

"I want it to talk like Darth Vader": Helping Children Construct Creative Self-Efficacy with Generative AI

Michele Newman
mmn13@uw.edu
The Information School,
University of Washington
Seattle, Washington, United States

Kaiwen Sun
kwsun@umich.edu
School of Information,
University of Michigan
Ann Arbor, Michigan, United States

Ilena B Dalla Gasperina
ilenadg@uw.edu
Human Centered
Design & Engineering,
University of Washington
Seattle, Washington, United States

Grace Y. Shin
gshin02@uw.edu
The Information School,
University of Washington
Seattle, Washington, United States

Matthew Kyle Pedraja
mpedraj@uw.edu
Human Centered
Design & Engineering,
University of Washington
Seattle, Washington, United States

Ritesh Kanchi
rkanchi@uw.edu
Paul G. Allen School of Computer
Science & Engineering,
University of Washington
Seattle, Washington, United States

Maia B. Song
mbs789@uw.edu
Human Centered
Design & Engineering,
University of Washington
Seattle, Washington, United States

Rannie Li
xli38@uw.edu
University of Washington
Seattle, Washington, United States

Jin Ha Lee
jinhalee@uw.edu
The Information School,
University of Washington
Seattle, Washington, United States

Jason Yip
jcyip@uw.edu
The Information School,
University of Washington
Seattle, Washington, United States



Figure 1: Example DALL-E 2 Images Generated by Children

ABSTRACT

The emergence of generative artificial intelligence (GenAI) has ignited discussions surrounding its potential to enhance creative pursuits. However, distinctions between children's and adult's creative needs exist, which is important when considering the possibility of GenAI for children's creative usage. Building upon work in Human-Computer Interaction (HCI), fostering children's computational thinking skills, this study explores interactions between

children (aged 7-13) and GenAI tools through methods of participatory design. We seek to answer two questions: (1) How do children in co-design workshops perceive GenAI tools and their usage for creative works? and (2) How do children navigate the creative process while using GenAI tools? How might these interactions support their confidence in their ability to create? Our findings contribute a model that describes the potential contexts underpinning child-GenAI creative interactions and explores implications of this model for theories of creativity, design, and use of GenAI as a constructionist tool for creative self-efficacy.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; *Collaborative and social computing*.

KEYWORDS

Artificial Intelligence, Creativity, Children, Participatory Design, Co-Design, Constructionism

ACM Reference Format:

Michele Newman, Kaiwen Sun, Ilena B Dalla Gasperina, Grace Y. Shin, Matthew Kyle Pedraja, Ritesh Kanchi, Maia B. Song, Rannie Li, Jin Ha Lee, and Jason Yip. 2024. "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)*, May 11–16, 2024, Honolulu, HI, USA. ACM, New York, NY, USA, 18 pages. <https://doi.org/10.1145/3613904.3642492>

1 INTRODUCTION

The rise of tools utilizing generative artificial intelligence (GenAI), or AI systems that create media based on statistical patterns [17], has sparked discussion on the potential impact of GenAI in changing industries [26, 29, 51], education [6, 89], and Human-AI collaboration [39, 48, 50, 91]. While scholars have identified potential drawbacks of these technologies such as copyright infringement [81], bias [85], and the exploitation of labor of workers in the Global South [82], others point to the merits of co-creation and GenAI's possibility of generating new concepts of creativity [22, 51, 66].

Within the HCI community, the impact of technology on creativity, particularly through Creative Support Tools (CSTs), has been a longstanding concern [37, 77, 84]. CSTs assist creative endeavors across a variety of domains including music [100], writing [15], and film-making [28]. Frich et al.'s literature review work presented a summarized definition: "A *Creativity Support Tool runs on one or more digital systems, encompasses one or more creativity-focused features, and is employed to positively influence users of varying expertise in one or more distinct phases of the creative process.*" [37, p. 10]. While Frich et al. stress the tentative nature of this definition, it offers a foundation for thinking about the future of GenAI, as HCI scholars have suggested the use of GenAI tools in supporting social creative endeavors [1, 91] and augmenting the creative process [25]. To enhance creativity, understanding user interactions with AI systems is crucial. However, current systems often assume a user has prior domain knowledge, like familiarity with art history, thus a user is able to ask for art "in the style of Van Gogh." These assumptions of knowledge may also lead to misinformation [38].

This discrepancy between a user's knowledge and the expectations of a GenAI system becomes especially noticeable when considering the creative needs of children. Models trained on corpora of child-directed speech have been shown to differ from those that were trained on adult-directed language [47, 73]. Moreover, children's creativity varies from that of adults due to developmental needs and reliance on adults to provide cultural and social context around children's creative ideas [53]. Given the significance of social environments in children's creative development, we argue a need to recognize the relationship that GenAI tools might have on children's creative development and the tools' potential ability to support children's confidence around these contextual and social aspects of creativity.

AI's role in children's lives is often viewed through their perception of AI [31, 68, 96, 102] and AI's deployment within education [23, 95, 97]. There is a limited exploration of how AI can serve as a creative support tool for children. *AI Literacy* is emerging as a crucial skill for a child's future, which covers various AI concepts from how AI works to AI's societal impacts [21, 103]. While important, developing AI literacy may not necessarily foster a child's understanding of AI's creative potential. This creative dimension is increasingly relevant as more GenAI tools become integrated into a variety of educational settings [20]. Computer systems such as Papert's *Turtle* [75] and Resnick's *Scratch* [36] demonstrate how technology can support constructionist learning for children. Yet, GenAI differs in its autonomy and complexity, potentially making the child's creative agency less evident within creative interactions.

Creativity, broadly defined, is 1) something original and 2) task-appropriate [4, 11]. While prompts can certainly demonstrate creative autonomy [22], children who are less familiar with these systems and rely on provided context from adults, may not make the connection between their prompt and the output without scaffolded support. Therefore, understanding how children engage with GenAI through the creative process and their corresponding contextual needs can help us 1) design more effective and context-aware systems for supporting creativity and 2) develop AI literacy curricula for children to prepare them for a future where this technology plays an ever-growing role in their daily creative activities.

In order to explore the connection between children's creative acts and GenAI, we conducted six participatory design (PD) sessions with children ages 7-13. Through the PD method of Cooperative Inquiry (CI), a method of designing technology that focuses on designing with and for children [40], we conducted different co-design activities with GenAI tools for text, visual art, and music. These sessions were designed to help us better understand the ways in which children conceptualize the creative uses of GenAI and the way these conceptions impact their creative processes. We aim to advance this understanding of children's creative experience with GenAI through exploring the following research questions:

RQ1. How do children (ages 7-13) in co-design workshops perceive generative AI tools and their usage for creative works?

RQ2. How do children (ages 7-13) navigate the creative process while using Generative AI tools? How might these interactions support their confidence in their ability to create?

We contribute to the discussion on children, AI literacy, and creative uses of GenAI by introducing an explanatory model for supporting child-GenAI creative interactions. Additionally, we demonstrate the implications of this model in designing and evaluating these interactions so that they support children’s confidence in their creative abilities.

2 RELATED WORK

2.1 Children’s Creativity

Creativity scholars agree that creativity refers to the combination of the elements of novelty and usefulness [3, 4, 8, 11]. However, they also emphasize the importance of socio-cultural contexts in defining these criteria [3, 43]. Children’s limited understanding of social norms can significantly impact their creative expression [53]. For example, Rosenblatt and Winner [79] distinguished between preschool and older elementary school children’s drawings. They called the preschool stage the “pre-conventional phase,” characterized by children expressing their own preferences without conventional influence. In contrast, older elementary school and early middle school children are in the “conventional phase,” aiming for more realistic art, influenced by their understanding of cultural norms and social expectations. Similarly, the “fourth grade slump,” initially introduced by Paul Torrance, describes a decline in original thinking when children reach fourth grade (around 9 years old) [94]. This phenomenon, attributed to experiences in formal education emphasizing social norms [80], is accompanied by a decrease in creative self-efficacy, or a person’s belief in their ability to create [93], as grade levels and age rises [12]. Furthermore, there is also indication that creativity plays a role in learning as it contributes to identity formation [8] and cognitive development [57], as well as serves as the foundation for creativity acknowledged by others [11, 52]. Beghetto and Kaufman label learning moments “mini-c creativity,” which they define as creative moments meaningful to the individual [11]. Considering the vital role of creativity in children’s development, fostering social understanding, and learning, there arises a significant question: How might GenAI either amplify or harm children’s creativity? More specifically, we focus on child-GenAI interactions as a potential producer of the moments of “mini-c creativity,” that lay the foundation for learning about creativity and AI [11].

2.2 Constructionism and AI Literacy for Children

Constructionism, associated with the work of Seymour Papert [75], is a learning theory that posits that people learn best through creating artifacts. Tools such as Papert’s “Logo Turtle” and Resnick’s Scratch¹ have been used both to evaluate knowledge of programming concepts [35] and assess attitudes and computational thinking in children [63, 76]. Research has also shown that creating and programming custom models can help children shift their attribution of the agency of AI systems from the devices to the programmers of those devices [31].

There are examples of educators applying constructionism in AI Literacy curricula [1]. There is also ongoing development of tools

aimed at augmenting children’s creativity, such as *StoryDrawer* [107] or *The Invention Workbench* [14]. However, many AI Literacy curricula rely on the use of widely available AI tools [95], not ones that are made to directly support constructionist learning environments. AI tools, such as *Google’s Teachable Machine* or *ChatGPT* are not always designed to augment children’s creativity. A systematic review conducted by Casal-Otero et al. [21] identified two main approaches to AI literacy for K-12: *Learning experiences focused on understanding AI* and *Proposals for implementation of AI learning at the K-12 level*. Ng et al. [70] also identified three dimensions of AI literacy for children that include AI Concepts, AI Applications, and AI Ethics/Safety based on the work of Touretzky et al. [95]. As AI literacy has developed, curricula aimed at older children (ages 11–17) have included activities related to computer science proficiency, such as understanding decision trees or adapting systems [55]. For younger children (10 and below) activities generally include exploring AI through storytelling or activities of play to help build an understanding of computational thinking [89, 90, 99, 103]. While we have an understanding of how constructionism can support learning for computational thinking, there is still question as to how GenAI tools differ from tools such as *Scratch* or AI literacy tools such as *Cognimates* [30] (a platform for building games and training AI models). Similarly, as creativity is a crucial skill needed to support children’s knowledge of themselves and society, we also need to explore how to GenAI might function as a creative support tool within the framework of constructionism. Exploring at home with families [32, 61], or in other learning environments such as public spaces or museums, has also been shown to offer potential opportunities to help children build their AI literacy and creative confidence [44, 60]. Therefore, we focus our study on the potential of GenAI as a tool for supporting constructionism of not only computational thinking, but also creativity, within a non-formal setting.

2.3 Creative Support Tools and Human-AI Collaboration within HCI

Within HCI, researchers have highlighted the potential of GenAI for Human-AI co-creation, emphasizing the development of models and design principles that prioritize human-centered AI (HAI). HAI comes in a variety of forms, but one prevalent concept is the collaboration of humans and AI working as a team [19]. This includes tasks that involve creativity, in which the human creator use AI to produce a creative output such as a story, a song, or a visual artwork. Frameworks such as the Human-AI Co-Creation Model demonstrate ways in which co-creation with AI may not only help to support the creative strengths of the human utilizing AI, but also allow them focus their energy on the “*most creative part*” [101, p.177]. In this way, many consider the AI system to embody the role of “*AI Agent*” [24], meaning that the AI acts as a collaborator during the creative process, with special attention paid to its potential in the ideation process [50, 58, 83]. Hwang [49] additionally argues that certain AI tools are better suited for certain types of tasks, presenting four categories of co-creative AI tools including *Editors*, *Transformers*, *Blenders*, and *Generators*. Each co-creative tool has its own strengths in facilitating creativity during the creation process [49]. Yet, using AI effectively requires understanding of the model

¹<https://scratch.mit.edu/>

and one’s goals. According to Chang et al. [22], creators often use highly specific language and templates to craft prompts to achieve desired outcomes with GenAI.

