figure 7: An example of fine-tuning through drawing: a) Jellyfish before fine-tuning; b) Jellyfish after fine-tuning

**Incremental instructions (T1-S3).** Lastly, incremental instructions involve providing follow-up prompts to the interface in order to achieve a specific result. They differ from fine-tuning because they do not involve modifying a previous prompt, but rather using a series of complete and self-contained prompts that add or re-iterate information. This strategy was recorded by three groups in five different examples. For instance, when trying to generate a Pokémon-style dragon (Figure 6), C1 and C8 insert "Pokémon-style" in the pre-existing prompt. Instead, if the interface does not add the desired scales to a created dragon, C12 would input "*add scales*" as a new prompt. C12's behavior is an example of incremental instructions. Here follow examples of children who provided the interface with follow-up prompts until the desired result was achieved. In Session 4, C12 and the group drew a story about Jeff Bezos fighting against dragons for money. "*What happens if the AI draws a blue dragon instead of a red one?*"

asked one of the adults. His answer was that he would input "*change to red*" (C12, S4). "What if it drew a red dragon but it didn't draw it with scales?" continued the adult. "*I would say 'add scales'*" replied C12. The same strategy can be observed when C2 created the prototype of a tool based on verbal inputs. During his demonstration using a story revolving around pasta, an adult asked "*What if the computer doesn't know what's pasta?*". C2 answered, "*Then I just say 'pasta!'*" (C2, S2), showing how children expect the system to understand follow-up instructions.

This result implies that children expect a system to have memory and be intelligent enough to understand follow-up instructions.

The insights regarding (1) what children perceive as an incorrect output when doing collaborative storytelling, and (2) how and if they desire to negotiate with the system to correct the output are key elements in the creation of a conceptual model of how children perceive CSTs that aim to assist them in their creative activities, and therefore what they expect from a tool that aims to assist them in visual storytelling.

In our findings, children modified or added to an existing prompt alongside inputting instructions whose meaning was dependent on a previous one. This implies that children expect a stateful system that can retain memory from previous interactions and generate the output accordingly.

In conclusion, during the "*no negotiation*" modality, children looked for a small number of steps to change an undesired output. When they used the "fine-tuning" modality, they showed that every detail and every part of their input mattered. Finally, with the "incremental instructions" modality, they showed how a stateful interface can benefit the success of a child-computer interaction. From these considerations, we elaborated on 2 design implications: flexibility and statefulness. Indeed, we elicited that the interface should provide a diverse and flexible set of negotiation strategies, as well as retaining memory of past interactions in order to be able to interpret follow-up prompts and instructions.

### 3.7 Division of work (T2)

Previous literature has described how Distributed creativity, which consists of the automation of tasks related to creativity, can increase creative engagement, reduce the barrier of entry for inexperienced users, and enhance motivation [12]. The automation of tasks can be performed through conceptual or technical automation, which consists of delegating to the tool skills related to ideas (conceptual) or practical ones (technical). Automating some tasks to the tool implies dividing the work between the user and the system. Throughout our study, we have noticed four main ways in which children have thought about distributing the work of storytelling between the AI and themselves: *AI as starter and child as continuer*; *child as starter and AI as continuer*; *AI as a fine-tuner*; and *child and AI as co-creators*. These models have examples regarding both technical and conceptual automation. Technical automation consists of helping the user with technical aspects such as coloring, fixing lines to make them straight, and so on. Conceptual automation assists in generating and refining ideas and giving inspiration [12].

MAD LIBS

HOW TO DATE THE COOLEST GUY/GIRL IN SCHOOL

It's simple. Turn the cats (PLURAL NOUN). Make him/her want Quickly (ADVERB) to date you. Make sure you're always dressed to Swim (VERB). Each and every day wear a/an Skirt (ARTICLE OF CLOTHING) that you know shows off your leg (BODY PART) to Pink (ADJECTIVE) advantage and make your Sky (NOUN) look like a million turtles (PLURAL NOUN). Even if the two of you make meaningful tummy (ANOTHER BODY PART) contact, don't admit it. No hugs or Foxs (PLURAL NOUN). Just shake his/her Shoulder (ANOTHER BODY PART) firmly. And remember, when he/she asks you out, even though a chill may run down your Computer (NOUN) and you can't stop your Pen (NOUN) from Swiming (VERB ENDING IN "ING"), just play it beautiful (ADJECTIVE). Take a long pause before answering in a very Wonderful (ADJECTIVE) voice. "I'll have to write (VERB) it over."

Figure 8: Mad Libs used as prototype during DS1, example of interface where the AI creates an outline in the plot of the story

**AI as the starter and child as a continuer (T2-S1).** The AI starts the creation, and the child continues the work. In this model of work division, the AI can provide an outline for the child to continue with details. It can also offer prompts or inspiration to help get started, provide ideas about the personalities and characters in the story, or suggest a setting for the story to begin. AI can also be the starter of a drawing for the child to finish. This modality appeared across 8 different groups across our design sessions.

Next, we go over twelve examples of different ways in which children conceptualized this method during co-design sessions.

*Conceptual automation - Outline for the child to fill in with details.* In Design Session 1, C1's idea was that of an AI that provided a "*mad lib*" [25] (Figure 8), an outline of a complete story with some missing words that the children have to fill in Figure 13. "*Alright, give me a plural noun... Give me an adverb... Now give me a verb*" (C1 to the other children in her group while filling in missing parts of the story). Since the AI comes up with the themes and topic of the story (in the example, the topic is "*how to date the coolest girl/guy in school*"), we interpret it as a help in terms of ideas, collocating this typology of help in the dominium of conceptual automation.

