The Future of
Engineering Education
2024 Annual Conference & Exposition

Oregon Convention Center
Portland, OR . June 23 - 26, 2024

ASEE

Paper ID #42270

Designing with AI: Integrating Image-Generative AI into Conceptual Design in a CAD Class

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Does GAI enhance student design creativity?
Integrating image-generative AI into conceptual design in a CAD class

Abstract

The use of AI to generate images has sparked much debate among engineers and designers, but how it fits into teaching computer-aided design (CAD), especially in the conceptual stages of design, has not been closely examined. There is worry that generative AI (GAI) might negatively impact students' creativity. To explore this, we investigated how incorporating image-generative AI in the conceptual design phases of a CAD course affects creativity. We created a curriculum that includes an in-class workshop on using the Midjourney tool for design and a homework assignment where students use GAI to create a mood board for a practical design experience. This curriculum was tested with 20 students from a human-centered design department at a research-intensive university. To evaluate the impact of GAI on creativity, we compared student-created mood boards with and without GAI, which were evaluated by two design experts, and gathered their opinions on GAI and creativity through an open-text survey question. We also used a Creativity Support Index and interviews to get deeper insights into GAI's effect on their creative process. Most students felt that GAI enhanced their creativity via quick idea-to-image iterations in the design process, even though experts saw no significant difference in their artifacts. Additionally, while many found GAI enjoyable to use, they also felt it limited their ability to express their ideas fully. This study provides important insights into how GAI can be integrated into CAD education and implies future directions for AI-supported design tools.

Introduction

In today's educational settings, Generative AI (GAI) has had a significant influence on the fields of Science, Technology, Engineering, and Mathematics (STEM) education (Cooper, 2023). Among these technological advancements, text-to-text models like ChatGPT have been particularly prominent, as highlighted by Lo (2023). Furthermore, the impact of GAI extends into design and design education, where the advent of image-generative technologies such as Midjourney, DALL-E, and Stable Diffusion marks a significant shift (Burlin, 2023). These technologies not only streamline the design process but also make it easier for students to express their creative ideas visually, even if they lack traditional artistic skills (Hughes et al., 2021). GAI models allow designers to spot patterns and trends in their work, creating new designs and alternatives. This process helps them better understand design principles and improve their sense of aesthetics (Hashem & Hakeem, 2024). Given these advantages, there is a strong need for in-depth research into how image-generative AI can be effectively integrated into design education.

However, the swift advancement of text-to-image generative models introduces potential concerns and challenges for nurturing innovation and creativity in educational settings (Bozkurt et al., 2023). While some researchers view GAI as a fresh avenue for articulating design ideas and fostering creativity, others disagree. A primary concern is that most GAI systems are designed to replicate data from existing design spaces, which, although beneficial for ensuring realism and quality, may deter the generation of truly creative or unique designs (Vinchon et al., 2023). Additionally, the process of creating designs and artworks through GAI is often opaque, with creators not fully comprehending how their creations come to be generated (Rodriguez Maffioli, 2023). This "black-box" approach to creativity raises questions about the authenticity and originality of the output. Furthermore, studies (Smolansky et al., 2023) have observed a noticeable decline in using GAI, with students showing more reluctance than educators to accept these AI-generated prompts due to concerns over diminished creativity.

To address the lack of in-depth understanding of the impact of GAI usage on student creativity within design education, we conducted a field study with 20 students enrolled in a Computer-Aided Design (CAD) class within the human-centered design department of a research-intensive university. This study was initiated through a partnership between the course instructor and researchers, leading to the development of a workshop and a home assignment centered around using Midjourney (Midjourney, 2023), a leading image-generative AI tool. The workshop provided an in-class opportunity for students to familiarize themselves with GAI within a known educational setting. Then, the home assignment was

designed to encourage continuous engagement with GAI, integrating it into the conceptual design of their final course projects. The primary goal of this study was to delve into design creativity regarding the use of GAI for design, guided by specific research questions (RQs):

RQ1: Does GAI enhance student creativity in conceptual design?

RQ2: How does GAI influence student creativity in conceptual design?