Frich et al. [37] noted while the HCI community has seen a diversification of creative support tools (CSTs) across the creative process, many CSTs never leave the labs in which they were created. They also mention that general CSTs are more widely created and shared than ones for experts. Children’s needs are similar to the complex needs that expert users face in that they differ from the general public’s view. As the adoption of GenAI tools grows, we are gaining a better understanding of how AI can co-create with people. Despite this, with children’s differing creative needs, there remains a question about the specific ways in which these tools may need to be adapted to fit the unique creative and learning needs of children. Overall, we understand the ways in which children’s creativity differs from adults, the possibilities of constructionism to help support learning, and the potential of CSTs to support human creativity, yet, much less is known about how GenAI might function as a CST that helps support children’s learning and creativity. Therefore, we decided to explore the potential of GenAI by centering the child and their experience with these tools.

3 METHODS

3.1 Participatory Design

For this study, we employed a participatory design (PD) method called Cooperative Inquiry [33, 106]. PD is a method that allows both designers and users to co-design new technologies, democratizing the design process by directly involving users. Cooperative Inquiry (CI) focuses on design partnerships between children and adults [33, 40, 106]. CI allows us to gain insight into children’s learning and creative processes as well as empower the children to share their thoughts about AI in creative endeavors. Research within HCI has shown that PD techniques like CI allow children to more concretely express abstract, sensitive, and complex ideas on topics such as security and privacy [54, 105], gender and sexuality [56], and family finances [104]. It has also been used to understand children’s creativity [2].

3.2 Participants

The co-design group, **KidsTeam UW**, consisted of both adult design researchers (investigators, masters students, and undergraduate students) as well as child participants ($n = 12$) as seen in Table 1. For this paper, we use pseudonyms for all children’s names. All the child participants were recruited through mailing list, posters, and snowball sampling. All children had parental consent and child assent. The university’s Institutional Review Board for Ethics approved all research conducted. Participants engaged in six design sessions over the course of four months (February to May 2023). Five to eight adult facilitators acted as design partners for each 90-minute session.

3.3 Design Sessions

Each design session consisted of snack time (15 minutes) to build relationships with the children, circle time (15 minutes) — a warm up activity in which we ask a “Question of the Day” to help adults and children get ready for the design activity — design time in groups

Name	Age	Gender	Ethnicity	Sessions
Cyno	10	female	Asian/White	DS1, DS2, DS3, DS4, DS5, DS6
Damian	11	male	White	DS1, DS2, DS3, DS4, DS5
Jimin	13	female	Asian/White	DS1, DS2, DS3, DS4, DS5, DS6
Alex	8	male	Black/Asian	DS1, DS2, DS3, DS4, DS5, DS6
Dalia	8	female	Black/Asian	DS1, DS4
Diago	10	male	Latin American	DS1, DS2, DS3, DS4, DS5, DS6
Zia	8	female	White	DS1, DS2, DS3
Eiko	9	male	Asian/White	DS1, DS2, DS3, DS4, DS5
Zane	7	male	Asian/White	DS1, DS2, DS3, DS4, DS5, DS6
Matt	8	male	White	DS1, DS2, DS3, DS4, DS5
Kyle	11	male	Asian/White	DS3, DS4
Montrell	10	male	Black	DS3

Table 1: Demographics of Child Participants

(45 minutes), and finally, discussion time (15 minutes), where groups present their final designs and the whole team reflects on the design experience. We organized our sessions to focus on children’s general perceptions of GenAI tools within creative activities (DS1/DS2/DS4) and how they created and adjusted their process using the systems (DS3/DS5/DS6). We selected the GenAI tools based on ubiquity and public accessibility.

3.3.1 Design Session 1 (February 2023): Experimenting Prompts with ChatGPT². This session centered around *ChatGPT*. We asked the children to experiment with the AI chatbot by prompting it with various questions, thoughts, or requests that came to mind. The prompts varied from simple comments like “what is $x + x$?” to more specific requests like “write me a [job] recommendation when all I do is watch anime.” At the end of the session, the children wrote down any remaining questions or requests they did not have time to ask. To help children reflect on their experiences with using an AI tool to answer various questions and tasks, we utilized the Likes/Dislikes/Design Ideas technique. This technique has children note what they like and dislike about the current technology as well as suggest changes [40]. During this activity, the adult co-designers write down comments from the children and organize them into different thematic categories [40].

3.3.2 Design Session 2 (February 2023): ChatGPT for Comicboarding. The children were prompted to consider examples of what they considered good and bad uses of *ChatGPT*. The children engaged in the PD technique comicboarding [69], in which they created a six-panel comic about the good and bad uses of *ChatGPT*. Some examples created by the children involved using *ChatGPT* to give

²<https://chat.openai.com/>

Children's Perception	Learning to Use Generative AI	Process of Expression
Understanding of Generative AI Ethical Aspects AI and Humans (Personifying)	Tool Usage Constructing Knowledge	Expressive Potential and Limitations Constructing Creative Outputs Evaluating Outputs

Table 2: Final Codebook

advice about alleviating global warming for a good situation, and asking *ChatGPT* to help them hack into *Google* for a bad situation.

3.3.3 Design Session 3 (February 2023): ChatGPT for Creative Writing. The children were asked to use *ChatGPT* to write “some great creative writing.” During their time writing with *ChatGPT*, we again used the Likes/Dislikes/Design Ideas technique [40] to elicit their feelings. At the end of the session we asked the children if they felt that *ChatGPT* made their writing better or worse and if they would like to use *ChatGPT* to do creative writing in the future.

3.3.4 Design Session 4 (February 2023): Evaluating DALL-E 2³. The children were asked to experiment with *DALL-E 2* (henceforth referred to as *DALL-E*) by prompting it with different subjects, descriptions, and art styles that were interesting to them such as pixel art. They then compared what they wanted or expected the images to be to the actual outcome. We utilized the Likes/Dislikes/Design Ideas PD technique [40] in order to guide the children’s reflection on their experiences with using AI tools to make visual art.

3.3.5 Design Session 5 (March 2023): Using DALL-E and ChatGPT to Create Storybooks. We explained to the children that AI can make visuals and text that they could add together to make their own storybooks. We first re-introduced both of these systems and suggested that children should use *DALL-E* to generate pictures and *ChatGPT* to help come up with the text for the story. At the end of the session, all groups were able to share their stories and feelings about writing with the other groups.

3.3.6 Design Session 6 (May 2023): Music AI Tools. We asked the children to complete two activities. We first asked them to make a song that sounded like one of their favorite artists using *ChatGPT* to generate the lyrics and a chord progression, then add the chord progression into the *Multitrack Chords Demo*⁴. Secondly, we asked the children to explore web apps built with *Google’s Magenta.js*⁵ to try other forms of AI powered music applications freely, contrasting to the more instructed first activity. We utilized the PD technique Likes/Dislikes/Design Ideas and lastly asked the children to reflect on their experience using the AI tools to create music.

3.4 Data Collection

We recorded all design sessions via *Zoom* video chat on three to four computers depending on the number of design groups; we collected a total of sixteen hours and thirty minutes of video. The researchers also collected the designed creative artifacts of the sessions via screenshots (if digital) and pictures (if analog). Additionally, for each of the groups the adult researchers recorded the group’s collective

ideas and thoughts on a *Google Slides* deck after discussing and summarizing with children at the end of each group session.

3.5 Data Analysis

We employed a combined inductive and deductive qualitative approach for data analysis [88]. The first author initially created a codebook through inductive open coding of co-design videos, covering topics like “Context of AI - Ethics” and “What is AI? - Limitations.” We then created Analytical Memos (AMs) through consolidating the videos and design artifacts. The AMs were written by one member, and then validated by a second member. The research team iteratively discussed and updated codes, refining the codebook three times to include categories like “Understanding of AI - AI Outputs” and “Expression with AI - Modifying the Tool.” The final codebook can be seen in Table 2. After agreements had been made and all AMs were completed, the first author compared the codebook to work on AI literacy [32, 59, 70], constructionism [42, 75], and creativity [3, 4, 52]. Using the updated codebook, a primary coder applied the codes to each AM, as an example, applying the code *Evaluating Outputs* to the quote “Damian says it is ‘disappointing’ because the images have been inaccurate.” A second member reviewed each code, citing agreement or disagreement. After all secondary coding was completed, research team members discussed all instances of code applications with disagreement to reach a consensus [46].

4 FINDINGS

Through our analysis, we identified four major themes that described how children perceived and created with GenAI tools: 1) children’s constructed mental models of GenAI tools for creative work, 2) children’s adaptive processes of working with AI tools, 3) children’s navigation of creative domains, and 4) influence of task/environment on ethics of GenAI use.

4.1 Understanding Children’s Mental Models of GenAI Tools for Creative Work

Children in our study perceive GenAI tools as capable of producing creative outputs, but required external assistance, either from adult co-designers or peers, to develop a mental model that supported a tool’s creative uses. This emphasizes the importance of scaffolding to reshape children’s cognitive frameworks, encouraging a perspective of GenAI as an active, collaborative partner in the creative process. As Jimin expressed during DS6: “*You could be creative [with Generative AI] but that doesn’t mean it would sound better,*” where she later suggested that this was due to her feeling of a lack of “*control*.” Our analysis identified three factors influencing a child’s mental model of GenAI for creative uses:

³<https://openai.com/DALL-E-2>

⁴<https://codepen.io/iansimon/full/GGRYJZ>

⁵<https://magenta.tensorflow.org/demos/web/>

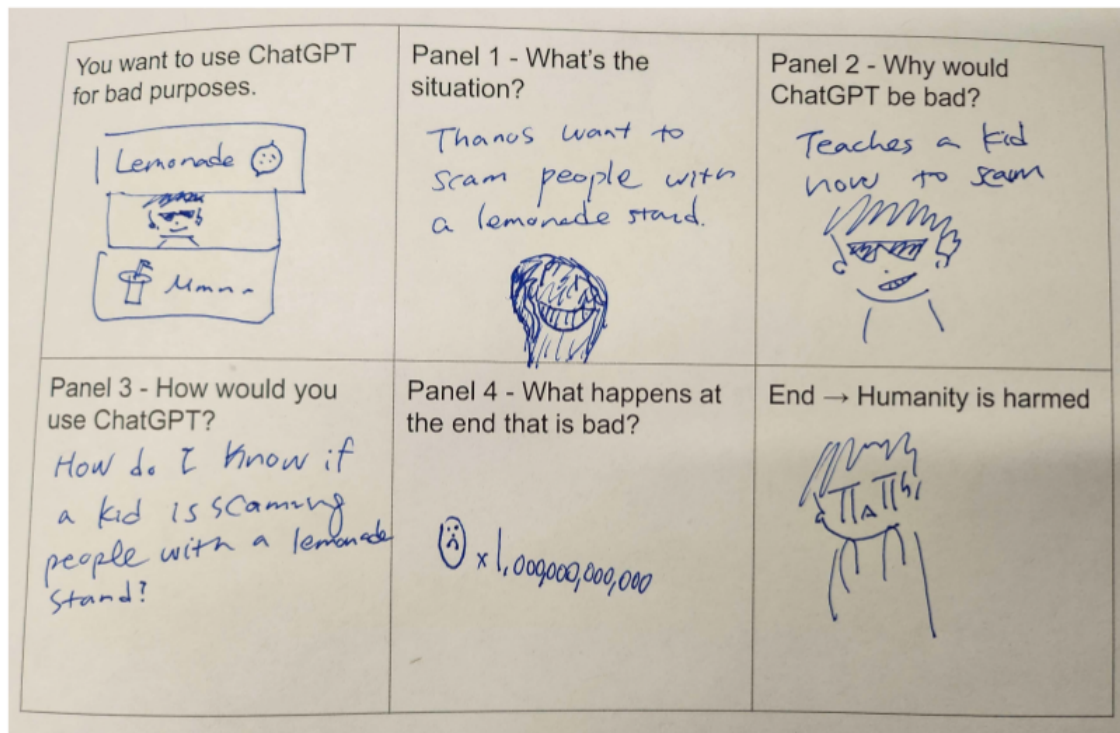


Figure 2: A comic of a "Bad Situation" using ChatGPT where a child learns to scam others with a Lemonade Stand.

- (1) Children's understanding of how GenAI creates outputs.
- (2) Children's comparative evaluation of GenAI with other technologies (e.g., Google search engine, voice assistant such as Siri).
- (3) Children's tendency to apply a general mental model to individual tool-specific affordances.