*Conceptual automation - Prompts or inspiration.* A common answer to Design Session 1's question of the day about how technology could help with storytelling was that AI could provide ideas and inspiration. C10, while designing, stated that AI could help by "*giving us inspiration*". During the design activity, C1 suggested that "*we should just ask it (n.d., the AI) to build a random world*" in which they could set their story. Similarly, in Design Session 2, C14's idea for an intelligent creativity support interface was "*Maybe AI could generate an image for the setting*". "*Generate ideas*", said C2 to the adult facilitators when he hadn't started prototyping yet. Since the help provided by the interface is related to ideas, it falls within the dominium of conceptual automation. What makes this case different from the provision of an outline is that prompts and initial ideas are just starting points meant to stimulate the children in their creative process. They can be modified, discarded, or incremented and are not rigid scaffolding that children have to draw on, as in the previous case.

*Conceptual automation - Ideas about the personalities and characters in the story.* Other children suggested that the AI could give "*ideas about personality and character*" (C2, DS1). During Design Session 1, a child also suggested that the AI could help with giving names to the characters: "*I would like it to help me by, like, giving me, like, a random animal to use as the main character and for names*" (DS1). During session 1, Group 1 said that "*Technology can help with characters (and world building)*". The case at hand differs from situations in which AI provides prompts and inspiration in a general sense. In this particular scenario, AI does not offer ideas to inspire children in general but rather contributes specifically to the characteristics of the story's characters.


Figure 9: Example of prototype for a drawing interface where the AI draws an outline and the child enriches it

Technical automation helps users with technical aspects like coloring, creating straight lines, and other repetitive tasks. In the following text, we explain in detail how the division of work based on AI as the starter and the child as the continuer was also observed in mechanisms of technical automation.

*Technical automation - Outline for the child to fill in with details.* In Design Session 1, C4 created an interface to help the child user in the drawing activity. Her prototype created the outline of a subject that the child would color or fill in with details. In their demonstration (Figure 9), the adult, as the AI, drew the outline of a female figure that was enriched by the girl with colors, cat ears, and an apron to make the character "*more memorable*" (C4, DS1). Moreover, the majority of groups (such as S3-G2, S4-G3, S3-G3 and others), when using *Freep!ck*, used the strategy of drawing outlines of subjects and then filling them with colors or details.

**Child as the starter and AI as a continuer (T2-S2)**. The child starts the work, which the AI continues. This can mean adding details to the child's drawing, creating the ending of the story and other kinds of contributions that involve the AI starting from what the child has started. This modality appeared in five different groups throughout the study, with six different examples, a subset of which will now be described.

*Conceptual automation.* During her first experience with the Pikaso Freep!ck tool, C4 used the following approach: she zoomed in on the page to see only her drawing canvas, hiding the AI output located on the right half of the interface (Figure 12). After finishing her creation, she zoomed out and only then revealed the AI output based on her drawing. The approach of having the child initiate the creation process independently and involving the Intelligent Creativity Tool (Pikaso) in the drawing at the end demonstrates how certain children choose to start a project themselves and then allow the AI to contribute and complete the project. During the same Design Session, C1 and C8, belonging to another group, chose to complete their drawings with an Imagination Level of 0 (Figure 10), meaning that the tool copied the user's drawing without making any noticeable modifications. They increased the Imagination Level to the goal level only after they had finished each drawing (Figure 11), to see how the AI modified the drawing to complete it.