To assess the impact of GAI on students' creativity, we applied several methods. Firstly, we gathered students' perspectives via an open-text survey questionnaire administered after the home assignment. Additionally, we analyzed the creative artifacts produced by the students for the assignment using the Consensual Assessment Technique (CAT), comparing their creativity levels of similar projects they completed one month before the workshop without using GAI. To delve deeper into GAI's effect on creativity, we employed the Creative Support Index (CSI) scale to gauge students' views across various dimensions. Interviews were also conducted to understand how students' interactions with GAI influenced their creativity. The findings from this study sparked discussions on integrating GAI into design education, offering valuable insights for educators and laying the groundwork for future advancements in GAI tool design.

This study offers several distinctive contributions: Firstly, we developed and implemented an integrated learning framework that included both a workshop and a home assignment, integrating GAI into the existing curriculum. Secondly, we investigated the impact of GAI integration into design education on students' creativity, examining their perceptions and the creative works they produced. Thirdly, we analyzed to understand the specific ways in which GAI affects students' creativity.

Previous studies
GAI in Design and Design Education

Generative AI (GAI) has significantly impacted the design field, primarily serving as a Creativity Support Tool (CST) that aids in ideation by retrieving, analyzing, suggesting, and combining existing relevant materials (Wan & Lum, 2023). Its influence extends across various domains; for instance, in architecture, GAI assists in devising innovative and functional layout plans for hospital operating departments (Zhao et al., 2023), and in the realm of educational facilities, it facilitates the generation of classroom layouts (Karadag et al., 2022). The fashion industry also benefits from GAI, with studies showing its transformative effect on design processes (Särmäkari & Vänskä, 2022). Furthermore, in user experience design, GAI plays a pivotal role in modernizing the design process, enhancing various stages from conception to completion (Houde et al., 2022).

In the context of design education, the adoption of GAI is recognized for its potential to enhance instructional methods and prepare both educators and policymakers for the future of learning, emphasizing a shift towards a more developmental role of education in the age of AI automation (Bahroun et al., 2023). Even though GAI technologies offer novel ways to produce creative digital content, impacting education areas such as music, animation, narratives, product design, fashion design, and visual arts (Kar et al., 2023), research on the application of image-generative AI lags that of text-generative AI, with a particular deficiency in comprehensive studies (Lee et al., 2023). One recent study (Lee et al., 2023) integrated GAI in classroom settings by running a workshop. However, taking the form of isolated workshops rather than fully integrated coursework overlooks two crucial aspects: first, the importance of integrated learning context for students to learn and use GAI naturally as a part of ongoing coursework; second, the necessity for students to engage in a thorough learning process with GAI tools by practicing on their own. Such learning context and process is crucial for students to fully comprehend and skillfully operate these technologies, which is a factor largely absent in previous studies. The applications of GAI tools in design education remain an underexplored area, highlighting the need for further research into their potential and challenges (Li & Zhang, 2023).

Creativity in Design Education

Design education views creativity as a complex concept that incorporates different viewpoints. Creativity is commonly understood to be the ability to identify or create something unique, new, or innovative (Adam, 2005). Some theories describe creativity as the generation of novel and original ideas

that bring about significant innovations (Sawyer & Henriksen, 2024), whereas others consider it as combining existing knowledge in innovative ways (Massaro et al., 2012). According to these varied perspectives, an object or idea is creative if it shows both newness or uniqueness (originality) and practicality or relevance (effectiveness) (Oppenlaender, 2022). The dual aspect of creativity—originality and usefulness—has been widely accepted in research because it allows the concept to be divided into two parts that can be measured. However, this approach focuses on the end product of the creative process, meaning that an object's creativity is judged based on the tangible result (Oppenlaender, 2022) and ignores the creation process. Recently, Ko et al. (2023) suggested that evaluating creativity in text-to-image generation projects requires evaluating the effectiveness of prompts in generating images, which reflects creative thinking.

Consensual Assessment Techniques (CAT) is a method to measure the creativity of artifacts. CAT has garnered significant attention in the realm of higher education for its efficacy in evaluating student learning outcomes, particularly in disciplines requiring qualitative assessment (Baer & McKool, 2009). Firstly introduced by Amabile (1982), it involves a structured process wherein multiple expert raters independently evaluate student work and subsequently engage in a consensus-building discussion to arrive at a shared assessment. This technique has been applied across various domains, including writing assessment (Huot, 1990), creativity assessment (Treffinger et al., 2002), and critical thinking assessment (Halpern, 1998). CAT has been instrumental in evaluating the originality and novelty of student-generated ideas across disciplines (Treffinger et al., 2002). These applications highlight the versatility and robustness of CAT as a method for assessing complex constructs in higher education.