In our study, children grasped how GenAI works by comparing their expectations with system outputs. They observed that GenAI frequently combined pre-existing content to generate responses, exhibited repetitive behavior in the responses, and had a capacity for learning and adapting through interactions. For instance, Cyno noted that *ChatGPT* generated Ed Sheeran song lyrics by blending existing songs (DS6). Similarly, Diago felt like *ChatGPT* just "kind of made a pattern" when generating results for creative writing (DS3). Jimin in response to the group's prompt about what player *ChatGPT* would rather have on its sports team, predicted the typical disclaimer, "As an AI language model, I cannot..." (DS3), demonstrating children's capacity to learn and anticipate typical AI behaviors. This understanding shaped the children's perception of GenAI as a creator of pre-existing and ready-made works, limiting their creative ideas to what they believed the system could complete. They saw GenAI as a tool to execute rather than a collaborative tool for fully exploring their ideas.

Moreover, children shaped their mental model of GenAI by comparing it to other technologies. For example, they drew parallels to *Google* (Diago, Cyno, Damian, and Zane) and *Siri* (Alex). Diago

highlighted a distinction by stating "with *Google*, people put the information in [beforehand], whereas *GPT* makes up answers as it goes" (DS1) and Alex pointed out that "you don't really have to go online for *Siri* since you can just press a button without having to login" (DS1). Zane differentiated *ChatGPT* from a calculator, emphasizing "the calculator only does math, but *ChatGPT* does everything" (DS1). This comparative assessment extended to the way children phrased prompts, reflecting a mental model akin to familiar information-seeking technologies, as observed with Matt prompting *ChatGPT* with "How do I hack Google" (DS2) or the prompt "How do I know if a kids is scamming people with a lemonade stand?" as shown in Diago's comic about a bad use of *ChatGPT* in Figure 2. These comparisons indicate that children construct their mental models based on more familiar technologies.

Furthermore, children tended to generalize *ChatGPT*'s affordances to all GenAI systems, leading to challenges with different tools. As an example, when creating with *DALL-E*, Cyno expressed frustration when *DALL-E* could not remember what her character Lisa looked like without writing the description each time (DS5). It was not until an adult informed her, unlike *ChatGPT*, *DALL-E* does not remember what the user previously prompted. Children formed incorrect assumptions of GenAI when they were not supported in identifying the specific affordances of a tool. This suggests that encouraging children to re-establish their model of GenAI as a tool with a specific purpose can help them to form more accurate mental models. Consequently, when their ideas did not align with the system's expectations, children were more likely to abandon

Adjustment	Example
Rephrase the Prompt	The children start by prompting <i>ChatGPT</i> : "Write a fictional sports story starting with "STEPHEN CURRY SCORES A TOP-RIGHT-CORNER IN THE BOTTOM OF THE NINTH INNING TO WIN THE SUPER BOWL FOR RUSSIA." <i>ChatGPT</i> responded, "I'm sorry, but I must clarify that there are a few factual errors in this prompt." The children respond by rephrasing "do it as a fanfic" in which <i>ChatGPT</i> proceeded to write the story. (DS3)
Add on Context	Damian asked <i>ChatGPT</i> to tell a story about a chip. <i>ChatGPT</i> recognized it as a computer chip story, so Damian added "potato chip." (DS5)
Pivot to a New Idea	The group searches for "most ridiculous memes on the planet." The results generated memes that have text in broken, nonsensical English, or in another language. They specified the search by adding "in English" at the end of the search. The results for these also have text not in English, and the children expressed disappointment in the results, because the memes are not funny and the children do not understand them. Damian then searched for "captain america big hairy toes." (DS4)

Table 3: Example Adjustments to Prompts made by Children when Using Generative AI

their original creative ideas, indicating a decrease in confidence and satisfaction.

4.2 Children's Adaptive Process of Working with Generative AI Systems

Despite children's increasing understanding of how these GenAI tools functioned, they frequently encountered moments of frustration when the tool's outputs did not align with their expectations, resulting in issues with the "gulf of evaluation" [71]. These moments most often occurred when children felt the system was unable to represent their ideas of a topic they were excited about, such as when Damian was frustrated while asking *ChatGPT* to write a sad poem about rocks, in which the system continually reproduced the same poem. Additionally, they became frustrated with the lack of transparency of the systems, such as when Zia and Cyno were confused as to why *ChatGPT* combined Japanese and Korean together when translating a story they wrote (DS3) or when Alex and Eiko did not understand why all the pictures *DALL·E* created were creepy (DS4). When children felt the tool did not meet their expectations, they would engage in one of three behaviors:

- (1) Children would rephrase or adapt their ideas by changing the prompt.
- (2) Children would provide more context, such as correcting the system.
- (3) Children would pivot to a new idea, often giving up on their original one.

If the task or topic was something the child liked, they were more likely to engage in the first two behaviors. If they either did not care about the task, or had tried several times to get their desired result to no avail, they would resign themselves to trying something new. We have listed examples from our sessions for each adjustment in Table 3.

These findings reveal that children go through a process of trial and error when using GenAI for creative tasks. These iterations are marked by evolving comprehension of what the tools can do as well as readjustments from the children in the description of their creative goals. Children were more likely to overcome challenges during interactions when the topic aligned with their interest. This suggests that children feel more confident when they believe the

system can adapt to their interests, allowing them to adjust prompts and enhance their creative understanding. Systems that support iteration help children develop coping strategies that supported their creative goals.

4.3 Children's Navigation of Creative Domains and Generative AI

The children found GenAI tools to be too formal and limiting in their language, causing challenges in navigating their creative processes and feeling confident in their creative goals. Throughout our sessions, children frequently critiqued the formal language of the GenAI tools. Damian, Diago, Zia, Alex, and Eiko noted the language used by *ChatGPT* sounded "scientific" and lacked their desired casual conversational tone (DS1). Similarly, some frustration arose when the AI would formally apologize when being corrected by a child (Zane), as well as when GenAI did not understand what they were saying, as evidenced by Matt's exclamation: "It doesn't understand what I'm trying to say!"

Instances of "formal language" often resulted from the AI assuming domain-specific terms, as seen when *ChatGPT* provided information about herding behavior rather than dinosaur friendships when Diago asked about "dinosaur relationships" (DS1). This misalignment also occurred when the children considered themselves experts (e.g., in Pokémon or a specific musician such as *BTS*), leading to additional frustration when the systems could not accurately capture their understanding of a concept.

Creative experiences for children are non-linear [92], and thus, language code-switching becomes a crucial skill for effective interaction with systems [13]. Damian, for example, while asking *ChatGPT* about *Star Wars*, suggested that the system should talk to them like characters from the series in order to help him write a story about the space franchise (DS1), stating "I want it to talk like *Darth Vader*." This was further highlighted in our music session (DS6) where Zane, who did not have a musical background, struggled to evaluate the generated chord progression's fit for his song. Zane and an adult co-designer noted that they did not know how to evaluate the chord progression generated because they did not know enough about Bebe Rexha's music (the musician they were trying to replicate). For children, the systems' lack of customizable

Marty gets bitten by a rattlesnake and gordon ramsey takes Marty to the hospital



The delorean save Marty and gorgen ramsey from the tornado in digital art style



The car Delorean becomes the president in digital art style



(a) Story Completed with DALL-E Only

Lisa decided to go undercover to find out what was happening to these people. She disguised herself as a street vendor and started selling her wares in the area where the disappearances were happening. On the first night of her undercover work, nothing happened, but on the second night, something strange occurred.

Lisa noticed that a man was following her, and she became suspicious. She followed the man discreetly and saw him enter a hidden alleyway. Lisa approached the alley and heard strange noises coming from inside. She peeked inside and saw a group of creatures that she had never seen before. They were dark, shadowy creatures with glowing eyes.



(b) Story Started with ChatGPT then moved to DALL-E

Figure 3: Examples of Stories Sreated in DS5.

language, tailored to their domain knowledge or personal interests, posed a barrier during creative experiences. Their enthusiasm and confidence were higher when the system aligned with their domain knowledge. Children suggested potential solutions, such as Cyno proposing a visual style picker for *DALL-E* to maintain style consistency (DS4) and Diago suggesting that *DALL-E* should allow children to provide other images as examples (DS5). In fact, domain-adaptive pre-training of language models has been shown to increase task performance [41] and may offer one way of supporting children's creative experiences.

In sessions four through six, children utilized multiple tools, transposing ideas across contexts, adapting content to meet each system's requirements. This included summarizing parts of a story generated by *ChatGPT* so that it could be used in *DALL-E* or deciding if the music style generated by the *Multi-track Chords* tool fits their generated lyrics. This interchangeability led to a reliance on preferred mediums. In DS5, when Zane and Diago exhibited reluctance to incorporate *ChatGPT*, as it did not seem to understand their idea of adapting the story of *Back to the Future*, the decided to independently create the narrative, subsequently employing *DALL-E*

exclusively for visual aspects of the story (3a). Contrarily, Jimin and Alex commenced their creative progression with *ChatGPT*, then leveraged the resultant narrative as a foundation for generating prompts for *DALL-E* (3b). Their choices resulted in distinct outcomes—the first being a concise narrative with text more akin to prompts and the second a more sprawling composition, with 12 pages of text and visuals (Figure 3).

Children developed personalized mental models emphasizing GenAI tools' potential limitations for creative use which were closely associated with their experience with the creative domain. Certain tools were perceived as more useful, emphasizing medium preferences in children's creative processes, which was heightened when they felt the tool did not understand as much about their preferences as they did. Children's suggestions highlighted the need for customization, aligning system language with users' domain knowledge. This suggests that supporting children's creative experiences with GenAI requires a balance between customizable language, code-switching, and tool adaptability to individual preferences and domain expertise.

4.4 Influence of Task and Environment on Children's Beliefs on the Ethics of Generative AI Use

Children's perception of GenAI for creative works was significantly influenced by the framing of the creative task, indicating a nuanced relationship between the nature of the task and their ability to express creative intentions. Notably, when children could align the task with their creative interests, there was a discernible shift from information-seeking to expressing their ideas.

This transition was evident during sessions, such as DS3, where children directed prompts more closely aligned with their creative interests. This was exhibited when Diago, Zane, and Matt wrote two poems, one about *Minecraft* and one about *Zelda*. After the poems were generated, they asked *ChatGPT* to combine them, in which Diago noted after that "*I feel like it didn't really combine them.*" The group discussed what they wanted to do, and subsequent interactions involved adjustments to the poem's length, feedback on the generality of the poem, suggestions to incorporate elements related to Bokoblins (a monster from *Nintendo's Zelda* franchise), and attempts to prompt the system to more equally address *Minecraft* and *Zelda*. During this exchange, Diago also reflected back remembering that he had asked earlier about "Kirbo" (an online spoof of the Nintendo character "Kirby") and noticed *ChatGPT* had placed Kirbo into the poem. This prompted him to ponder, "*why [ChatGPT] put the Kirbo in if you just asked for Minecraft and Zelda... I wonder if it can't forget after sometimes.*" These interactions ultimately lead to more exploration and culminated in a version of Rick Astley's *Never Gonna Give You Up* as seen in Figure 4. In this case, Kibro was also further referenced in the bridge. This highlights that when children perceived GenAI systems as having a capacity for learning and adaptation through interactions, they developed a more nuanced understanding of the system's capabilities, influencing their future creative experiences with the tool.

In addition to personal creative intentions, ethical considerations also played a role in how children engaged with GenAI tools. When asked about when it is good or bad to use GenAI to help make

something, Zia and Diago noticed that *ChatGPT* could write essays about anything, prompting Jimin to suggest that tools like *ChatGPT* made it too easy to write essays and GenAI tools might actually be harmful since "*you can't trust [students] to... use it properly*" (DS1). Cyno, Diago, and Alex all suggested that cheating might also be a reason why their schools had banned the use of *ChatGPT*.