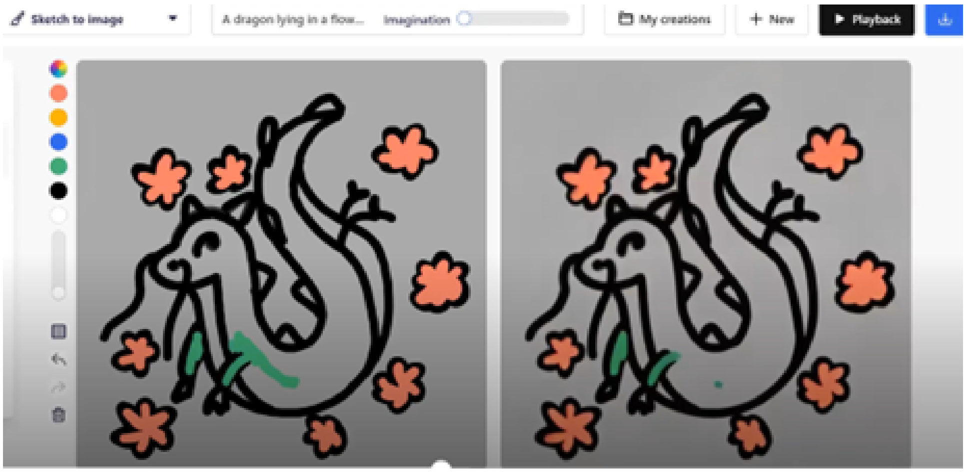



Figure 10: Children drawing with an IL of 0

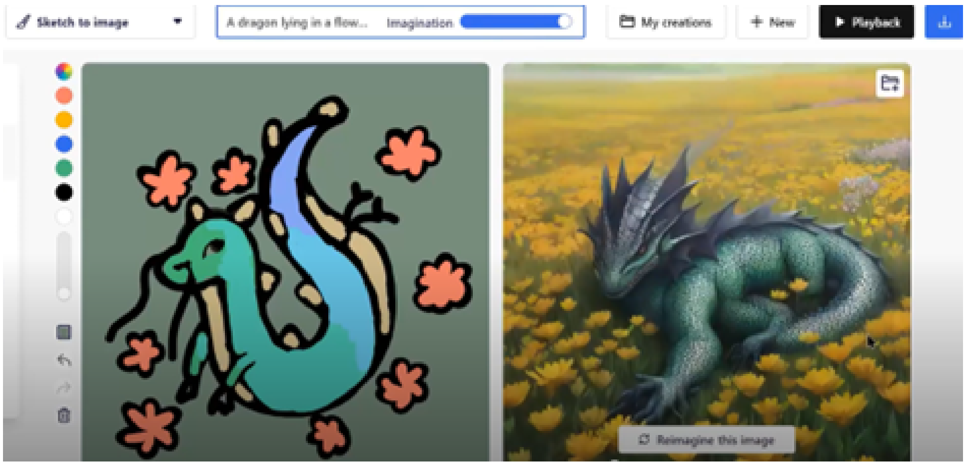



Figure 11: Children increasing the IL

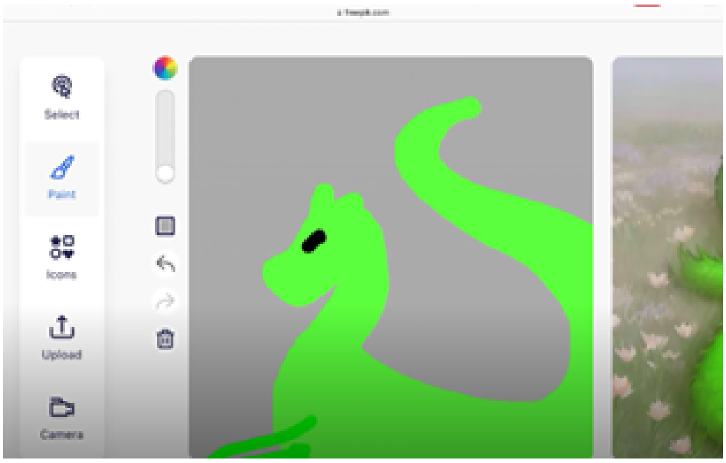



Figure 12: Screen of the iPad while C4 was drawing. She can only clearly see what she is drawing, hiding the tool's output

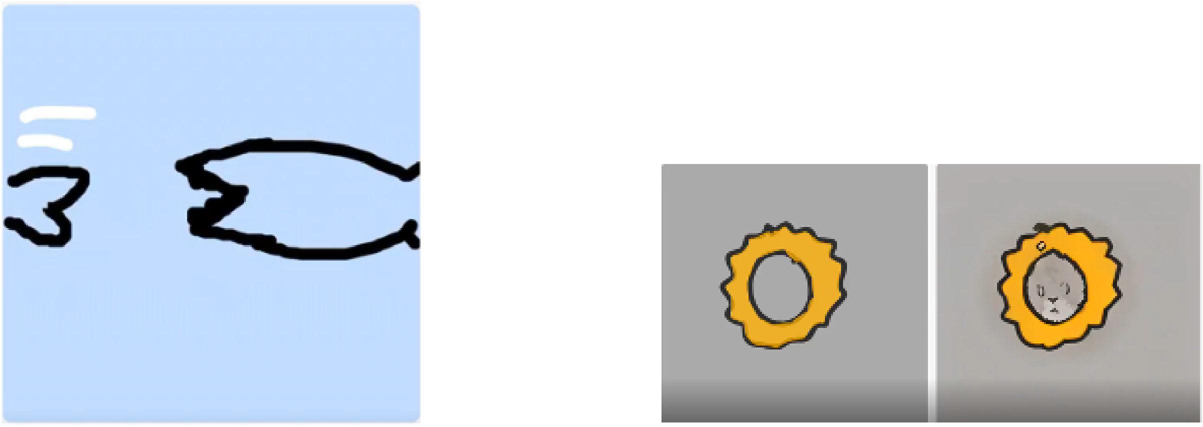
**AI as a fine-tuner (T2-S3).** Fine-tuning consists of making minor changes to something to make it work [26]. We have already used this term to identify a strategy adopted by a subgroup of the children to negotiate a desired result, that involved making minor changes to the input until a well-received output is obtained. In our study, we define a minor change as anything that doesn't change the creation's composition, main concepts, and ideas, such as the position of subjects in a drawing or a character's hair color. In the context of distribution of work, fine-tuning identifies a strategy adopted by the AI to contribute to the child's work whether AI's role is to enhance the child's work instead of actively generating ideas. We registered examples of this modality seven times, across Discussion Time, Circle Time, and Design session time, where it appeared in four groups.

*Technical automation.* For example, in the context of technical automation, the AI could help by fixing lines; this was mentioned during Session 3, when C4 suggested that the tool could improve by helping children achieve "*straighter lines*" (C4, DS3). During Design Session 3, C10 said: "*I would like a computer to help me draw, like, fixing lines for me unless I wanted them to stay that way*" (C10, DS3). This approach involves providing technical assistance to the child, which sets it apart from all categories related to conceptual automation. Additionally, what sets fine-tuning apart from other types of technical automation is that the system does not play an active role in creation as a starter, a continuer, or a co-creator, as defined in the other sections.

*Conceptual automation.* During Design Session 3, many children expressed their annoyance when the AI contributed to the drawing in a way that changed the structure or the composition of it. During the debriefing session, a child's comment about his experience with the interface was "*I think I would have liked for it to be focused more on the actual drawing*", highlighting how most of the children were observed to expect the AI to only add some details to their original drawing and/or enhance it, and seemed annoyed when it did otherwise, introduced new ideas or changed the idea of the child. Another way AI can help is by correcting children's grammar: "*I feel like I'd just use it for grammar*" (C11, DS4). These findings highlight children's preference for feeling in control of their creative outputs and inclination towards creative autonomy when collaborating with AI, where AI can help them in terms of minor changes and enhancements (*fine-tuning*). This way of children's conceptualization of child-AI collaboration can inform the creation of tools for children's storytelling that include collaboration dynamics, ensuring that the users feel in control of their creations by means of an AI that is able to provide little help during storytelling. Intelligent strategies can be used by the system to fine-tune and enhance the user's creation.