Self-evaluation of creativity has been adopted to measure perceptions of the creation process, presenting individual differences in creative behavior (Reiter-Palmon et al., 2012). Individuals' self-assessments of their creative abilities provide valuable insights into their perceived strengths and weaknesses in generating novel ideas and solutions (Beghetto & Kaufman, 2009). The employment of self-report measures relies on two underlying presumptions (Reiter-Palmon et al., 2012). Firstly, it assumes that participants possess an understanding of the inquiries posed, whether they pertain to personality traits, values, or creativity. Secondly, it presupposes that participants are inclined to provide truthful responses. However, this exclusive reliance on self-reports may introduce biases attributable to various factors, such as social desirability and concerns regarding self-presentation (Silvia et al., 2012). Moreover, discrepancies often exist between self-perceived creativity and objective measures of performance, highlighting the complexity of assessing creativity through self-reports alone (Karwowski, 2014). Despite these limitations, self-reported creativity measures remain a valuable tool in research, offering a window into individuals' subjective experiences and perceptions of their creation process. Integrating self-reported data with other assessment methods can enhance the comprehensiveness and accuracy of measuring creativity in diverse populations and contexts.

Methods

This research employed a quasi-experimental case study, as it provides the researchers with the opportunity to engage in in-depth data collection (Creswell et al., 2007) in a concrete, real-life environment (Yin, 2017) and helps formulate concepts (Mahoney, 2010). A single case study was utilized. A quasi-experiment was applied in which student participants completed a design task without using GAI tools first, then they were given a workshop on GAI and completed a similar design task using GAI tools. In this section, we first introduce the study process, including tools, study context, participants, and procedures to give readers an overview. Next, we briefly describe how Consensual Assessment Technique (CAT) and open-texted survey questions were used to answer RQ1. Finally, we described how the Creativity Support Index and interviews were applied to answer RQ2.

Study Process and Participants

In this research, we used Midjourney via Discord as a GAI tool. Firstly, Midjourney is a Web-based tool with good user experience, especially for entry-level design students (Borji, 2022). Compared with another popular tool, stable diffusion, Midjourney is easier for a novice to learn and start. The features have been widely used by design students and professional designers (Caires et al., 2023). Compared to Dall-E,

which aims for a highly realistic look, Midjourney focuses more on incorporating different art styles (Thoring et al., 2023). Another reason for choosing Midjourney is that it records every prompt in the server, which allows researchers to understand how students use it. We created Discord accounts for students and subscribed them to the Midjourney one-month basic plan. Students were required to create their server so that their prompts could be recorded. Figure 1 is a screenshot of the Midjourney user interface.
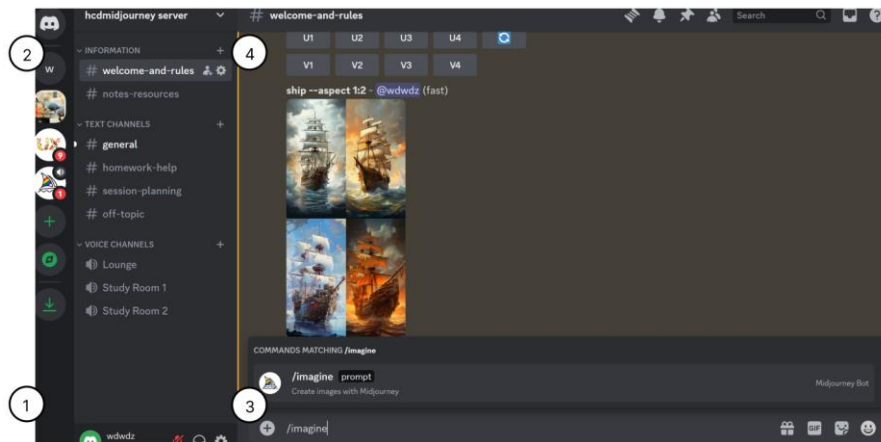

Figure 1. A screenshot of the Midjourney user interface. 1. Discord account; 2. Separate server; 3. Prompts input area; 4. Specific buttons.