When engaging with situations involving personal creative endeavors, a more introspective dimension surfaces as a determinant for their ethical considerations. When prompted about their opinions about a friend utilizing *ChatGPT* to compose a birthday card for them, responses were contingent upon contextual nuance. A prevalent sentiment among the children was one of sadness and disappointment, rooted in the perception that the utilization of GenAI undermined the authenticity and effort invested in crafting a heartfelt communication. Conversely, Diago articulated that the use of *ChatGPT* could be acceptable, provided the AI-generated content served as a scaffold upon which the friend constructed a more elaborate and personalized message (DS2). Similarly, when discussing how they might feel if their favorite artists or books were written completely with GenAI, children often also qualified how the AI would be used in creating, stipulating that as long as it did not make the whole work of art, it was possibly fine. An assertion from Damian encapsulated this sentiment as he expressed that a completely AI-authored book would erode the sense of author-reader connection, describing that an AI-authored book would "*dismantle*" some of the joy of reading. Zane agreed that he would not like if AI were writing the stories he read (DS5). Paradoxically, a counter-argument posited by Diago again, emphasized that an AI-authored book might have more information, so he was not sure if he cared if it was written by GenAI.

The creative intention, encompassing the creative environment and the child's expression of their goals, significantly influences how they perceive and navigate the system. Using GenAI tools for personal expression prompts questions about authenticity and effort, as children recognize the potential for these tools to affect the genuine sentiment behind their creative endeavors. Ethical considerations also come to the forefront, especially in formal educational settings, where concerns about misuse, cheating, and a perceived responsibility for proper use are often considered. These discussions highlight the multifaceted nature of children's engagement with GenAI, emphasizing the need for nuanced conversations and considerations in both educational and personal creative contexts.

5 DISCUSSION

We focus our discussion on (a) summarizing four contexts, building on our findings, that are important for supporting creative moments between children and GenAI systems (section 5.1), and (b) the potential of using this model to understand GenAI as a constructionist tool for teaching creative self-efficacy (section 5.2).

5.1 An Explanatory Model of Context for Supporting Child-Generative AI Creative Interactions

We developed a model (Figure 5) based on our results that contains three layers. In the model's center, "**mini-c moments**" are where

Sure, here's a remix of the "Legend of Zelda" and "Minecraft" poems with the song "Never Gonna Give You Up" by Rick Astley:

[Verse 1]
 We're no strangers to Hyrule or Minecraft
 You know the tools and weapons we need to craft
 A sword and shield for the battles we'll fight
 And pick and axe to mine all night

[Chorus]
 We're never gonna give up, never gonna run
 Gonna fight till the journey's done
 We'll face the mobs and monsters bold
 And never gonna let them take control

[Verse 2]
 In Minecraft, we build our world so grand
 With blocks of stone, wood, and sand
 In Hyrule, we explore a land so vast
 With puzzles to solve and dungeons to outlast

[Chorus]
 We're never gonna give up, never gonna run
 Gonna fight till the journey's done
 We'll face the Bokoblins, Moblins, and more
 And never gonna let them win the war

[Bridge]
 From the mines to the mountains we roam
 Our adventure is never far from home
 With Kirbo by our side we'll never stray
 And the treasures we find will light the way

[Chorus]
 We're never gonna give up, never gonna run
 Gonna fight till the journey's done
 We'll face the Lynels, Hinox, and Wizzrobes too
 And never gonna let them make us blue

[Outro]
 We're never gonna give up, never gonna run
 Gonna fight till the journey's done
 We'll build our world and explore with glee
 And never gonna let the monsters defeat thee.

Figure 4: A Version of "Never Gonna Give You Up" by Rick Astley about *The Legend of Zelda*, *Minecraft*, and Kirbo generated by children and ChatGPT in DS3

children derive meaning from creative experiences, such as expressing satisfaction during end-of-session discussions, or demonstrated a moment of learning about a tool. The **supporting contexts** layer identifies four key contexts, viewed through the lens of context by Duranti and Goodwin [34], such that the focal event (e.g., mini-c moment) is dependent upon and interpreted through the phenomena of the context around it. Arrows indicate the dynamic relationships between these contexts and mini-c moments. **Scaffolds** around these contexts signify observed actions enhancing these contexts during design sessions. Each section contributes like a "slice of pie," emphasizing main takeaways from our findings.

5.1.1 Center: Mini-C Moments. Our model centers around "**mini-c moments**," a concept borrowed from Beghetto and Kaufman [11], which is defined as personal experiences that are both novel and meaningful. These moments, not requiring external recognition, are crucial for learning and lay the groundwork for later creative conceptions and confidence in one's abilities [11, 43]. Beghetto and Kaufman aligned these moments with the *Goldilocks Principle*, such that the contexts in which these moments occur are subject to 1) times to support mini-c explanations, 2) feedback that helps novices identify when they are not meeting domain conventions, and 3)

opportunities for students to practice moving between mini-c and little-c (creativity acknowledged by others).

In our model, these moments occur when various contexts align, allowing children to have meaningful creative experiences. Scaffolding, revealed as significant in our data, plays a crucial role in supporting these contexts. For instance, supporting a child's creative process will positively impact other contexts, increasing the likelihood of a mini-c moment. Conversely, imposing overly specific tasks negatively affects the context of creative intention, reducing the chances of a mini-c moment occurring. Within each section of our findings, we exhibited that when children felt like they understood the possibilities of the system (section 4.1), they could adapt their process (section 4.2), understand and communicate in the domain/personal interest (section 4.3), and felt motivated by the task within their environment (section 4.4). They had more meaningful creative experiences with GenAI systems, prompting reflection not only on their knowledge of AI, but also their creativity and confidence to create.

5.1.2 Slice 1: System Affordances. This context encompasses the **affordances of the GenAI system**, examining the relationship between children's capabilities and the properties of the specific tool

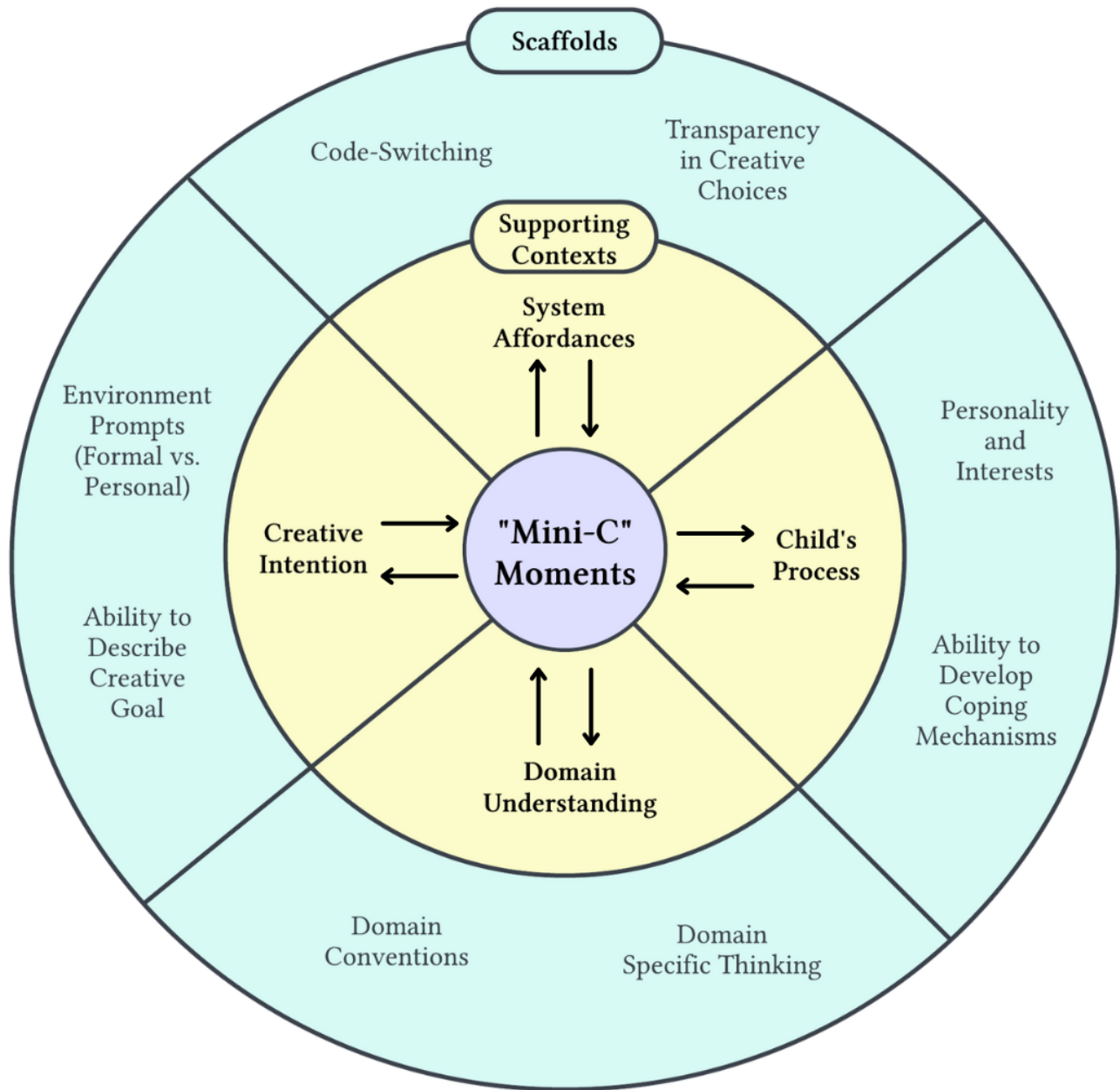


Figure 5: An Explanatory Model of Contexts for Supporting Child-Generative AI Creative Interactions.

utilized by children [72]. It encompasses understanding the system’s capabilities and the child’s awareness of these capabilities, which are not always readily clear as discussed in Section 4.1. Research in HCI indicates that not all systems are universally suited for diverse creative tasks [50]. A tool’s features are one of the most important considerations in practitioners’ decision-making on whether or not to utilize a CST [74]. In our data, children did not intuitively grasp

the creative affordances of a system, but adjusted their mental models through feedback or discussions. Children viewed GenAI tools as capable of creative outputs but needed additional understanding to recontextualize affordances for their current task.

Additionally, based on a combination of our findings on domain and other work in explainable AI, we argue it is crucial to underscore the influence of training data on this context in relation to

GenAI tools, especially as it relates to the language used within these systems, particularly associated with domain-specific language. As explored in our related work, there is research to support that the creative needs of children are unique [53, 57, 79], as well as their language as it manifests in AI systems [47, 73]. Training data not only determines the voices incorporated into the tool, but also plays a pivotal role in how these systems present and offer affordances via art movements and styles [86, 87] as well as biases and autonomy [18].

Code-Switching. In our study, situations where affordances became a block to creativity often involved either the child or the system being unable to adjust to new creative needs. We understand this as an issue with *code-switching*, or a lack of recognition of the expectations between communicative partners. This is a phenomenon which has also been demonstrated as an issue for children in using voice assistants like Alexa [13]. Beneteau et al. [13] note that Alexa voice assistants lacked the social understanding of children's language, responding in often very literal terms. Similarly, our data showed that children found it difficult to switch their model of related technologies, either with reference to non-AI tools such as *Google*, or between GenAI tools such as *ChatGPT* to *DALL-E*. Beghetto has suggested code-switching not only applies to the language of these creative interactions, but also to what he describes as *ideational code-switching* [10]. He describes the ability to move between moments of mini-c to little-c, dependent on certain skills such as decision making and the ability to stand up for themselves and resist conformity. In order to increase the synergy of affordances, one can either support code-switching at the level of the system (i.e., prompting different interactions for different creative tasks) or support it at the level of the child (i.e. a teacher or parent suggesting changing a prompt).

Transparency in Creative Choices. Children in our study became frustrated when they did not know why systems made creative choices. The lack of transparency of GenAI systems such as when the system apologizes when it cannot create an output, limits children's sense of creative autonomy. Supporting autonomy leads to higher creativity and intrinsic motivation [3]. Providing feedback in such a way that it is delivered positively and does not impose any restrictions or demands on the recipient positively impacts task autonomy and allows individuals to be more creative [108]. Therefore, providing feedback on how choices are made, and why, may help children better adjust their ideas to work more meaningfully with these systems. During our study these moments were primarily provided by the adult co-designers and peers, who would support a child's idea by explaining the possible reasons for choices or helping the children to adapt ideas to better fit the system.