**Child and AI as co-creators (T2-S4)**. The AI and the child contribute equally to the work in terms of ideas and drawing. In this model, the AI collaborates equally with the child in creating the visual story, rather than being a starter or a continuer. We registered twenty different examples related to this model of division, across eleven different groups.

*Conceptual automation.* Children were bothered when the AI took too much initiative regarding ideas and concepts. We have already said that children expressed their annoyance when the AI contributed to the drawing in a way that changed the structure or the composition of it. However, they did not seem to mind when the AI put itself at the same level of the child as a co-creator. On the other hand, as soon as the interface considered some aspect of the drawing that the child considered relevant (e.g., the subject or the composition), the subjects expressed their annoyance. "*What is it doing to my beautiful baby lion?! It looks like a worm!*" (Figure 13) screamed C1 when the interface made radical changes to her drawing, taking more lead than she expected. This was not appreciated, even though the AI followed the written prompt. Instead, They expressed satisfaction when the AI began to give more consideration to their drawings.putting itself at the same level as the child. "*Oh there!*" exclaimed C1 when her composition and structure of the drawing were respected by the AI. At a certain point, the AI added sunglasses to the bee C6 was drawing; "*it has sunglasses, for some reason*" exclaimed C6 with an annoyed tone. "*It's trying to make it more realistic, but my drawing isn't*", was another critique to the interface. Compared to when the AI made significant changes (e.g., modifying the composition of a drawing) to the creation, children were not visibly annoyed when the AI respected the composition of the child and significantly took into consideration the idea and vision of the child, putting itself at the same level as the child creatively speaking, and never above.



a b

Figure 13: An example of division of work where child and AI are co-creators: a) Example of movement through drawing; b) Too much lead from the AI

*Technical automation - Showing movements through drawing.* In this model of division, the system neither does just perform minor changes to the child's drawing (*fine-tuning*), nor does it start or complete its creation. The AI collaborates with the child by contributing to parts of the drawing that are as relevant as those created by the young user, such as movement expression. Movement can be expressed through drawing in different ways. The technique noticed during the sessions is drawing stripes next to the body part that is in movement. C4 used this method during Design Session 4, where she drew a swimming shark. In order to communicate the movement of the shark's tail, she drew white stripes (Figure 13). The AI could co-create with the child by understanding the intention of this techniques and insert movement into the drawing.

### 3.7.1 Input Interaction Methods (T3)

Interaction methods describe how children give input to the interface. During Design Session 1 and Design Session 2, children prototyped their Intelligent Creativity Support Tool. In Design Session 2, they were asked to *be creative* with input methods and think outside the box. We report here the results of our analysis regarding means of interaction.

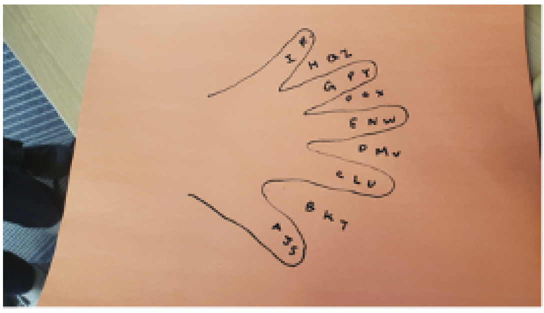
**Text input (T3-S1)**. Text input is a way of interacting with the interface by using text. In the demonstration of his prototype, C14 used the chat to communicate the prompt to the adult facilitators, who had to embody the AI and represent the story like a movie.

**Visual input (T3-S2)**. With visual input, we indicate the provision of input to the interface through images (e.g., drawings). For example, during Design Session 2, Group 1 created an interface that received drawings as input. After receiving the drawing, the AI would say what it thinks it wants you to do, and the user would be able to choose if they want to change it or not.

**Physical input (T3-S3)**. Physical input consists in interacting with the interface through body movements. The interface created by Group 3 during Design Session 2 had stepping as a main means of interaction. During Design Session 2, C6 said that "*the weirdest way to communicate with the computer is to like jump up and down*".

**Auditory input (T3-S4)**. This involves using voice to give input to the system. "I think the weirdest way to communicate with the computer is by getting by Guinea pigs to squeak, and each squeak means a different thing" said C12 during Design Session 2. During the Design Session Time of Design Session 2, C14 suggested that "You tell a part of a story and the AI continues".

**Multimodal (T3-S5)**. Multimodality consists of using more than one input modality to interact with the tool. Many children inserted text input in their drawing panels (Figure 14). Furthermore, the children began with an initial prompt but then continued drawing without adjusting the prompt. This caused the output to be more focused on the outdated prompt than the new drawing, which the children didn't like. One potential solution to this issue would be an AI system asking children if they want to update the prompt when the drawing has been significantly changed without a corresponding update to the prompt.