The educational program included a workshop and a home assignment. As shown in Table 1, the educational program was co-designed with the course instructor. We chose mood board design as the take-home task. Mood boards are fundamental tools used in design education. The creation of mood boards involves cognitive processes in conceptual design and was used as not just a design tool but also a design research tool (Cassidy, 2011) for studying personal creativity (Mcdonagh & Storer, 2004; Lucero, 2012). Previous research has explored the use of GAI in mood board design, employing various tools like GANCollege (Wan & Lu, 2023), DesignAID (Cai et al., 2023), and Dream Studio (Lee et al., 2023). Here, students were tasked with creating mood boards using GAI as part of their process for conceptualizing and completing their final projects.

One month before the workshop, students already completed a mood board design without using GAI. In the workshop, a range of commonly used features of Midjourney were taught from basic to advanced levels. Each part included a 15-minute lecture followed by a 5-minute practice to complete a simple design task based on the lecture's content. After the workshop, all students were asked to complete a home assignment as a part of their course final projects. This home task required students to design a mood board for their final projects using at least eight images. At least four images must be generated via Midjourney. They are also encouraged to form their own workflows to complete the concept design via Midjourney.

Table 1. The educational program for the workshop

Part	GAI learning content	Design practice content
Introduction	GAI brief Midjourney setup	GAI in the design brief
Basics features	Prompts basics Blend	Generate an image via basic features
Main features	/settings, /describe Vary region, remix	Generate an image via the main features
Advanced prompts	Image prompts, multi prompts Parameters, styles	Generate an image via advanced prompts

Participants consisted of 20 college students (5 male, 15 female; mean age = 19; age range 18 – 22 years old) in a CAD course at a large U.S. university, who were informed of this research and gave us consent for participation. From the survey results before the study, 17 students had no experience using GAI in design, while three students had tried GAI features in Adobe Photoshop Beta, TikTok filters, or DALLE 2.0 but without much experience. Except for two students, the other 18 students used ChatGPT at least once a week for their general coursework. All students have learned CAD tools in this course, such as Adobe Photoshop, Illustrator, etc., for ten weeks.

Data Collection and Analysis for RQ1

To understand RQ1, whether GAI influenced students' creativity, we applied open-text survey questions and the Consensual Assessment Technique (CAT). After students completed the home task, we sent them an open-text survey question via Qualtrics: "Comparing your experience of creating a mood board with and without Midjourney (i.e., Project 1), to what extent and in which way do you feel Midjourney has influenced your creativity?" In the analysis, we grouped the answers based on their propensity and summarized the reasons.

Using the Consensual Assessment Technique (CAT), we engaged two experienced professors from the design department to assess the creativity of students' mood board designs with and without using GAI. They used a scale from 1.0 to 5.0, where 1 indicates a lack of creativity, and 5 signifies a high level of creativity. The instructions specified that they should rely on their professional judgment, developed over more than ten years of teaching design, to assess the creativity of each mood board compared to the others within the same group. It was important that they conducted their assessments independently, without being influenced by each other's ratings.

Data Collection and Analysis for RQ2

To understand RQ2 on how GAI influenced creativity, we mainly used the Creativity Support Index (CSI) and interviews. CSI is a self-reported quantitative psychometric tool designed to assess how well a digital tool supports creative processes (Cherry & Latulipe, 2014). It was developed to address the challenge of evaluating creativity support tools, considering creativity is not easily defined and measured. The CSI measures six dimensions of creativity support: Exploration, Expressiveness, Immersion, Enjoyment, Results Worth Effort, and Collaboration. In our study, we removed Immersion as the items in this dimension were irrelevant after reading by the researchers. The CSI has been utilized in studies with various creativity support tools, offering a structured way to understand and improve the creative capabilities of digital tools. We applied the Friedman test (Friedman, 1937) to analyze the survey data. We conducted pairwise Wilcoxon signed-rank tests (Woolson, 2007) to identify which dimensions were different. P-values were adjusted using the Bonferroni multiple-testing correction method. Kendall's W (Kendall & Smith, 1939) was used to measure the Friedman test effect size.