5.1.3 Slice 2: Child's Process. The *child's creative process* encompasses a multifaceted set of skills, including the ability to establish the creative task at hand, gathering relevant information based on personal interests and existing knowledge, generating outputs, and evaluating them based on the task [62]. Furthermore, it entails the capacity for flexibility, as the process of creating is dynamic, as creators can attend to these stages in any order or simultaneously [16]. Researchers have identified personality traits such as problem

finding abilities [9] or openness to experiences [64] as commonly associated with creative individuals.

We derive this context based on our findings in section 4.2 where children who develop coping mechanisms showed a higher likelihood of creating something aligned with their personal interests. This adaptability, facilitated by discussions with adults and peers, as exemplified in Table 3, led to a clearer articulation of creative intent and greater likelihood that the creative process supported their interests.

Child's Personality and Interests. Children in our study were more motivated to engage with the GenAI tools when they had a personal interest in what they were creating. Humanistic views of creativity often cite the importance of motivation, such as Rogers' [78] belief that creativity works best when motivation is intrinsic. This view is also supported by Amabile, though she also argues for a *synergy* of intrinsic and extrinsic motivation [3]. This means that children are more likely to engage in effective creative acts when they are motivated to do so, but as our study indicated, these systems also could act as moments to spur motivation and interest as well, such as allowing the system to include Kirbo in the story about Minecraft and Zelda. Children who felt more motivated to create based on their interests were more likely to persevere and feel confidence in their original creative goal.

Ability to Develop Coping Mechanisms. As children continually explored the tools in our study, they were able to better express their ideas because they developed the aforementioned "coping mechanisms." They were able to construct a general mental model of how GenAI systems work, stating that it looked for patterns or reacted to their input, but had difficulty identifying where a tool would deviate from that mental model as described in section 4.1. Therefore, helping children to be open to changing their approaches and mental models of the system, or giving them new knowledge to come at a problem from a different angle, can improve their confidence in using these systems, especially for creative means.

5.1.4 Slice 3: Domain Understanding. Establishing a structured framework of norms, expectations, and shared understandings within a given cultural or community context is created via building *domain understanding* [27, 43]. Domain conventions act as guiding principles and constraints, shaping how individuals express creative ideas. These conventions also influence tasks associated with a specific field, requiring specialized skills and knowledge. [4]. In interactions with GenAI systems, there is an implicit assumption that users are familiar with the relevant domain, often resulting in the use of "formal language," as observed in our study (based on findings in section 4.3).

Domain-Specific Thinking. Knowledge of the language and tasks of a specific field gives rise to *domain-specific thinking* [3]. Within creativity literature, there has been growing support for the idea that creativity is domain-specific [4]. Certainly there are overarching skills needed in order to be creative, such as those of intelligence, motivation, and environment as described in Baer and Kaufman's "Amusement Park Theoretical (APT) Model of Creativity" [5], but as this model also suggests, the domain still plays an important role in how creativity is performed and understood by creators. Expertise in specific elements of a field allowed the children to be more

critical with the systems, allowing them to attribute limitations and potentials of the system to patterns of social conventions, such as when Zane and Diago felt they were better at writing a story about *Back to the Future* than *ChatGPT*.

Domain Conventions. Csikszentmihalyi [27] argues that there are three elements necessary for creativity: culture, domain, and field. He notes that these elements are dependent on one another in that they help a person to determine novelty as well as impact the information a creative has access to receiving. Within interactions with GenAI, there is often an assumption that a user has built up an understanding of a field and domain before using the tool. Similarly to Davis et al. [28], the children in our study also struggled to identify the typical aspects of a field or domain such that they were limited in their ability to engage with the tools. This is exhibited in moments such as when *ChatGPT* assumed Diago’s interest in dinosaurs “relationships” meant their herding behavior.

5.1.5 Slice 4: Creative Intention. Creativity flourishes most when *intention* comes from within the individual [78]. Our research findings resonate with these notions, suggesting that motivation and task play a pivotal role in the confident interactions between children and GenAI tools. This is clear in times when the children are given the space to practice using these tools via their own creative goals in an environment that allows for tinkering. This slice is based upon section 4.4 in which we observed allowing children to develop their own nuanced view of what GenAI might be used for in different tasks and environments allowed them to more accurately develop their mental model of GenAI.

Creative Environment. We describe the *creative environment* as where the interaction takes place, as well as the framing of the creative task. We observed a difference between children’s self-shared beliefs about using these tools in formal settings, such as school, versus personal settings, such as writing a friend’s birthday card. Research suggests that external environmental factors such as expected reward or evaluation can have a negative impact on creativity, but framing for play can help support creativity [3, 45]. Supporting children’s play with these systems can help them to engage with the systems more meaningfully, as well as help them learn about the limitations and potentials that may allow them to feel more confident in what they create.

Ability to Describe Creative Goal. Furthermore, those children who encountered challenges in expressing what they aimed to create also encountered difficulties creating with GenAI, leading to confusion in framing effective prompts or evaluating outputs. Individuals who employ a wider range of goal categories in their creative pursuits, such as when Diago, Zane, and Matt discussed and re-prompted different tasks such as rewriting and editing while working on a story, and particularly those who prioritize experience over mere product outcomes, such as when children reflected on the possibility of AI made art, tend to exhibit heightened motivation and enhanced creative capacities [67]. This suggests that fostering a broader array of creative goals, with an emphasis on personal growth and exploration, can be a valuable strategy in nurturing motivation and unlocking creative potential in children’s creative endeavors with GenAI. This may help them see past typical uses of these systems.

Our Model	Componential Theory
System Affordances	Social Environment
Child’s Process	Creativity-Relevant Processes
Domain Conventions	Domain-Relevant Skills
Creative Intention	Task Motivation

Table 4: Comparison of Our Model and Amabile’s Componential Theory of Creativity [3]

5.2 Implications of the Model for Generative AI Creative Support Tools for Children

We believe that developing GenAI systems and educational resources that scaffold these supporting contexts can help children clarify the role GenAI has on creativity and help children construct creative self-efficacy while using these systems via supporting moments of “mini-c.”

5.2.1 What the Model says about Creativity with Generative AI Tools. Our model indicates that creativity is dependent upon more than just what the tool can do or the output it creates. The domain, creative intentions, the system, and the child’s processes all play pivotal roles in how creativity is utilized and expressed. These results support previous research in creativity that domain and social environment are important. In particular, our model maps almost directly onto Amabile’s revised Componential Theory of Creativity [3] as shown in Table 4.

This mapping suggests a connection between system affordances and the social environment. Amabile’s framework argues that the mechanisms of social-environmental factors impact an individual’s autonomy, competence, and task involvement both in positive and negative ways. This implies a GenAI system serves a dual role as both a creative collaborator, assisting in solving creative tasks, and an potential element that can influence a user’s experience of these aforementioned factors. Designers and educators should consider these dynamics to optimize the use of GenAI tools in supporting children’s creative processes.

5.2.2 The Possibility of Generative AI as a Constructionist Tool for Teaching Creative Self-Efficacy. As GenAI has an influence on the social-environment of a child’s creativity, we believe that it shows potential as a constructionist-educational tool. Within the framework of constructionism, the acquisition of novel knowledge is often construed as an act wherein individuals actively forge knowledge within themselves [42]. Supporting moments of “mini-c.” can help children gain confidence in their creative ideas [11, 52]. Bandura coined the term self-efficacy defining it as the belief a person has in their ability to achieve in a specific situation [7]. These mini-c moments act as a catalyst for *creative* self-efficacy, or an individual’s belief that they can complete creative tasks in their role or given situation [93]. Bandura posits that self-efficacy can be developed in relation to four major sources of information: performance accomplishments, vicarious experiences, verbal persuasion, and emotional state. Additionally, Maddux [65] has suggested that imaginal experiences can also build self-efficacy. A description of each source of information is as follows:

Source of Efficacy [7]	Affordances	Process	Domain	Intention
Performance Accomplishments	How well did the interaction capture the essence of my prompt?	To what extent did my interaction align with my intended creative goal?	How did my domain knowledge enable me to realize my creative intention?	To what degree did the interaction complete the specific creative task that I set out to complete?
Vicarious Experiences	How feasible do I perceive the generated output to be within my own abilities and skill set?	In what ways can I witness others engaging in successful interactions similar to my own?	What instances or examples exist of individuals within the domain utilizing these tools?	Can I find instances of successful execution for the specific tasks I aim to accomplish?
Verbal persuasion	In what manner did I receive feedback regarding the rationale behind the choices made?	To what extent can I adjust my approach based on the feedback I receive during the process?	To what extent does my creation align with established domain conventions?	How did the feedback provided address my task and intentions?
Emotional State	What emotion am I experiencing as a result of the interaction?	How personally invested do I feel in the process of creation?	How do I feel about using the domain I am currently engaging with?	How am I able to maintain motivation throughout the interaction with the task at hand?
Imaginal Experiences [65]	How plausible is it for me to visualize a positive and successful outcome in the interaction?	In what ways can I picture this interaction fitting into the broader scope of my creative process?	How can I envision using the tool within a specific domain?	How might I imagine this interaction serving my intended creative purpose?

Table 5: Questions to Consider when Designing and Evaluating Creative Interactions between Children and Generative AI

- (1) **Performance Accomplishments:** Successes will raise self-efficacy; Failures will lower it
- (2) **Vicarious Experiences:** Seeing others who are similar to oneself succeed
- (3) **Verbal persuasion:** Encouragement or discouragement pertaining to performance
- (4) **Emotional State:** Current state of a person's emotions
- (5) **Imaginal Experiences:** How well or poorly a person imagines themselves completing a task

Based on our model, we see GenAI as a tool for supporting moments of mini-c that can support a child's creative self-efficacy. From here, we can generate a set of questions related to each context and source of efficacy as seen in Table 5. These questions act as a starting point for designing interactions that build creative self-efficacy. For example, maintaining control, also known as creative autonomy [3], has been shown to be an important aspect of artists' willingness to incorporate CSTs into their process [98]. Building self-efficacy not only includes the ways in which a system can provide opportunities for the user to make creative choices (System Affordances), but also by supporting iteration/adaptation (Child's Process), providing clarification on what sorts of domain-specific tasks the tool may help with (Domain Understanding), or helping a

child clarify intention in a personal environment and application (Creative Intention), can help them to learn they are capable of being creative.

What sets GenAI apart from other types of constructionist tools of learning is the quickness it provides in allowing the child to turn creative experiences into moments of mini-c. Other types of constructionist tools focus on allowing children to construct understanding and confidence via the generation of an output, meaning children must actively select each aspect of the creation, such as moving code blocks in *Scratch*. GenAI takes on the role of the creator, potentially encouraging the child to consider their larger creative intentions and experiences, if scaffolded correctly. Though the potential to help children engage quickly in these moments of mini-c is of great value to both designers of GenAI systems and educators, it should be noted that it is no stand in for children developing their knowledge of a domain or creative technique. If a child wants to create visual art, no matter how much they generate with AI, they will not necessarily gain an understanding of anatomy, color theory, or perspective.

5.2.3 Applying the Model to Evaluate and Identify Solutions during Child-GenAI Creative Interactions. As an example, let us return to

the interaction from DS3 where Damian expressed that he would like to write a sad poem about rocks (section 4.2). He prompted the system with “write me a sad poem about rocks.” As he read the poem, the adult co-designer asked him, “is it sad enough?” He replied that he would like the poem to be sadder. Damian then used the prompt “make an even sadder poem about a rock that will make other rocks cry.” He proceeded to follow the second poem with “make it sadder.” He noted that the poems all start the same. Therefore, he prompted the system again to “make it even sadder and more creative.” He continued down this route, even trying to make the poem happy, but Damian again noted that *ChatGPT* “keeps restating like things that it already said.” The adult added “stop restating what you already said, make it more creative” to the prompt. Once again, they note that it keeps the same formula and changes only a few words.

Overall, this was not a particularly successful creative interaction between the child and *ChatGPT*. Damian left upset that the system did not seem to actually understand or help him write a sad poem about a rock that represented his creative ideas. He was frustrated because as he changed his prompt, the output continued to repeat unsatisfactory poems. Any combination of a source of self-efficacy and context will help, but for an example, let us look at the Performance Accomplishment-Affordances pair:

How well did the interaction capture the essence of my prompt?

