Exploring the Impact of Human-AI Collaboration on College Students' Tangible Creation: Building Poetic Scenes with LEGO Bricks

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Abstract

This paper presents findings from an exploratory study investigating the impact of human-AI collaboration on the poetic and creative expression of college students. A preliminary study involved 22 undergraduate students, randomly assigned to two experimental groups tasked with creating LEGO structures based on their interpretations of poems during 3 consecutive sessions. One group utilized OpenArt, an AI image generation tool, as an aid, while the other did not. Our results indicate that the use of generative AI tools enhances confidence in the creative process. However, while AI tool elevate creative expression to a certain extent, they also impose constraints that limit further expansion. Based on our findings, we recommend exploring the impact of generative AI on broadening creative experiences of college students by fostering confidence, increasing playful creation opportunities, and providing comprehensive prompt engineering training for iterative use of generative AI to aid creativity and cognition.

Keywords

Human-AI Collaboration, Creative Expression, Generative AI Tools, Playful Creation, Tangible Play, LEGO

1. Introduction

In this paper, we explore elements of play and human-AI collaboration in creative expression among college students. Current research on creative and tangible play has largely concentrated on children[1, 2, 3]. Despite the well-established benefits of play in lifelong learning[4], the college student population has rarely been studied. In higher education, creativity is studied in the context of digital interaction and gamification[5], with limited emphasis on tangible play. Interestingly, stress among today's college students is closely related to the pervasive use of digital devices[6]. Recognizing the stress-alleviating potential of tangible play[7], our study aims to value the integration of tangible play experiences within higher education settings, particularly among undergraduate students.

In the area of human-AI creative collaboration, studies have explored tools fostering collaborative creativity between humans and AI[8, 9]. These tools enhance user engagement and influence perceptions of the creative process. In the context of more effective AI collaboration,

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researchers have provided guidelines for prompt engineering[10]. Our study extends this exploration by examining the impact of generative AI art on tangible creative experiences. We use LEGO bricks as the tangible components of our study because they are accessible to individuals with limited art and design experience. By offering alternative meanings in the creative process, LEGO bricks are also able to prompt individuals to produce visually stimulating representations that support divergent thinking [11].

We report findings from a study, which consists of three LEGO building sessions with 20 undergraduate students to explore the effects of generative AI on tangible creative processes. In the paper, we detail our methods, data analysis, and present our results. We also share recommendations, based on our findings, for expanding creative experiences with AI tools.

2. Related Work

While existing research has focused on human-AI collaboration in creative processes[8, 9], and roles of digital and tangible play in enhancing creativity and learning experiences[12, 13, 1], our study extends these investigations by furthering the focus to AI facilitation in the tangible creative process.

2.1. Human-AI Collaborative Creativity

Previous research has explored the development of tools aimed at fostering collaborative creativity between humans and AI, including drawing interfaces[8] and AI-to-human communication systems[9]. These studies indicate that co-creation with AI not only enhances user engagement but also influences perceptions of the creative process. In the realm of better collaboration with AI, specifically with generative art AI, researchers have synthesized guidelines for an improved prompt engineering approach[10]. Our study seeks to extend this exploration by examining the impact of generative art AI on specific creative tasks.

2.2. Tangible and Digital Play

When referring to tangible artifacts, we mean physical objects that can be interacted with in the real world, as opposed to virtual or digital objects. Both tangible and digital design tools enable individuals to externalize their ideas[14, 15]. By digitally augmenting play and integrating tangible elements like toys, individuals are more inclined to engage in exploratory activities and actively participate in storytelling experiences[16]. In the context of our study, we employ LEGO bricks as tangible elements for creative tasks. According toSutton-Smith, who challenges the widely-thought binary distinction between work and play, a toy like LEGO is actually an intellectual machine[17]. It is the process through which individuals create or build something using materials, involving the realization of ideas or strategies based on the inherent possibilities of the materials used[18]. Interactions with this system have demonstrated higher scores in divergent thinking, particularly in generating explanations and understanding various tasks[19]. This outcome is significant as divergent thinking serves as an indicator of one's creative potential that contributes to the enhancement of the overall creative process[20].