In addition, we interviewed to understand further how GAI influenced students' creativity. We sent interview invitations to all participants and received five voluntary interviewees (3 females and 2 males). Four interviewees expressed GAI enhanced creativity, while one did not in the open-text question. The interviews were conducted individually via ZOOM meetings. Before the interviews, all interviewees consented to the conversation being recorded. Each interview lasted from 15 to 20 minutes. In the first part of the interview, the interviewee was asked to recall their mood board design process based on their interactions with Midjourney. We then asked them whether and how Midjourney influenced their creativity, using questions like 'How do you feel when using Midjourney in design?' and 'Do you feel Midjourney increased your creativity?' The authors mainly used the constant comparative method (Glaser & Strauss, 2017) to generate insights presented in this paper. ZOOM transcribed the interview data automatically, and one researcher checked and completed nuanced and unclear parts in conversation contexts. Then, two authors did the first round of open coding of these transcripts by assigning codes to important instances in the interview questions. After that, two coders sat together and compared codes, then merged similar ones (different in wording) to a consistent name. The coders combined similar codes to generate common themes

such as "design iteration," "personalized images," "visualizing ideas," and "not following my mind." Finally, these themes were organized to answer RQ2.

Results

Response to RQ1

From the result of the open-text survey question focusing on participants' own assessments of creativity, a majority reported that using generative AI (GAI) improved their creativity in creating mood boards. Specifically, 17 out of 20 participants acknowledged the positive effect of using Midjourney on their creative abilities in mood board design. The benefits highlighted by participants centered on how GAI enhanced their creative process. Eleven participants mentioned that GAI helped them quickly transform their ideas into actual images, allowing them to compare and refine different concepts iteratively. Eight individuals noted that the tool expanded their creative possibilities by making it possible to convert vague ideas into concrete visual representations. They valued the tool's capability to generate images from text, create mood boards inspired by ideas they had not thought of themselves, and bypass their limitations in drawing skills. Five participants pointed out that Midjourney was particularly useful for visualizing concepts and merging images in unexpected ways, facilitating the creation of unique mood boards, enlarging their repository of images, and bringing their imaginative concepts to life.

However, three participants expressed concerns about the limitations of Midjourney. One participant mentioned that its impact on their creativity was minimal, pointing out that the tool needed a well-defined idea to generate good outcomes. Another participant emphasized the irreplaceable value of human design skills, noting that there are certain projects, especially those requiring conceptual diagrams on specific themes, that AI struggles to manage. Two individuals observed that the tool tended to produce complete images on its own, which, while it might accelerate the design process, diminished the opportunity for personal creative contribution and did not necessarily enhance their creative abilities.

In contrast to most students' perceptions regarding the enhancement of creativity through GAI, the design professor raters generally agreed that Midjourney had no impact on design creativity. Rater A assigned lower average scores (mean = 3.0) to students' mood board designs following the Midjourney workshop compared to before (mean = 3.3). Only 4 out of the 20 students' works were identified as exhibiting improvements in design creativity facilitated by Midjourney. Rater B assigned similar scores both before and after the workshop (M = 3.4), and 7 out of 20 students were recognized as showing enhanced creativity post-Midjourney training. In this example (Figure 2), both raters rated 4 for the mood board design, indicating no difference in the design creativity after using GAI.
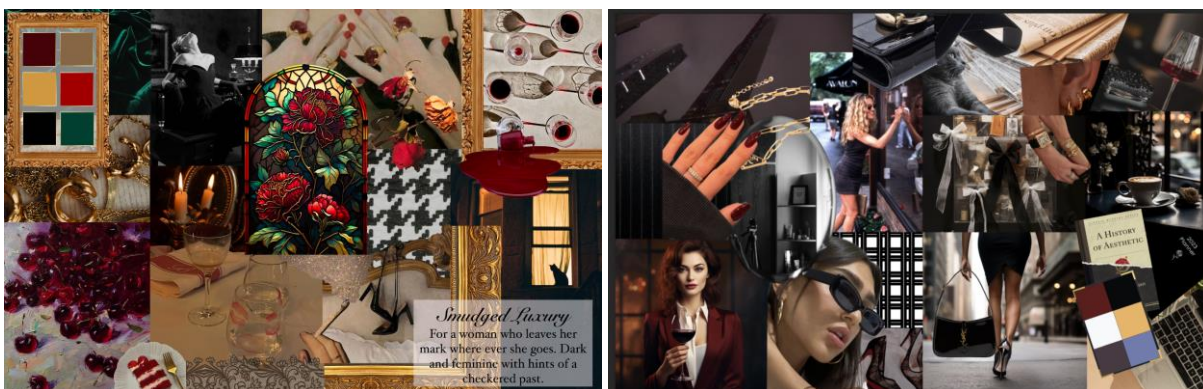