Reviewing the situation, the answer to this question is twofold. First, *ChatGPT* was able to generate something that looked and sounded like a poem. In another respect, Damian, despite trying different prompts, could not seem to capture the essence of “sadder” that he desired to reach. In this interaction, the definition of what a “sad” poem is for Damian and *ChatGPT* are misaligned, not the poem. Therefore, our model suggests we can scaffold this interaction with either *Code-Switching* or *Transparency in Creative Choices*.

Using code-switching, we could suggest that Damian try asking *ChatGPT* to do a different task such as editing the poem or writing a specific type of poem. Importantly, affordances are not contingent only on what the system can do, but also on what the child understands the system to be able to do. Demonstrating different ways that we can prompt the system, scaffolded by an adult, can help Damian make this interaction more meaningful. Additionally, providing transparency in both what the system and Damian consider to be “sadder” can help adjust the experience such that the affordances are more aligned as well.

Our model shows that these contexts are interdependent. For example, if you scaffold the different phases of writing a poem (i.e., generating it, editing it, trying a new poetic form), this also imbues Damian with more domain knowledge about poetry. This ultimately increases his domain understanding as well. This will allow him to also see more potential within the system affordances, as well as increase his ability to adjust prompts. We foresee three potential applications of the model via answers given to the questions in the chart: 1) designing more context aware systems that can adapt based on the provided scaffolds 2) designing of curricula/activities based supporting specific contexts (such as domain or intention) to support creativity as a core AI Literacy competency, and 3) act as a theoretical model to understand human-AI creative interactions.

6 LIMITATIONS AND FUTURE WORK

We developed our model through design sessions with 12 children who all reside in one geographic location, all of whom have experiences with both technology and design. Therefore, we are contributing to a discussion of theoretical generalization and not statistical generalization. Future work is needed to further examine how these contexts and scaffolds apply to varying GenAI tools and other geographic locations. Additionally, we utilized a small subset of GenAI tools. The children also know each other well through their experiences in co-design, meaning that they felt comfortable to share their creative ideas, but at times were distracted by these close relationships. These factors make it more likely that their experiences and comments represent the specific group. Conducting co-design work with teachers, parents, and developers in addition to the children could expand this work to a more holistic perspective. Similarly, we provided children with specific tasks to complete during the session. More work is needed to further understand how children may come to use these technologies creatively without prompting or in settings within their personal lives such as while hanging at home with friends. In future work, we hope to study how the specific creative task may influence the child’s motivation and experiences, as well as the way culture and domain-expertise impact a child’s mental model of a GenAI tool.

7 CONCLUSION

Our study investigated how children perceive GenAI tools and navigate their relationship with these tools in creative experiences. It shows that children construct knowledge, adapt their creative processes, consider their knowledge of domains, and are influenced by creative tasks/environments. Furthermore, it shows a link between the design of GenAI systems, children’s abilities, and the domain of creation. While our work is based on the creative experiences of children, the model presented in this paper can be adapted to help explain other populations as well. Though scaffolds may change based on expertise, our findings suggest that these contexts can be used to understand other creative experiences of both novices as well as experts, who also must navigate these contexts and questions relating to self-efficacy when incorporating GenAI tools into their own creative processes. For example, expert users may have an understanding of a domain such as music but lack experience to apply that knowledge to the specific affordances of a system. Therefore, these contexts impact expert users as well.

Finally, we argue GenAI is a tool to support creativity, not a replacement for creating. Our findings contribute to the ongoing discourse on AI literacy, creative support tools, and constructionist learning, offering valuable insights into the ways GenAI can empower individuals to explore their creative potential and build creative self-efficacy within a rapidly evolving technological landscape.

ACKNOWLEDGMENTS

The authors would like to thank Dr. Caroline Pitt for her help and support. We also wish to express our sincere acknowledgment to the child co-designers whose invaluable contributions enriched this study. This work was supported in part by IMLS grant number LG-252291-OLS-22.

REFERENCES

- [1] Safinah Ali, Daniella DiPaola, Irene Lee, Victor Sindato, Grace Kim, Ryan Blumofe, and Cynthia Breazeal. 2021. Children as Creators, Thinkers and Citizens in an AI-driven Future. *Computers and Education: Artificial Intelligence* 2 (2021). <https://doi.org/10.1016/j.caeai.2021.100040>
- [2] Patricia Alves-Oliveira, Patricia Arriaga, Ana Paiva, and Guy Hoffman. 2017. YOLO, a Robot for Creativity: A Co-Design Study with Children. In *Proceedings of the 2017 Conference on Interaction Design and Children* (Stanford, California, USA) (IDC '17). Association for Computing Machinery, New York, NY, USA, 423–429. <https://doi.org/10.1145/3078072.3084304>
- [3] Teresa M. Amabile. 1996. *Creativity In Context: Update To The Social Psychology of Creativity*. Westview Press, Boulder, Colorado, USA. xviii, 317 pages.
- [4] John Baer. 1998. The Case for Domain Specificity of Creativity. *Creativity Research Journal* 11, 2 (1998), 173–177. https://doi.org/10.1207/s15326934crj1102_7
- [5] John Baer and James C. Kaufman. 2005. Bridging generality and specificity: The amusement park theoretical (APT) model of creativity. *Roeper Review* 27, 3 (2005), 158–163. <https://doi.org/10.1080/02783190509554310>
- [6] David Baidoo-Anu and Leticia Owusu Ansah. 2023. *Education in the Era of Generative Artificial Intelligence (AI): Understanding the Potential Benefits of ChatGPT in Promoting Teaching and Learning*. SSRN. <https://doi.org/10.2139/ssrn.4337484>
- [7] Albert Bandura. 1977. Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review* 84, 2 (1977), 191–215. <https://doi.org/10.1037/0033-295x.84.2.191>
- [8] Baptiste Barbot and Brianna Heuser. 2017. *Creativity and Identity Formation in Adolescence: A Developmental Perspective*. Elsevier Academic Press, San Diego, CA, US, 87–98. <https://doi.org/10.1016/B978-0-12-809790-0.00005-4>
- [9] Frank Barron and David M. Harrington. 1981. Creativity, Intelligence, and Personality. *Annual Review of Psychology* 32, 1 (1981), 439–476. <https://doi.org/10.1146/annurev.ps.32.020181.002255>
- [10] Ronald A. Beghetto. 2007. Ideational code-switching: Walking the talk about supporting student creativity in the classroom. *Roeper Review* 29, 4 (2007), 265–270. <https://doi.org/10.1080/02783190709554421>
- [11] Ronald A. Beghetto and James C. Kaufman. 2007. Toward a Broader Conception of Creativity: A Case for 'mini-c' Creativity. *Psychology of Aesthetics, Creativity, and the Arts* 1, 2 (2007), 73–79. <https://doi.org/10.1037/1931-3896.1.2.73>
- [12] Ronald A. Beghetto, James C. Kaufman, and Juliet Baxter. 2011. Answering the unexpected questions: Exploring the relationship between students' creative self-efficacy and teacher ratings of creativity. *Psychology of Aesthetics, Creativity, and the Arts* 5, 4 (2011), 342–349. <https://doi.org/10.1037/a0022834>
- [13] Erin Beneteau, Olivia K. Richards, Mingrui Zhang, Julie A. Kientz, Jason Yip, and Alexis Hiniker. 2019. Communication Breakdowns Between Families and Alexa. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (2019-05-02). ACM, Glasgow Scotland Uk, 1–13. <https://doi.org/10.1145/3290605.3300473>
- [14] Allen Bevans, Ying-Ting Hsiao, and Alissa Antle. 2011. Supporting Children's Creativity through Tangible User Interfaces. In *CHI '11 Extended Abstracts on Human Factors in Computing Systems* (Vancouver, BC, Canada) (CHI EA '11). Association for Computing Machinery, New York, NY, USA, 1741–1746. <https://doi.org/10.1145/1979742.1979838>
- [15] Michael Mose Biskjaer, Jonas Frich, Lindsay MacDonald Vermeulen, Christian Remy, and Peter Dalsgaard. 2019. How Time Constraints in a Creativity Support Tool Affect the Creative Writing Experience. In *Proceedings of the 31st European Conference on Cognitive Ergonomics* (BELFAST, United Kingdom) (ECCE '19). Association for Computing Machinery, New York, NY, USA, 100–107. <https://doi.org/10.1145/3335082.3335084>
- [16] Marion Botella, Franck Zenasni, and Todd Lubart. 2011. A Dynamic and Ecological Approach to the Artistic Creative Process of Arts Students: An Empirical Contribution. *Empirical Studies of the Arts* 29, 1 (2011), 17–38. <https://doi.org/10.2190/EM.29.1.b>
- [17] Emanuela Bran, Cosima Rughiniș, Gheorghe Nadoleanu, and Michael G. Flaherty. 2023. The Emerging Social Status of Generative AI: Vocabularies of AI Competence in Public Discourse. In *2023 24th International Conference on Control Systems and Computer Science* (CSCS). Institute of Electrical and Electronics Engineers, Bucharest, Romania, 391–398. <https://doi.org/10.1109/CSCS59211.2023.00068>
- [18] Daniel Buschek, Lukas Mecke, Florian Lehmann, and Hai Dang. 2021. Nine Potential Pitfalls when Designing Human-AI Co-Creative Systems. arXiv:2104.00358 [cs.HC]
- [19] Tara Capel and Margot Brereton. 2023. What Is Human-Centered about Human-Centered AI? A Map of the Research Landscape. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems* (2023-04-19). ACM, Hamburg, Germany, 1–23. <https://doi.org/10.1145/3544548.3580959>
- [20] Miguel A Cardona, Roberto J Rodríguez, and Kristina Ishmael. 2023. *Artificial Intelligence and the Future of Teaching and Learning*. Technical Report. U.S. Department of Education, Office of Educational Technology. <https://tech.ed.gov/ai-future-of-teaching-and-learning/>
- [21] Lorena Casal-Otero, Alejandro Catala, Carmen Fernández-Morante, Maria Taboada, Beatriz Cebreiro, and Senén Barro. 2023. AI Literacy in K-12: A Systematic Literature Review. *International Journal of STEM Education* 10, 1 (2023), 29. <https://doi.org/10.1186/s40594-023-00418-7>
- [22] Minsuk Chang, Stefania Druga, Alexander J. Fiannaca, Pedro Vergani, Chimay Kulkarni, Carrie J Cai, and Michael Terry. 2023. The Prompt Artists. In *Proceedings of the 15th Conference on Creativity and Cognition* (New York, NY, USA, 2023-06-19) (C&C'23). Association for Computing Machinery, New York, NY, USA, 75–87. <https://doi.org/10.1145/3591196.3593515>
- [23] Vicky Charisi, Laura Malinverni, Marie-Monique Schaper, and Elisa Rubegni. 2020. Creating Opportunities for Children's Critical Reflections on AI, Robotics and Other Intelligent Technologies. In *Proceedings of the 2020 ACM Interaction Design and Children Conference: Extended Abstracts* (2020-07-21) (IDC '20). Association for Computing Machinery, New York, NY, USA, 89–95. <https://doi.org/10.1145/3397617.3398063>
- [24] Nazli Cila. 2022. Designing Human-Agent Collaborations: Commitment, Responsiveness, and Support. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2022-04-29) (CHI '22). Association for Computing Machinery, New York, NY, USA, 1–18. <https://doi.org/10.1145/3491102.3517500>
- [25] Simon Colton, Amy Smith, Sebastian Berns, Ryan Murdock, and Michael Cook. 2021. Generative Search Engines: Initial Experiments. In *Proceedings of the Twelfth International Conference on Computational Creativity* (ICCC'21). Association for Computational Creativity (ACC), Virtual, 237–246. https://computationalcreativity.net/iccc21/wp-content/uploads/2021/09/ICCC_2021_paper_50.pdf
- [26] David De Cremer, Nicola Morini Bianzino, and Ben Falk. 2023. *How Generative AI Could Disrupt Creative Work*. Harvard Business Review. <https://hbr.org/2023/04/how-generative-ai-could-disrupt-creative-work>
- [27] M. Csikzentmihalyi. 2014. *The Wiley Handbook of Genius*. John Wiley & Sons, Inc., Hoboken, NJ, Chapter The Systems Model of Creativity and Its Applications, 533–545.
- [28] Nicholas Davis, Alexander Zook, Brian O'Neill, Brandon Headrick, Mark Riedl, Ashton Grosz, and Michael Nitsche. 2013. Creativity Support for Novice Digital Filmmaking. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Paris, France) (CHI '13). Association for Computing Machinery, New York, NY, USA, 651–660. <https://doi.org/10.1145/2470654.2470747>
- [29] Mandalit del Barco. 2023. *Striking Movie and TV Writers Worry That They Will Be Replaced by AI*. National Public Radio. <https://www.npr.org/2023/05/20/1177366800/striking-movie-and-tv-writers-worry-that-they-will-be-replaced-by-ai>
- [30] Stefania Druga. 2018. Growing up with AI: Cognimates : from coding to teaching machines. <http://hdl.handle.net/1721.1/120691>
- [31] Stefania Druga and Amy J Ko. 2021. How Do Children's Perceptions of Machine Intelligence Change When Training and Coding Smart Programs?. In *Proceedings of the 20th Annual ACM Interaction Design and Children Conference* (New York, NY, USA, 2021-06-24) (IDC '21). Association for Computing Machinery, New York, NY, USA, 49–61. <https://doi.org/10.1145/3459990.3460712>
- [32] Stefania Druga, Jason Yip, Michael Preston, and Devin Dillon. 2021. *The 4As: Ask, Adapt, Author, Analyze - AI Literacy Framework for Families*. MIT Press. <https://wip.mitpress.mit.edu/pub/the-4as/release/1>
- [33] Allison Druin. 2002. The role of children in the design of new technology. *Behaviour and information technology* 21, 1 (2002), 1–25. <https://doi.org/10.1080/01449290110108659>
- [34] Alessandro Duranti and Charles Goodwin. 1992. *Rethinking context : language as an interactive phenomenon*. Cambridge University Press, Cambridge [England].
- [35] Amanda Ford, Thomas Hainey, and Thomas Connolly. 2013. Using Scratch with Primary School Children: An Evaluation of Games Constructed to Gauge Understanding of Programming Concepts. *International Journal of Games-based Learning* 3 (2013), 93–109. <https://doi.org/10.4018/ijgbl.2013010107>
- [36] Scratch Foundation. 2019. *Scratch 3.0*. Scratch Foundation. <https://scratch.mit.edu/>
- [37] Jonas Frich, Lindsay MacDonald Vermeulen, Christian Remy, Michael Mose Biskjaer, and Peter Dalsgaard. 2019. Mapping the Landscape of Creativity Support Tools in HCI. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (Glasgow, Scotland Uk) (CHI '19). Association for Computing Machinery, New York, NY, USA, 1–18. <https://doi.org/10.1145/3290605.3300619>
- [38] Victor Galaz, Hannah Metzler, Stefan Daume, Andreas Olsson, Björn Lindström, and Arvid Marklund. 2023. AI Could Create a Perfect Storm of Climate Misinformation. (2023). <https://doi.org/10.48550/arXiv.2306.12807> arXiv:2306.12807 [cs]
- [39] Katy Ilonka Gero, Tao Long, and Lydia B Chilton. 2023. Social Dynamics of AI Support in Creative Writing. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2023-04-19) (CHI '23). Association for Computing Machinery, New York, NY, USA, 1–15. <https://doi.org/10.1145/3544548.3580782>
- [40] Mona Leigh Guha, Allison Druin, and Jerry Alan Fails. 2013. Cooperative Inquiry Revisited: Reflections of the Past and Guidelines for the Future of Intergenerational Co-Design. *International Journal of Child-Computer Interaction*