2.3. Visual-Poetic Narratives

Our study incorporates poetic elements into the creative process, leveraging neuroscience findings that underscore the power of poetry and poetic language as robust catalysts for creativity. Research indicates that poetry can elicit peak emotional responses, including aesthetic chills that engage the primary reward circuitry[21] and promote introspection[22]. We aim to explore the transformative process from textual to visual and tangible information, unlocking new meanings and narratives. This process fosters self-exploration and interpretations that blend individual and social, intimate and spatial dimensions, enabling individuals to cultivate a sense of agency within the creative framework[23]. Additionally, our study aligns with extensive research on poetry generation using various algorithmic methods[24, 25, 26]. Inspired by visual-poetic embedding models[27], which generate poetic language in response to images, our study explores the intricate dynamics between poems and visual imagery, influencing our understanding of the creative interplay between the two.

3. Goals and Research Questions

Our study aims to explore the influence of generative AI in facilitating creative expression within the context of constructing scenes from specific poetic sources using LEGO bricks. We aim to examine whether an AI intervention has impacts on individuals' creative LEGO building experiences. Our research questions is the following:
To what extent does the use of a generative AI tool facilitate individuals' creative expression, as measured by complexity of the constructed outcome, interpretation of their own work, and effectiveness of prompting strategies?
To address this question, we conducted a study in the form of LEGO building sessions involving participants, who are college students from various academic disciplines. Our objective was to gain insights into how students interpret poetic sources and engage with LEGO in their own way during the creative process.

4. METHODS

In this section, we describe various facets of our study design, including recruitment, training, study sessions, measures, and data analysis in our research.

4.1. Procedure

The study was conducted in an undergraduate liberal arts college setting, involving 22 undergraduate students with diverse academic backgrounds across three class years. The intervention comprised three sessions, each separated by 2-3 days. We utilized a non-consecutive intervention schedule within a repeated measures design to enhance participant engagement.

On day 1, all participants received brief training, including a 3-minute YouTube video produced by LEGO titled "Creative Storytelling" [28] and an introduction to the study, expectations, and session duration.

All study procedures for the control and treatment groups were identical, with the exception of the treatment group, where OpenArt, a platform that enables users to generate images based on inputted text or images, was used as an aid during the creation process.Participants in this group received a live demonstration of how to use the tool, including both text-to-image and image-to-image generation functionalities (see demo slides in Appendix). The prompt given to participants was open-ended ("You can use OpenArt whenever and however you want.") No specific details or hints were provided regarding when or at what stage the OpenArt tool should be utilized. This aims to observe the participants' usage patterns and thought processes during Human-AI collaboration in interpreting the poem and engaging in LEGO building.

The building session was conducted on intervention days 1, 2, and 3. In each LEGO building session, participants were presented with a distinct short poem: Nothing Gold Can Stay by Robert Frost (Day 1), Passing Time by Maya Angelou (Day 2), and Preludes by T.S. Eliot (Day 3). They were allotted 15 minutes to create a LEGO structure using LEGO® Classic Brick Sets. The building session was conducted in a group of 2-5. Following the building session, participants had 1 minute to verbally describe their LEGO structure in a voice recording. The prompts for the LEGO building session ("build a LEGO structure based on your interpretation of the poem, you have 15 minutes") and the recording ("You have 1 minute to describe what you just built") were intentionally open-ended to minimize constraints on creativity and interpretation of the poem.

4.2. Data Collection and Analysis

20 participants, including 10 from the control group (no AI) and 10 from the treatment (AI) group completed the study. Our data collection involved images of LEGO structures, counts of colors, block types, and the number of total block usage in each structure, and 1-minute audio recordings for each participant's constructions. The AI group additionally provided screenshots capturing interactions with OpenArt, including inputs and outputs.

4.2.1. Structural Complexity

In formulating the Structural Complexity (SC) metric for LEGO structures, we assigned weights to the key elements—total block usage, colors, and block types—based on their perceived contributions to structural complexity. Total block usage, assigned a weight of 1, reflects the basic size of the structure but is considered the least influential. Colors, with a weight of 2, contribute to visual intricacy, occupying a middle ground in significance. Block types, assigned the highest weight of 3, are deemed the most crucial as they necessitate diverse construction techniques. Therefore, we operationalized SC as

$$\mathrm{SC} = 1 \times \textit{total block usage} + 2 \times \textit{Colors} + 3 \times \textit{Block Types} \tag{1}$$

Through a weighted assessment of three LEGO structure aspects in our Structural Complexity (SC) metric, we acknowledge that the level of imagination and innovation in a LEGO structure involves more than just size. Rather, it includes diversity and ingenuity in design.