a


b

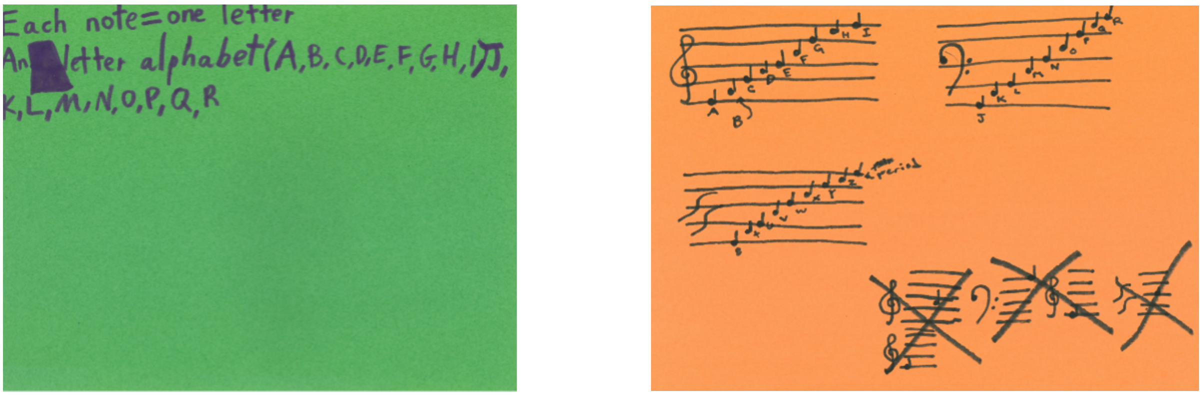
Figure 14: a) An interface that implements a secret language through hand gestures; b) An example of multi-modality where children both draw and write on the canvas

**Inventing new communication languages (T3-S6)**. New communication languages are input modalities that are novel and "never seen before." Here are some examples of new languages invented by children during the study.

*Hand gestures.* Children have used finger tapping to spell out words. In Figure 14 above, we can see the proposal of Group 4 during Design Session 2. For instance, to spell the word "cat," one has to tap the second finger once, the first finger once, and the space between the two three times.

*Tapping the objects around.* During Design Session 2, Group 3 invented an AI whose input method was tapping colorful objects in the space around the user. For instance, tapping a blue object three times meant "boy".

*Music notes.* Along with the hand gestures, Group 4 suggested, during Design Session 2, a secret language based on music notes, where each note corresponded to a letter (Figure 15).




a b

Figure 15: Music notes as secret language. a) Written explanation; b) Note-letter correspondence

Future interfaces could benefit from implementing creative and engaging ways for children to provide input to the system instead of limiting interaction modalities to texting and vocal input, as for chat bots and Intelligent User Interfaces like Alexa, Siri, and Cortana.

Moreover, most children have frequently expressed the need for an eraser and a filling button during their interaction with the interface, resulting in inventive methods to solve these absences(e.g., erasing by using a brush color of the same color as the background). They also frequently asked for customizable brush sizes, and solved the absence of that by zooming the screen to simulate the result of a smaller brush. Therefore, as design guidelines, we suggest creating tools that include customizable granularity erasers, filling tools, and brushes with a diverse set of sizes.

# CHAPTER 4

# DISCUSSIONS

Our main goal was to understand the conceptual models of children in order to identify the potential need for AI-based assistance in visual storytelling and the input methods they might envision using when interacting with creativity interfaces for storytelling. The results of our study can be utilized by designers to guide the development of Intelligent Creativity Support interfaces tailored for children. Our research specifically focused on intelligent interfaces designed as tools for visual creativity, a field previously explored by Zhang et al. [13] in their investigation of how digital interfaces can enhance children's creative output. Additionally, Zhang et al. [1] examined how the use of drawing-based technologies can improve children's retention of botanical information. These studies have explored how scaffolding, in general, can benefit children's cognitive development. In our research, we explored children's expectations and mental models related to technical and conceptual automation within visual storytelling, and also regarding input modalities. We discovered that children expected automation mechanisms to always give them most of the credit for the final output. This applies to both technical and conceptual automation: in technical automation, it means that in children only expect a tool to enhance or add details to their drawings, never changing its composition or main components; in conceptual automation, this finding implies that children think of the AI help as something that does not make radical changes to their main idea and concepts related to the story.

As an output of our study, we created a conceptual diagram of how children perceive Child-AI creativity support tools for visual storytelling. Our conceptual diagram answered to the following research questions: (1) how do children think of interacting with child-AI visual storytelling interfaces? (2) what kind (if any) of technical automation can assist children during visual storytelling? (3) what kind (if any) of conceptual automation can assist children during visual storytelling? For what regards our first research, our findings revealed that children expect a diverse set of input modalities, including visual, auditory, physical, multimodal, and based on secret codes. However, it's important to note that most interfaces, such as chatbots and famous GenAI interfaces, primarily use text as the main means of interaction. Regarding technical automation, children's mental models suggest that they expect a tool to enhance or add details to their drawings, without changing the composition or main components, such as adding details. For example, during Session 3, C1's lion drawing was well-received when the AI generated the face of the animal while preserving the mane as she had drawn it (Figure 13.b). In terms of conceptual automation, children perceive AI help as something that does not make radical changes to their main idea and concepts related to the story. C10, while designing, stated that AI could help by "giving us inspiration"

A previous example of a conceptual model of how children perceive intelligent tools is the three-layer explanatory model for Child-Generative AI Creative Interactions developed by Newman et al. [5]. This model explores children's perceptions of the tool's capabilities. They observed how children think about giving input to a tool, negotiating a desired output, and collaborating with it in the creation process. Their conclusions align with our findings, highlighting children's expectations of a wide and diverse range of input modalities, negotiation methods, and collaboration models.