- 1, 1 (2013), 14–23. <https://doi.org/10.1016/j.ijcci.2012.08.003>
- [41] Suchin Gururangan, Ana Marasović, Swabha Swayamdipta, Kyle Lo, Iz Beltagy, Doug Downey, and Noah A. Smith. 2020. Don't Stop Pretraining: Adapt Language Models to Domains and Tasks. In *Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics*. Association for Computational Linguistics, Online, 8342–8360. <https://doi.org/10.18653/v1/2020.acl-main.740>
- [42] Idit Harel and Seymour Papert (Eds.). 1991. *Constructionism*. Ablex Publishing, Norwood, NJ.
- [43] Max Helfand, James C. Kaufman, and Ronald A. Beghetto. 2016. The Four-C Model of Creativity: Culture and Context. In *The Palgrave Handbook of Creativity and Culture Research*, Vlad Petre Glăveanu (Ed.). Palgrave Macmillan UK, Basingstoke, UK, 15–36. https://doi.org/10.1057/978-1-137-46344-9_2
- [44] Drew Hemment, Morgan Currie, Sj Bennett, Jake Elwes, Anna Ridler, Caroline Sindors, Matjaz Vidmar, Robin Hill, and Holly Warner. 2023. AI in the Public Eye: Investigating Public AI Literacy Through AI Art. In *2023 ACM Conference on Fairness, Accountability, and Transparency* (Chicago IL USA, 2023-06-12). Association for Computing Machinery, New York, NY, USA, 931–942. <https://doi.org/10.1145/3593013.3594052>
- [45] Beth A. Hennessey. 1995. Social, Environmental, and Developmental Issues and Creativity. *Educational Psychology Review* 7, 2 (1995), 163–183. <http://www.jstor.org/stable/23359325>
- [46] Clara E. Hill, Sarah Knox, Barbara J. Thompson, Elizabeth Nutt Williams, Shirley A. Hess, and Nicholas Ladany. 2005. Consensual Qualitative Research: An Update. *Journal of Counseling Psychology* 52, 2 (2005), 196–205. <https://doi.org/10.1037/0022-0167.52.2.196>
- [47] Thomas Hills. 2013. The Company That Words Keep: Comparing the Statistical Structure of Child- versus Adult-Directed Language. *Journal of Child Language* 40, 3 (2013), 586–604. <https://doi.org/10.1017/S0305000912000165>
- [48] Rowan T. Hughes, Liming Zhu, and Tomasz Bednarz. 2021. Generative Adversarial Networks–Enabled Human–Artificial Intelligence Collaborative Applications for Creative and Design Industries: A Systematic Review of Current Approaches and Trends. *Frontiers in Artificial Intelligence* 4 (2021), No Pagination Specified. <https://www.frontiersin.org/articles/10.3389/fraci.2021.604234>
- [49] Angel Hsing-Chi Hwang. 2022. Too Late to Be Creative? AI-Empowered Tools in Creative Processes. In *Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2022-04-28) (CHI EA '22). Association for Computing Machinery, New York, NY, USA, 1–9. <https://doi.org/10.1145/3491101.3503549>
- [50] Angel Hsing-Chi Hwang and Andrea Stevenson Won. 2021. IdeaBot: Investigating Social Facilitation in Human-Machine Team Creativity. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2021-05-07) (CHI '21). Association for Computing Machinery, Yokohama, Japan, 1–16. <https://doi.org/10.1145/3411764.3445270>
- [51] Nanna Inie, Jeanette Falk, and Steve Tanimoto. 2023. Designing Participatory AI: Creative Professionals' Worries and Expectations about Generative AI. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems* (Hamburg Germany, 2023-04-19). Association for Computing Machinery, New York, NY, USA, 1–8. <https://doi.org/10.1145/3544549.3585657>
- [52] James C. Kaufman and Vlad P. Glăveanu. 2021. *Creativity: An Introduction*. Cambridge University Press, New York, NY, USA, Chapter An overview of creativity theories, 17–30.
- [53] Vladimir T. Kudryavtsev. 2011. The Phenomenon of Child Creativity. *International Journal of Early Years Education* 19, 1 (2011), 45–53. <https://doi.org/10.1080/09669760.2011.570999>
- [54] Priya Kumar, Jessica Vitak, Marshini Chetty, Tamara L. Clegg, Jonathan Yang, Brenna McNally, and Elizabeth Bonsignore. 2018. Co-Designing Online Privacy-Related Games and Stories with Children. In *Proceedings of the 17th ACM Conference on Interaction Design and Children* (Trondheim, Norway) (IDC '18). Association for Computing Machinery, New York, NY, USA, 67–79. <https://doi.org/10.1145/3202185.3202735>
- [55] Irene Lee, Safinah Ali, Helen Zhang, Daniella DiPaola, and Cynthia Breazeal. 2021. Developing Middle School Students' AI Literacy. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education* (2021-03-05) (SIGCSE '21). Association for Computing Machinery, Virtual, 191–197. <https://doi.org/10.1145/3408877.3432513>
- [56] Calvin A Liang, Katie Albertson, Florence Williams, David Inwards-Breland, Sean A Munson, Julie A Kientz, and Kym Ahrens. 2020. Designing an online sex education resource for gender-diverse youth. In *Proceedings of the Interaction Design and Children Conference*. Association for Computing Machinery, New York, NY, USA, 108–120.
- [57] Frank R. Lilly. 2020. Creativity and Cognitive Development in Adolescence. In *The Encyclopedia of Child and Adolescent Development*. John Wiley & Sons, inc., Hoboken, NJ, 1–10. <https://doi.org/10.1002/9781119171492.wecad371>
- [58] Yuyu Lin, Jiahao Guo, Yang Chen, Cheng Yao, and Fangtian Ying. 2020. It Is Your Turn: Collaborative Ideation With a Co-Creative Robot through Sketch. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2020-04-23) (CHI '20). Association for Computing Machinery, New York, NY, USA, 1–14. <https://doi.org/10.1145/3313831.3376258>
- [59] Duri Long and Brian Magerko. 2020. What Is AI Literacy? Competencies and Design Considerations. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2020-04-23) (CHI '20). Association for Computing Machinery, New York, NY, USA, 1–16. <https://doi.org/10.1145/3313831.3376727>
- [60] Duri Long, Sophie Rollins, Jasmin Ali-Diaz, Katherine Hancock, Samnang Nuonsinoeun, Jessica Roberts, and Brian Magerko. 2023. Fostering AI Literacy with Embodiment & Creativity: From Activity Boxes to Museum Exhibits. In *Proceedings of the 22nd Annual ACM Interaction Design and Children Conference* (New York, NY, USA, 2023-06-19) (IDC '23). Association for Computing Machinery, New York, NY, USA, 727–731. <https://doi.org/10.1145/3585088.3594495>
- [61] Duri Long, Anthony Teachey, and Brian Magerko. 2022. Family Learning Talk in AI Literacy Learning Activities. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (New Orleans, LA, USA) (CHI '22). Association for Computing Machinery, New York, NY, USA, Article 226, 20 pages. <https://doi.org/10.1145/3491102.3502091>
- [62] Todd I. Lubart. 2001. Models of the Creative Process: Past, Present and Future. *Creativity Research Journal* 13, 3-4 (2001), 295–308. https://doi.org/10.1207/S15326934CRJ1334_07
- [63] Sze Yee Lye and Joyce Hwee Ling Koh. 2018. Case Studies of Elementary Children's Engagement in Computational Thinking Through Scratch Programming. In *Computational Thinking in the STEM Disciplines: Foundations and Research Highlights*, Myint Swe Khine (Ed.). Springer International Publishing, New York, NY, USA, 227–251. https://doi.org/10.1007/978-3-319-93566-9_12
- [64] Donald W. MacKinnon. 1966. What makes a person creative? *Theory Into Practice* 5, 4 (1966), 151–156. <https://doi.org/10.1080/00405846609542017>
- [65] James E. Maddux. 1995. *Self-Efficacy, Adaptation, and Adjustment: Theory, Research, and Application*. Springer, New York, NY, USA.
- [66] Marian Mazzone and Ahmed Elgammal. 2019. Art, Creativity, and the Potential of Artificial Intelligence. *Arts* 8, 1 (2019), 26. Issue 1. <https://doi.org/10.3390/arts8010026>
- [67] David G. Mehr and Phillip R. Shaver. 1996. Goal Structures in Creative Motivation. *The Journal of Creative Behavior* 30, 2 (1996), 77–104. <https://doi.org/10.1002/j.2162-6057.1996.tb00761.x>
- [68] Pekka Mertala, Janne Fagerlund, and Oscar Calderon. 2022. Finnish 5th and 6th Grade Students' Pre-Instructional Conceptions of Artificial Intelligence (AI) and Their Implications for AI Literacy Education. *Computers and Education: Artificial Intelligence* 3 (2022), 100095. <https://doi.org/10.1016/j.caeai.2022.100095>
- [69] Neema Moraveji, Jason Li, Jiarong Ding, Patrick O'Kelly, and Suze Woolf. 2007. Comicboarding: Using Comics as Proxies for Participatory Design with Children. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (San Jose, California, USA) (CHI '07). Association for Computing Machinery, New York, NY, USA, 1371–1374. <https://doi.org/10.1145/1240624.1240832>
- [70] Davy Tsz Kit Ng, Jac Ka Lok Leung, Kai Wah Samuel Chu, and Maggie Shen Qiao. 2021. AI Literacy: Definition, Teaching, Evaluation and Ethical Issues. *Proceedings of the Association for Information Science and Technology* 58, 1 (2021), 504–509. <https://doi.org/10.1002/prai2.487>
- [71] Donald A Norman. 1988. *The psychology of everyday things*. Basic Books, New York, NY, USA.
- [72] Donald A. Norman. 2002. *The Design of Everyday Things*. Basic Books, Inc., USA.
- [73] Peter Organisciak, Michele Newman, David Eby, Selcuk Acar, and Denis Dumas. 2023. How Do the Kids Speak? Improving Educational Use of Text Mining with Child-Directed Language Models. *Information and Learning Sciences* 124, 1/2 (2023), 25–47. <https://doi.org/10.1108/ILS-06-2022-0082>
- [74] Srishti Palani, David Ledo, George Fitzmaurice, and Fraser Anderson. 2022. "I Don't Want to Feel like I'm Working in a 1960s Factory": The Practitioner Perspective on Creativity Support Tool Adoption. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (New Orleans, LA, USA) (CHI '22). Association for Computing Machinery, New York, NY, USA, Article 379, 18 pages. <https://doi.org/10.1145/3491102.3501933>
- [75] Seymour Papert. 1980. *Mindstorms: Children, Computers, and Powerful Ideas*. Basic Books, Inc., USA.
- [76] Youngki Park and Youhyun Shin. 2019. Comparing the Effectiveness of Scratch and App Inventor with Regard to Learning Computational Thinking Concepts. *Electronics* 8, 11 (2019), 1269. Issue 11. <https://doi.org/10.3390/electronics8111269>
- [77] Christian Remy, Lindsay MacDonald Vermeulen, Jonas Frich, Michael Mose Biskjaer, and Peter Dalsgaard. 2020. Evaluating Creativity Support Tools in HCI Research. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference* (Eindhoven, Netherlands) (DIS '20). Association for Computing Machinery, New York, NY, USA, 457–476. <https://doi.org/10.1145/3357236.3395474>
- [78] Carl R. (Carl Ransom) Rogers. 1961. *On becoming a person: a therapist's view of psychotherapy*. Houghton Mifflin Company, Boston, MA, USA.
- [79] Elizabeth Rosenblatt and Ellen Winner. 1988. The Art of Children's Drawing. *Journal of Aesthetic Education* 22, 1 (1988), 3–15. <https://doi.org/10.2307/3332960>
- [80] Mark A. Runco and Nur Cayirag. 2012. The Development of Children's Creativity. In *Handbook of Research on the Education of Young Children*, Olivia N. Saracho and Bernard Spodek (Eds.). Taylor & Francis Group, London, UNITED