4.2.2. Participants' Narrative

Thematic analysis was applied to 1-minute recordings from 20 participants across all days to explore their emphasis during the building process—whether on interpreting the poem or focusing more on construction. Utilizing Otter.ai for transcription, the iterative process of coding and reviewing recorded data led to the development of granular codes by three independent coders. Collaboratively, these codes were integrated into cohesive themes during a joint review of transcripts. The finalized codebook was then employed to systematically code all transcripts, evaluating its effectiveness in aligning codes with the text using Excel.

4.3. AI Prompting Strategies

A similar qualitative analysis was conducted on participants' interactions with OpenArt. Prompts were manually transcribed from screenshots, and three coders independently developed granular codes. These codes were then collaboratively merged into themes during a joint review of transcripts. The finalized codebook was utilized for systematic coding of all transcripts, assessing its effectiveness in aligning codes with the text using Excel.

5. RESULTS

5.1. Structural Complexity

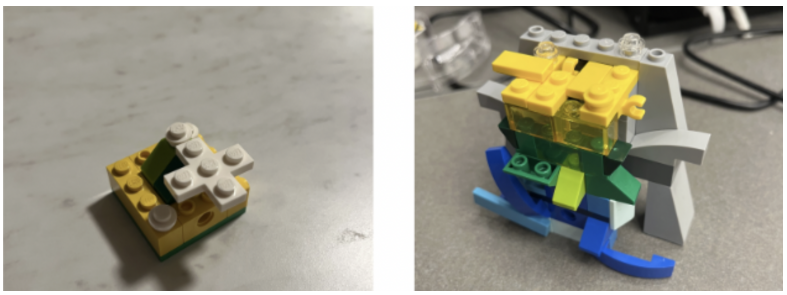

Figure 1: LEGO Creations for 'Nothing Gold Can Stay'. Left: Low structural complexity LEGO creation by P7 (no AI Group). Right: High structural complexity LEGO creation by P14 (AI Group)

Table 1
Comparison of no AI Group and AI Group Means with P-values

	No AI Group Mean (SD)	AI Group Mean (SD)	P-value
Session 1	78.55 (29.87)	107.91 (30.53)	0.04 *
Session 2	76.09 (27.45)	115.09 (47.72)	0.03 *
Session 3	103.73 (57.80)	109.82 (43.08)	0.72

For session 1, the Wilcoxon rank-sum test produced a statistically significant result (W = 28, p-value = 0.04), validating a structural complexity difference between participants solely

engaged in LEGO construction and the group utilizing generative AI assistance during LEGO building.

For session 2, the findings similarly show a significant difference between the groups. The Wilcoxon rank-sum statistic ($W = 27$, $p = 0.03$) substantiates a consistent difference in structural complexity between the two groups from the first session.

For session 3, however, results from the Wilcoxon rank-sum test indicated are not significant ($W = 54.5$, p-value $= 0.72$). This suggests there is no statistical difference between the groups regarding the structural features of LEGO building in the final session.

Combining data from all three sessions and examining the overarching trend, it becomes evident that the AI group exhibits a consistently higher baseline in structural complexity. This observation suggests that while the AI group starts with a higher baseline, the no-AI groups display a more consistent trajectory of improvement as the sessions progress. This dynamic may imply that while AI can elevate the baseline level of creativity to a certain extent, it concurrently imposes constraints that somewhat limit further improvement beyond that point.

It is crucial to note that these results should not be indiscriminately generalized to the broader concept of participants' creativity. There is a lack of direct implication from structural complexity to creativity, as creativity is a multifaceted construct encompassing various dimensions beyond mere structural intricacy. Instead, we employ structural complexity as a metric to assess how the integration of AI influences the creative efforts of college students. It serves as a quantitative measure offering insights into the impact of AI on the participants' creative endeavors within the specific context of LEGO construction under a short-term intervention.