Another conceptual diagram of how children perceive technology was created by Garg et al. [27], who conducted a series of three Participatory Design sessions related to children's and parent's perspectives on in-home learning technologies. Their resulting model, generated through affinity diagramming, included among its main themes System Intelligence, User Input Modalities, User Behavior, System Output Modalities, and System Behavior [27]. They concluded that children expect a diverse set of Input Modalities. The same conclusion resulted from our data analysis: in our conceptual model, children expect interfaces that can offer input methods that are visual, auditory, physical, visual, multimodal and also based on secret codes. However, chatbots and famous GenAI interfaces like Co-Pilot, ChatGPT and Gemini have text as the main (when not only) mean of interaction. Woodward et al. also created a conceptual diagram, exploring how children thought about Intelligent Tools [1]. In our research, we focused on a specific kind of intelligent interfaces, which are intelligent tools for visual creativity, a field that was previously explored by Zhang et al. [13] in their work regarding how digital interfaces can increase children's creative output. Similarly, Zhang et al. [1] studied how the usage of technologies based on drawing can improve children's retention of botanical information. The mentioned works have explored how scaffolding in general can be beneficial for children's cognitive development. We have explored what are children's expectations and mental models related to some specific types of scaffoldings which are technical and conceptual automation, and also regarding input modalities. We found out that automation mechanisms should always give children most of the credit for the final output. When it comes to technical automation, this means that in children's mental models they only expect a tool to enhance or add details to their drawings, never changing its composition or main components; for conceptual automation, this finding implies that children think of the AI help as something that does not make radical changes to their main idea and concepts related to the story . We have consequently created a conceptual diagram of how children perceive creativity support tools for visual storytelling. The following paragraphs describe the main findings of our research.

## 4.1 The output: Conceptual Diagram of Collaborative Child-AI Visual Storytelling Interface

We have conducted four co-design sessions with 7 children aged 8-13. We have analyzed the data using thematic analysis and affinity diagramming, which are techniques that are useful when there is the need to study a big mole of qualitative data. The conceptual model we created confirms that tools directed to children are expected to have a high intelligence, as already stated by the studies of Woodward et al. [15,21]. However, our conceptual model focuses on interaction and collaboration, aiming to enrich the literature on Intelligent Interfaces and children. Among the most interesting findings of our research, we will discuss how a system directed to children should be stateful (meaning, its output should change according to the current input and the past ones as well), put itself at the same level of the child as a creator, and include different and flexible ways to interact with children. Below I will describe how each Research Question was answered by the model we created.

## 4.2 RQ1: What kind of interactions best suit children's needs and is well-received by them

We analyzed a wide range of interaction methods, including text and auditory input, body movement, and musical notes. The key insight is that children could benefit from interfaces with a variety of interaction methods, rather than being restricted to just one.

## 4.3 RQ2 and RQ3: What kind, if any, of technical and conceptual automation can assist children in their creative journey

Both technical and conceptual automation share the common principle that the AI system should not position itself above the child user. Instead, the system should either initiate the child's work, continue it, fine-tune the output by adding details, or co-create alongside the child. In the case of co-creation, the child expected their idea to make the biggest contribution over the final output, while engaging with the system as an equal creator. As we can see from the richness of the conceptual model, children expect a flexible system that can adapt its behavior based on past interactions and the specific needs of each user.

In addition, we obtained further insights from our sessions, which are outlined below.

## 4.4 System Intelligence

Past work on CCI focused on the aspect of System Intelligence when creating conceptual models [15, 21]. Our findings add to that conversation and also discuss insights on interaction methods and reactions to undesired outputs.

### 4.4.1 Memory

Our findings suggest that children expect a stateful interface that keeps the memory of previous interactions, and its current output depends on past states. The statefulness of the system is suggested by the theme of *Negotiation (T1).* The mechanism of *Incremental Instructions* presumes a tool with the ability to retain memory, create connections between follow-up prompts, and link the current one with the previous one to change or modify the output accordingly.

### 4.4.2 Flexibility

The possibility of customization was already included in the conceptual model created by Woodward et al. [15]. Coherently, the themes in our research indicate that children's needs regarding interaction methods, error response, and automation vary widely. The negotiation mechanisms we observed span a wide spectrum. Children's division of tasks with AI ranges from situations where the system adjusts the child's work to models where the child and the system work together as co-creators. Finally, the interaction methods that were suggested during the sessions vary widely, including auditory inputs, movement, and textual interactions. This variety suggests that children expect a system that is able to provide a rich set of behaviors.

## 4.5 Control and Credit

The majority of children manifested disappointment when the AI significantly changed their design and composition, manifesting a need to feel in control of their creations. We suggest that future designers of tools for children create interfaces that allow children to feel like they retain the most credit for the final output. Only one subject (C4) was willing to accept significant contributions of AI in the final drawing, creating an interesting starting point for future discussions about what contributed to this different approach.

### 4.6 Privacy

Many children proposed new communication languages that incorporated secret input modalities, such as gibberish and Morse code-style tapping, indicating a concern for privacy in their communications. It would be valuable for future research to investigate whether this concern about cybercrime is prevalent among children interacting with computer interfaces or if it is influenced by *KidsTeam's* past participation in co-design sessions for other studies related to privacy and security, as mentioned by the UW researchers during one of our meetings.

### 4.7 Co-design sessions

Woodward et al. [15] emphasized that direct interviews do not provide as rich insights as co-design sessions. To this finding, we add that children's answers to the same direct question can vary in richness before and after taking part to a design activity. In Session 4, during Circle Time, most of the children stated that they would not want to receive help from the AI for storytelling since they want to take full credit for their creations. Conversely, after performing the storyboarding activity, children admitted they found drawing, choosing a prompt, and developing an initial idea very difficult. We conclude that, in situations where direct interviews are needed, asking the questions after a related design activity might enrich the content of the answers.