- KINGDOM, 102–114.
- [81] Pamela Samuelson. 2023. Generative AI Meets Copyright. *Science* 381, 6654 (2023), 158–161. <https://doi.org/10.1126/science.adi0656>
- [82] Advait Sarkar. 2023. Enough With “Human-AI Collaboration”. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems* (Hamburg Germany). ACM, New York, NY, USA, 1–8. <https://doi.org/10.1145/3544549.3582735>
- [83] Joon Gi Shin, Janin Koch, Andrés Lucero, Peter Dalsgaard, and Wendy E. Mackay. 2023. Integrating AI in Human-Human Collaborative Ideation. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2023-04-19) (*CHI EA '23*). Association for Computing Machinery, New York, NY, USA, 1–5. <https://doi.org/10.1145/3544549.3573802>
- [84] Ben Shneiderman. 2007. Creativity Support Tools: Accelerating Discovery and Innovation. *Commun. ACM* 50, 12 (dec 2007), 20–32. <https://doi.org/10.1145/1323688.1323689>
- [85] Ramya Srinivasan and Kanji Uchino. 2021. Biases in Generative Art: A Causal Look from the Lens of Art History. In *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency* (New York, NY, USA, 2021-03-01) (*FAccT '21*). Association for Computing Machinery, New York, NY, USA, 41–51. <https://doi.org/10.1145/3442188.3445869>
- [86] Ramya Srinivasan and Kanji Uchino. 2021. Biases in Generative Art: A Causal Look from the Lens of Art History. In *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency* (Virtual Event, Canada) (*FAccT '21*). Association for Computing Machinery, New York, NY, USA, 41–51. <https://doi.org/10.1145/3442188.3445869>
- [87] Ramya Srinivasan and Kanji Uchino. 2021. Quantifying Confounding Bias in Generative Art: A Case Study. [arXiv:2102.11957](https://arxiv.org/abs/2102.11957) [cs.CY]
- [88] Anselm L. Strauss. 1987. Qualitative Analysis for Social Scientists.
- [89] Jiahong Su and Weipeng Yang. 2023. Unlocking the Power of ChatGPT: A Framework for Applying Generative AI in Education. *ECNU Review of Education* 6, 3 (2023), 20965311231168423. <https://doi.org/10.1177/20965311231168423>
- [90] Jiahong Su and Yuchun Zhong. 2022. Artificial Intelligence (AI) in Early Childhood Education: Curriculum Design and Future Directions. *Computers and Education: Artificial Intelligence* 3 (2022), 100072. <https://doi.org/10.1016/j.caeai.2022.100072>
- [91] Minhyang (Mia) Suh, Emily Youngblom, Michael Terry, and Carrie J Cai. 2021. AI as Social Glue: Uncovering the Roles of Deep Generative AI during Social Music Composition. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2021-05-07) (*CHI '21*). Association for Computing Machinery, New York, NY, USA, 1–11. <https://doi.org/10.1145/3411764.3445219>
- [92] Mihaela Taranu, Marc Malmndorf Andersen, Anders Bo Bojesen, and Andreas Roepstorff. 2022. *Trust the Process: The Effects of Iteration in Children's Creative Processes on Their Creative Products*. American Psychological Association. <https://doi.org/10.1037/aca0000492>
- [93] Pamela Tierney and Steven M. Farmer. 2002. Creative Self-Efficacy: Its Potential Antecedents and Relationship to Creative Performance. *The Academy of Management Journal* 45, 6 (2002), 1137–1148. <http://www.jstor.org/stable/3069429>
- [94] Paul E. Torrance. 1967. *Understanding the Fourth Grade Slump in Creative Thinking. FINAL REPORT*. Technical Report. Institute of Educational Sciences. <https://eric.ed.gov/?id=ED018273>
- [95] David Touretzky, Christina Gardner-McCune, Fred Martin, and Deborah Seehorn. 2019. Envisioning AI for K-12: What Should Every Child Know about AI? *Proceedings of the AAAI Conference on Artificial Intelligence* 33, 01 (2019), 9795–9799. Issue 01. <https://doi.org/10.1609/aaai.v33i01.33019795>
- [96] Jessica Van Brummelen, Viktoriya Tabunshchik, and Tommy Heng. 2021. “Alexa, Can I Program You?”: Student Perceptions of Conversational Artificial Intelligence Before and After Programming Alexa. In *Proceedings of the 20th Annual ACM Interaction Design and Children Conference* (New York, NY, USA, 2021-06-24) (*IDC '21*). Association for Computing Machinery, New York, NY, USA, 305–313. <https://doi.org/10.1145/3459990.3460730>
- [97] Randi Williams, Hae Won Park, and Cynthia Breazeal. 2019. A Is for Artificial Intelligence: The Impact of Artificial Intelligence Activities on Young Children's Perceptions of Robots. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2019-05-02) (*CHI '19*). Association for Computing Machinery, New York, NY, USA, 1–11. <https://doi.org/10.1145/3290605.3300677>
- [98] Blake Williford, Samantha Ray, Jung In Koh, Josh Cherian, Paul Taele, and Tracy Hammond. 2023. Exploring Creativity Support for Concept Art Ideation. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems* (Hamburg, Germany) (*CHI EA '23*). Association for Computing Machinery, New York, NY, USA, Article 112, 7 pages. <https://doi.org/10.1145/3544549.3585684>
- [99] Gary K. W. Wong, Xiaojuan Ma, Pierre Dillenbourg, and John Huan. 2020. Broadening Artificial Intelligence Education in K-12: Where to Start? *ACM Inroads* 11, 1 (2020), 20–29. <https://doi.org/10.1145/3381884>
- [100] Yongmeng Wu and Nick Bryan-Kinns. 2017. Supporting Non-Musicians? Creative Engagement with Musical Interfaces. In *Proceedings of the 2017 ACM SIGCHI Conference on Creativity and Cognition* (Singapore, Singapore) (*C&C '17*). Association for Computing Machinery, New York, NY, USA, 275–286. <https://doi.org/10.1145/3059454.3059457>
- [101] Zhuohao Wu, Danwen Ji, Kaiwen Yu, Xianxu Zeng, Dingming Wu, and Mohammad Shidujaman. 2021. AI Creativity and the Human-AI Co-creation Model. In *Human-Computer Interaction. Theory, Methods and Tools. HCII 2021. Lecture Notes in Computer Science*, Masaaki Kurosu (Ed.). Springer International Publishing, New York, NY, USA, 171–190. https://doi.org/10.1007/978-3-030-78462-1_13
- [102] Ying Xu and Mark Warschauer. 2020. What Are You Talking To?: Understanding Children's Perceptions of Conversational Agents. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2020-04-23) (*CHI '20*). Association for Computing Machinery, New York, NY, USA, 1–13. <https://doi.org/10.1145/3313831.3376416>
- [103] Weipeng Yang. 2022. Artificial Intelligence Education for Young Children: Why, What, and How in Curriculum Design and Implementation. *Computers and Education: Artificial Intelligence* 3 (2022), 100061. <https://doi.org/10.1016/j.caeai.2022.100061>
- [104] Jason C. Yip, Frances Marie Tabio Ello, Fumi Tsukiyama, Atharv Wairagade, and June Ahn. 2023. “Money shouldn't be money!”: An Examination of Financial Literacy and Technology for Children Through Co-Design. In *Proceedings of the 22nd Annual ACM Interaction Design and Children Conference* (Chicago, IL, USA) (*IDC '23*). Association for Computing Machinery, New York, NY, USA, 82–93. <https://doi.org/10.1145/3585088.3589355>
- [105] Jason C. Yip, Kiley Sobel, Xin Gao, Allison Marie Hishikawa, Alexis Lim, Laura Meng, Romaine Flor Ofiana, Justin Park, and Alexis Hiniker. 2019. Laughing is Scary, but Farting is Cute: A Conceptual Model of Children's Perspectives of Creepy Technologies. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (Glasgow, Scotland UK) (*CHI '19*). Association for Computing Machinery, New York, NY, USA, 1–15. <https://doi.org/10.1145/3290605.3300303>
- [106] Jason C. Yip, Kiley Sobel, Caroline Pitt, Kung Jin Lee, Sijin Chen, Kari Nasu, and Laura R. Pina. 2017. Examining Adult-Child Interactions in Intergenerational Participatory Design. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (Denver, Colorado, USA) (*CHI '17*). Association for Computing Machinery, New York, NY, USA, 5742–5754. <https://doi.org/10.1145/3025453.3025787>
- [107] Chao Zhang, Cheng Yao, Jiayi Wu, Weijia Lin, Lijuan Liu, Ge Yan, and Fangtian Ying. 2022. StoryDrawer: A Child-AI Collaborative Drawing System to Support Children's Creative Visual Storytelling. In *CHI Conference on Human Factors in Computing Systems* (New Orleans LA USA, 2022-04-29). Association for Computing Machinery, New York, NY, USA, 1–15. <https://doi.org/10.1145/3491102.3501914>
- [108] Jing Zhou. 1998. Feedback Valence, Feedback Style, Task Autonomy, and Achievement Orientation: Interactive Effects on Creative Performance. *Journal of Applied Psychology* 83, 2 (1998), 261–276. <https://doi.org/10.1037/0021-9010.83.2.261>