5.2. Participants' Narrative

Throughout the sessions, we observed an increase in personal voice. At the end of the study, more than half of the participants in each group attributed a personal voice to their narratives. Some participants conveyed direct emotions toward their LEGO creation: "I'm actually pretty proud of this" (P9). Some participants expressed their opinions on the poem: "I like the last line [of the poem] about and then the lighting of the lamps" (P1). P6 was "inspired by the part where [the poem has] a contrast between light and dark". Some actively visualized the poem: P17 "imagined [the poem] as wintry neighborhood with a lot of newspapers in the ground". P2 and P22 further connected the poem to their personal memories: "I interpreted the poem as a cold winter day and a big city... [the poem] reminded me of the city where I live or just like any city in my country during winter" (P2); "[...]it's getting dark really early, but there's also a lot of like joy to be found in, like comfort and being at home, and like golden light" (P22). From these diverse expressions, we see the participants' engagement with both the poetic material and their personal experiences throughout the creative process.

Regardless of the use of AI, both groups emphasized on the creative process and how they carried out each decision. Some participants stated out loud their thinking process: P1 "wanted the gold to be in one specific section, and [wasn't sure] how to do it" (P1); P9 "switched [to] a more colorful look, [...] wanted to make [a flower]" (P9). Some participants present their reasoning behind certain characteristics of their LEGO creation. P8 "included [bright colors] to represent the flower, and [had] some yellow to represent gold" (P8). P14 "wanted [more stability] to the piece...so built [the LEGO] like a waterfall that was flowing from a rock structure out in

this path and passing of time" (P14). Across many participants' narratives, there is frequent use of orderly language to articulate their building process, suggesting the importance of decision-making in various creative processes, whether assisted by AI tools or not.

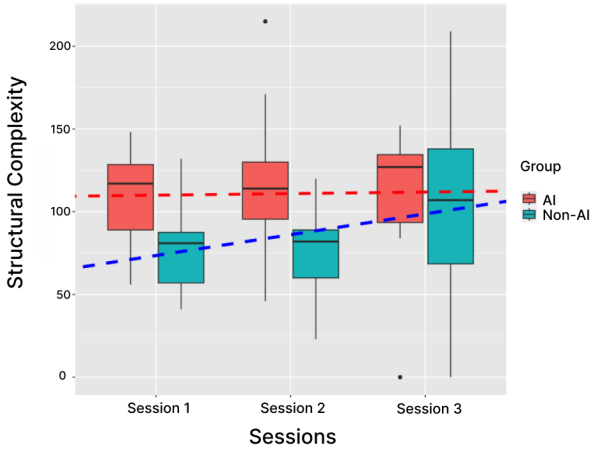

Figure 2: Structural Complexity Across Sessions

5.3. OpenArt Prompt Inputs

In this section, we present the analysis of participants' AI prompts, revealing two major prompting strategies and trends we observed.

5.3.1. Direct Input

More than half (20 out of 38 prompts) of the prompting inputs are whole poems, indicating that most participants simply copied and pasted the whole poem provided in digital format to OpenArt. Among those participants, many did not mention any of the AI work in their description of their LEGO work, which may indicate a perceived lack of usefulness or a tendency to refer to an AI-generated picture in their LEGO creative process.

Some other participants structured their prompts to seek an example or answer structure of the poem from OpenArt. For example, P13 prompted OpenArt with "Art having to do with the poem Passing Time by Maya Angelou" and "'Your skin like dawn Mine like musk One paints the beginning of a certain end. The other, the end of a sure beginning.' with Legos", directly seeking a sample visualization of the assigned poem from OpenArt.

In these cases, there was no evident personal interpretation in their prompting process, and none of these participants utilized the AI tool during the actual creative process. Instead, they solely used it for inspiration of the final structure.

5.3.2. Iteration

Three participants incorporated their interpretations of the poem into their interactions with OpenArt. For example, P22 opted for an exploratory approach by testing different phrases such as "Youth is fading, loss of innocence, time is passing," "Youth is fading, loss of innocence," and simply "aging." This nuanced method reflected their distinctive comprehension of key concepts within the poem. During the second session, P22 continued to refine their approach by extracting distinct themes like "parent and child relationship" from the poem. They prompted the tool twice with specific and slightly different keywords, aiming to enhance the AI-generated image. In the subsequent third session, P22 initially selected three keywords and later added "broken" as the fourth prompting word. Differently, P15 performed prompting iteration by inputting pictures of their incomplete LEGO structure, together with the entire poem, into OpenArt in the middle of their creation several times. They prompted OpenArt with their interpretation of the poem in the form of LEGO.