### 4.8 Limitations and future work

We hope that the conclusions of this research project inform the designers of creativity support tools for children in a way that allows them to align with children's expectations and needs regarding Intelligent CSTs for storytelling. Our analysis was conducted using data collected through a limited number of co-design sessions (four) with a small group of young subjects. Hence, before generalizing our findings, an essential step would be to conduct a study with a larger group of subjects to explore how our themes adapt to a larger and more diverse population. It would be interesting if future research explored whether and how these conclusions vary with the age of children. Throughout the study, children have interacted with only one Intelligent tool (*Pikaso Freep!ck*). We think that by making the subjects use a more diverse set of tools, a more extensive set of design guidelines and conclusions could be drawn. We encourage future research on this matter. Another aspect to consider when reading our study is that the subjects, that belong to an existing research group at UW called *KidsTeam*, already had taken part in other studies related to Intelligent Tools and Generative AI. Therefore, these children already had a chance to find out the basics of how AI interfaces work and what a programming language is. It would be interesting to create a new conceptual model with a group that has less understanding of the inner workings of a computer program. Finally, another matter that can't be ignored is the limited number of children that took part in the study.

When it comes to co-design groups with children, a larger number of subjects might impact the spirit behind the technique, which aims to create a collaborative environment where children and adults work as equals. The dynamics of collaboration can become chaotic with a large group, especially when working with young children. Even though our group was small, some of the recordings were hard to hear because of background noise. Therefore, this project has involved the same number of subjects as past projects that involved co-designing with children [5, 15], preferring a group with reduced number of members, seven in our case.

We still believe that the results of our study play the important role of giving a first approach to children's needs, expectations and conceptual model related to CSTs for storytelling. After being able to gain useful insights through this Participatory Design study, other techniques like direct interviews or focus groups can be performed on a larger number of subjects to determine how our conclusion scale to a larger population. We encountered certain limitations due to the use of a tool that was not developed by us, such as the absence of a filling tool and the non-linearity of the Imagination Level bar. Such as the absence of functions like the eraser and filling tool, and the non-linear nature of the Imagination Level bar. Nevertheless, we obtained valuable insights by observing how the children were able to creatively overcome and adapt to these interface limitations.

Even though we have addressed our three Research Questions, we intend to continue analyzing the data to determine if our conceptual model can be further developed with additional themes. This may help us answer additional research questions that were not part of the original study.

# CHAPTER 5

# CONCLUSION

Intelligent interfaces are not always designed to meet the needs and diverse interactions of children. We held four co-design sessions with a group of children called KidsTeam UW. Throughout these sessions, we gathered insights on how children prefer to interact, how work is distributed, and the conceptual and technical aspects of automation. We used affinity diagramming and thematic analysis to examine the data we collected and created a conceptual diagram with three main themes on how children view Intelligent CSTs for Visual Storytelling. Our findings indicate that children appreciate flexible and stateful interfaces that can provide various interaction and collaboration methods and produce outputs based on past interactions.

# APPENDIX

## DEMOGRAPHIC QUESTIONNAIRE

APPENDIX (Continued)

# Demographics Questionnaire

Child-AI Creativity Support Tools: A Co-Design Study with Children

Thank you for participating in our study. This questionnaire should take about 2-5 minutes to complete.

**Participant ID:** ______________________

*Please answer the following questions*

**Age:** _________ years

**Gender Identity**: __________

1. **What is your ethnicity?**

☐ White
☐ Hispanic or Latino
☐ Black or African American
☐ American Indian, Native American, or Alaskan Native
☐ Asian
☐ Native Hawaiian or other Pacific Islander
☐ From multiple races: ________
☐ Some other race: ______

2. **How often do you use intelligent chatbots such as ChatGPT?**

☐ I don't know what they are
☐ I have never used one.
☐ I rarely use it
☐ I use it at most once or twice a month.
☐ I use it a few times a week.
☐ I use it almost every day.

3. **How often do you use creativity tools such as Photoshop, Figma, Sketch, Canva?**

☐ I don't know what they are
☐ I have never used one.
☐ I rarely use it
☐ I use it maybe once or twice a month.

- ☐ I use it a few times a week.
- ☐ I use it almost every day.

**4. How experienced are you with AI tools such as ChatGPT and Bard?**

- ☐ I don't know what they are
- ☐ I have never used them but I have heard of them
- ☐ I am not very good with them
- ☐ I know the basics
- ☐ I am pretty good with them
- ☐ I am an expert

**5. How often do you use text-to-image tools such as DALL-E?**

- ☐ I don't know what they are
- ☐ I have never used one.
- ☐ I rarely use it
- ☐ I use it at most once or twice a month.
- ☐ I use it a few times a week.
- ☐ I use it almost every day.

**6. How often do you like storytelling?**

- ☐ I like it very much
- ☐ I like that.
- ☐ I am neutral about that
- ☐ I don't like it.
- ☐ I hate it.
- ☐ I don't know what it is

# CITED LITERATURE


1. Zhang, C., Yao, C., Wu, J., Lin, W., Liu, L., Yan, G., and Ying, F.: Storydrawer: A child-ai collaborative drawing system to support children's creative visual storytelling. In Conference on Human Factors in Computing Systems - Proceedings. Association for Computing Machinery, 4 2022.

2. Agosto, D. E.: Why storytelling matters: Unveiling the literacy benefits of storytelling. https://www.journals.ala.org/index.php/cal/article/view/5990/7646.

3. Chu, S. L., Quek, F., and Sridharamurthy, K.: Augmenting children's creative self-efficacy and performance through enactment-based animated storytelling. In Proceedings of the Ninth International Conference on Tangible, Embedded, and Embodied Interaction, pages 209–216. ACM, 1 2015.

4. Chu, S. L., Quek, F., and Tanenbaum, T. J.: Performative Authoring: Nurturing Storytelling in Children through Imaginative Enactment, pages 144–155. 2013.

5. Newman, M., Sun, K., Dalla Gasperina, I. B., Shin, G. Y., Pedraja, M. K., Kanchi, R., Song, M. B., Li, R., Lee, J. H., and Yip, J.: "i want it to talk like darth vader": Helping children construct creative self-efficacy with generative ai. In Proceedings of the CHI Conference on Human Factors in Computing Systems, CHI '24, New York, NY, USA, 2024. Association for Computing Machinery.

6. Shaw, A. and Anthony, L.: Toward a systematic understanding of children's touchscreen gestures. In Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems, pages 1752–1759. ACM, 5 2016.

7. Narayanan, S. and Potamianos, A.: Creating conversational interfaces for children. IEEE Transactions on Speech and Audio Processing, 10:65–78, 2002.

8. Soni, N., Aloba, A., Morga, K. S., Wisniewski, P. J., and Anthony, L.: A framework of touchscreen interaction design recommendations for chil-

dren (tidrc). In Proceedings of the 18th ACM International Conference on Interaction Design and Children, pages 419–431. ACM, 6 2019.

9. Kim, M. K., Druga, S., Esmaeili, S., Woodward, J., Shaw, A., Jain, A., Langham, J., Hollingshead, K., Lovato, S. B., Beneteau, E., Ruiz, J., Anthony, L., and Hiniker, A.: Examining voice assistants in the context of children's speech. International Journal of Child-Computer Interaction, 34:100540, 2022.

10. Frich, J., Vermeulen, L. M., Remy, C., Biskjaer, M. M., and Dalsgaard, P.: Mapping the landscape of creativity support tools in hci. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, pages 1–18. ACM, 5 2019.

11. UNESCO: Artificial intelligence in education. `https://www.unesco.org/en/digital-education/artificial-intelligence`.

12. Davis, N., Winnemöller, H., Dontcheva, M., and Do, E. Y.-L.: Toward a cognitive theory of creativity support. In Proceedings of the 9th ACM Conference on CreativityCognition , pages 13–22. ACM, 6 2013.

13. Zhang, C., Zhou, Z., Hu, Y., Liu, L., Wu, J., Shao, Y., Liu, J., Zhang, L., Liu, L., Chen, H., Ying, F., and Yao, C.: Observe it, draw it: Scaffolding children's observations of plant biodiversity with an interactive drawing tool. In Proceedings of the 22nd Annual ACM Interaction Design and Children Conference, pages 253–266. ACM, 6 2023.

14. of Washington, U.: At kidsteam adults partner with children to design new technology for children. `https://www.kidsteam.ischool.uw.edu/`.

15. Woodward, J., McFadden, Z., Shiver, N., Ben-hayon, A., Yip, J. C., and Anthony, L.: Using co-design to examine how children conceptualize intelligent interfaces. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, pages 1–14. ACM, 4 2018.

16. Yadav, S., Chakraborty, P., and Mittal, P.: Designing drawing apps for children: Artistic and technological factors. International Journal of Human–Computer Interaction, 38:103–117, 1 2022.

17. Han, A. and Cai, Z.: Design implications of generative ai systems for visual storytelling for young learners. In Proceedings of the 22nd Annual ACM Interaction Design and Children Conference, pages 470–474. ACM, 6 2023.

18. Doorn, V.: Children as co-researchers in design enabling users to gather, share and enrich contextual data. Doctoral Dissertation, KU Leuven, 2016.

19. Mechelen, M. V.: Designing technologies for and with children: theoretical reflections and a practical inquiry towards a co-design toolkit. 2016.

20. Mazzone, E., Iivari, N., Tikkanen, R., Read, J. C., and Beale, R.: Considering context, content, management, and engagement in design activities with children. In Proceedings of the 9th International Conference on Interaction Design and Children, pages 108–117. ACM, 6 2010.

21. Woodward, J., Alemu, F., Adames, N. E. L., Anthony, L., Yip, J. C., and Ruiz, J.: "it would be cool to get stampeded by dinosaurs": Analyzing children's conceptual model of ar headsets through co-design. In CHI Conference on Human Factors in Computing Systems, pages 1–13. ACM, 4 2022.

22. Soni, N., Aloba, A., Morga, K. S., Wisniewski, P. J., and Anthony, L.: A framework of touchscreen interaction design recommendations for children (tidrc). In Proceedings of the 18th ACM International Conference on Interaction Design and Children, pages 419–431. ACM, 6 2019.

23. Hecker, J. and Kalpokas, N.: The ultimate guide to qualitative research - part 2: Handling qualitative data. https://atlasti.com/guides/qualitative-research-guide-part-2/research-memos.

24. Caulfield, J.: How to do thematic analysis | step-by-step guide examples. https://www.scribbr.com/methodology/thematic-analysis/.

25. Printables. https://www.madlibs.com/printables/.

26. Dictionary, C.: Fine-tuning: dictionary entry. https://dictionary.cambridge.org/it/dizionario/inglese/fine-tuning.

27. Garg, R. and Sengupta, S.: Conversational technologies for in-home learning: Using co-design to understand children's and parents' perspec-

tives. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, pages 1–13. ACM, 4 2020.

## VITA

# FRANCESCA FUSCO

| | |
|---|---|
| EDUCATION | Liceo Scientifico Giuseppe Peano (2014-2019)<br>B. S. in Computer Engineering, Politecnic di Torino (2019-2022)<br>Double Degree with UIC and Politecnico di Torino, (2022-in progress) |
| MEMBERSHIPS | IEEE (Institute of Electrical and Electronics Engineers) Member<br>IEEE HKN Mu Nu Chapter |
| SERVICES | Tutoring for the course of Computer Architecture at Politecnico di Torino, (March 2022-June 2022)<br><br>Organization of the event "Mental Wellness and Digital Wellbeing" at Politecnico di Torino as a member of the Logistics and Fundraising area in the HKN student association<br><br>Organization of the event "Quantum Quest" at Politecnico di Torino as a member of the Logistics and Fundraising area in the HKN student association |