The distinct approaches by P22 and P15 collectively showcase the diverse ways participants infuse their personal interpretations into the artistic collaboration with OpenArt ranging from nuanced keyword selection to integrating tangible artistic expressions.

5.3.3. Prompting Strategies Trends Over 3 Sessions

The study reveals dynamic shifts in participants' AI utilization strategies across three sessions, indicative of evolving engagement with OpenArt. Specifically, Participants P12 and P21 refrained from utilizing OpenArt initially but adopted OpenArt in their later sessions' creative process with increased openness to AI.

Participants who inputted the entire poem into OpenArt consistently utilized the straightforward strategy across sessions. In contrast, those strategically using prompts, like P17 who selected keywords for specific visualizations, prompted the tool more frequently, resulting in enhanced iterations.

Moreover, participants in the AI group integrated their interactions with OpenArt into their narratives. Some found inspiration in the generated images: P18 was "influenced by the [OpenArt generated] pictures because [it] showed the street lamps...and [was] imagining that with hazy mist" (P18). Others, such as P13, actively used the output for guidance, searching for ideas directly related to LEGO bricks. However, there were instances where suggestions from OpenArt led to creative impasses: P13 "started to not know what to build anymore", but they eventually continued building based on newly generated outputs by OpenArt.

6. Discussion

6.1. Increased Building Proficiency

The increase in structural complexity (SC) scores is evident in both the control and AI groups. While SC is not inherently tied to creativity, our study highlights an enhanced proficiency in LEGO building across the three intervention sessions. The observed progress underscores the potential of tangible play in fostering the creative process for undergraduate college students. We therefore advocate for the integration of such activities into educational settings, recognizing

the potential of hands-on experiences in cultivating creative experiences, skills, and confidence among college students.

6.2. Creative Ownership and Agency

In our investigation of OpenArt usage, we noted an impact on participants' familiarity with generative AI. During the initial session, a participant unfamiliar with generative AI expressed discomfort and exhibited resistance to its integration into the creative process. In contrast, participants who are familiar with OpenArt went through multiple iterations, effectively refining their creative outputs. Furthermore, participants familiar with generative AI displayed a heightened engagement in cognitive processes. They actively interpreted poems, extracted keywords, and explored text-to-image and image-to-image generation, contributing to the iterative development of LEGO structures. Conversely, some participants opted for a more direct approach by copying and pasting entire poems into the AI tool, potentially impeding the cognitive aspects of the creative process.

We recommend a more in-depth prompt engineering instruction for human-AI collaboration during tangible creation. This demo should clarify the tool's potential, outline iteration processes, suggest optimal stages for usage to maximize cognitive engagement, and position generative AI tools as valuable aids in the creative process.

7. Limitation and Future Directions

7.1. Study Setting

There are several limitations in our study. First, the sample size was relatively small, comprising only 20 participants. Additionally, the study was conducted at a historically women's college in the United States, potentially limiting its generalizability to participants from a diverse genders. Additionally, due to resource constraints, we conducted sessions in groups of 2-5 participants, sharing one set of LEGO, which may have introduced influences or distractions during the individual LEGO building processes. Furthermore, all participants created based on the same set of poems during each session, which could have influenced one another's creations. Moreover, the complexity of the poems themselves might have impacted participants' building processes, as some poems may have been more conducive to construction than others.

7.2. Language Barrier

Our focus on building LEGO from poems in English may pose challenges for non-native English speakers. This linguistic diversity could impact their interpretation of the poem and their ability to articulate their thoughts within the one-minute time limit during the study sessions.

7.3. Creativity Measure

While the study mainly utilized the metric of SC for the discussion of creativity, it is important to acknowledge that SC can not directly capture creativity. Variation in the number of LEGO

shapes used, the number of LEGO colors utilized, and the total number of LEGO blocks employed to assess SC could be influenced by various factors beyond creativity, such as increased proficiency in LEGO building among participants across sessions and the length of the poem being interpreted. While employing individual sessions with randomized poem lengths can aid in lessening the impact of poem complexity, there remains a necessity to include broader scope of metrics to assess creativity more comprehensively. This could involve integrating participants' self-reported aesthetic mindset scores alongside expert evaluations regarding the alignment of participants' creations with the original poem.

7.4. Future directions

In this study, our main focus was on exploring the impact of human-AI collaboration on the poetic and creative expression of college students. To expand beyond the scope, we are motivated to explore the broader influence of generative AI on creative experiences, by looking at the connection between the sense of creative ownership and creators using AI tools. This can potentially be investigated through longitudinal studies that examine how the sense of ownership evolves in long-term creative practices. In addition, considering participants' different approaches to utilizing the AI tool, we are interested in studying more closely to inspect how the participants use the generated AI images in the physical construction process. Moreover, we are interested in taking a closer look at the emotional and aesthetic responses elicited among the creative individuals by the AI-generated content in creative collaboration. Evaluating how individuals connect emotionally with AI produced output can contribute to a more thorough understanding of the human-AI co-creative activities.

8. Conclusion

In this study, we explored the impact of human-AI collaboration on the poetic and creative expression of college students. A 3-step interaction involved 22 undergraduates, randomly assigned to two experimental groups tasked with creating LEGO structures based on their interpretations of poems. One group utilized OpenArt, an AI image generation tool, as an aid, while the other did not. Our results indicate that the use of generative AI tools enhances confidence in the creative process. However, while AI elevates creativity to a certain extent, it concurrently imposes constraints that limit further expansion. Based on our findings, we recommend exploring the broader impact of generative AI on creative experiences by fostering confidence, increasing playful creation opportunities for college students, and providing comprehensive prompt engineering training to maximize cognitive thinking when iterating with generative AI for enhanced creativity.

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A. Appendix

A.1. Poem 1: Nothing Gold Can Stay

Nature's first green is gold,
Her hardest hue to hold.
Her early leaf's a flower;
But only so an hour.
Then leaf subsides to leaf,
So Eden sank to grief,
So dawn goes down to day
Nothing gold can stay.

A.2. Poem 2: Passing Time

Your skin like dawn Mine like musk

One paints the beginning of a certain end.

The other, the end of a sure beginning.

A.3. Poem 3: Preludes

The winter evening settles down
With smell of steaks in passageways.
Six o'clock.
The burnt-out ends of smoky days.
And now a gusty shower wraps
The grimy scraps
Of withered leaves about your feet
And newspapers from vacant lots;
The showers beat
On broken blinds and chimney-pots,
And at the corner of the street
A lonely cab-horse steams and stamps.

And then the lighting of the lamps.

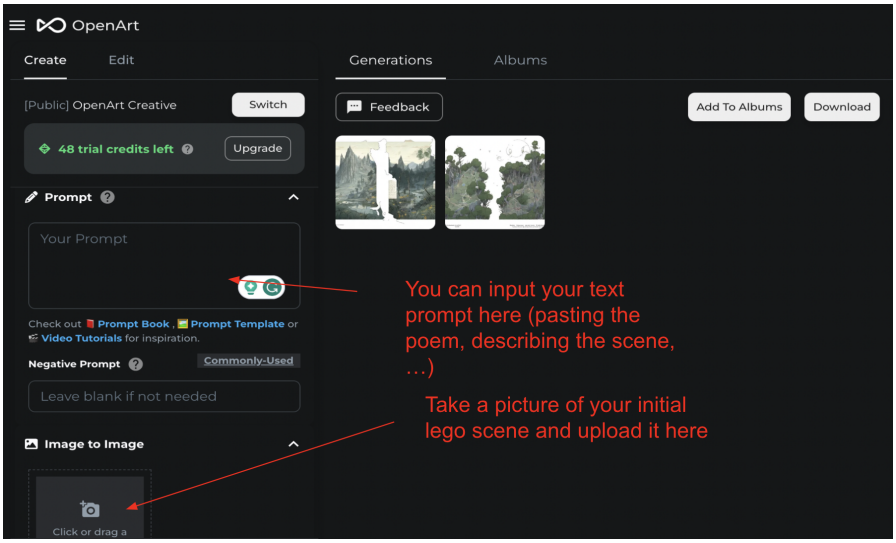

Figure 3: OpenArt Demo: Text-to-Image and Image-to-Image Generation