Figure 2. An example of two mood board designs by a student participant. Left: no GAI, Right: using GAI

Response to RQ2

We first coded an answer to 7-point Likert-type questions to ranking values (1-strongly disagree; 7-strongly agree). Then, we calculated the median and IQR for each CSI dimension to understand students' perceptions of creativity support in summary. We conducted the Friedman test to understand whether the

perceptions were different. In addition, we calculated Kendall's W to measure the effect size. We also did Paired Wilcox tests to understand the difference between each two dimensions and further to understand the effect of workshop and home tasks. The results are presented in Table 2.

In general, students expressed high levels of positive perception on each dimension (median = 6 means agree with the statement of the GAI's role in creativity support). The Friedman test showed significant small differences among all dimensions. Paired Wilcox tests further compared perceptions between each of the two dimensions. There is a significant difference between perceived expressiveness and enjoyment. This indicates that students perceived GAI more on enjoyment support and less on expressiveness support.

Table 2. CSI dimensions statistics

	N	Median	IQR	Friedman	Wilcox
Collaboration	20	6	1	F = 10.9*	Expressiveness
Enjoyment	20	6.5	1	W = 0.13	and Enjoyment*;
Exploration	20	6	0.5		Other pairs ns
Expressiveness	20	5.75	0.5		
Results worth effort	20	6	0.125		

*Note: *<0.05, W<0.3 small effect*

The interviews provided additional insights into how Midjourney impacts creativity. Generally, it was regarded as a beneficial tool for boosting creativity in mood board design despite some challenges in precisely capturing the users' intentions. P2, P3, P4, and P5 appreciated its ability to broaden their creative horizons by facilitating the creation of custom images and encouraging more imaginative thinking through the use of specific prompts. The images created with Midjourney served as a source of inspiration during the conceptual design phase, further underlining its value in enhancing creativity. For example, P3 and P5 stated:

"I feel like Midjourney has allowed me to tap into ideas that I didn't know would fit within the parameters of my mood board and allows me to extend my bubble…(P3)."

"It allows me to look at my own work in a different way and draw inspiration from things I was not thinking about…(P5)."

Furthermore, the ability to quickly produce high-quality images supports the brainstorming process. By tweaking the generated images, participants felt like they were creating something new. Both participants P4 and P3 highlighted how features that allow for gradual changes to images, such as "remix" and "variation," aided them in improving their creations through iterations. For example, as P4 mentioned,

"I think Midjourney aided me in the initial brainstorming phase of the design process, helping me visualize some of the ideas I had quickly… It then reminded me of some new ideas, and I changed the images with additive prompts (P4)"

Similarly, P3 also said, *"It is very automated and brings visuals to life within seconds…I used the 'remix' feature to change the images locally, back and forth, to finally achieve what I want."*

Nevertheless, P1 expressed reservations, perceiving a discrepancy between the tool's workflow and its ability to resonate with personal creative processes:

"I don't think Midjourney has really influenced my creativity…I enjoyed being able to see ideations of my thoughts without having to create them first…(P1)."

P2, P3, and P5 also mentioned that sometimes Midjourney did not generate something they wanted even after several rounds of iterations, and they felt frustrated when it happened.

Discussion

This study investigated how students perceive generative AI (GAI) for designing mood boards in a computer-aided design (CAD) course regarding design creativity. Specifically, we introduced a workshop and a homework assignment that incorporated the GAI tool Midjourney into the students' final CAD projects, aiming to teach 20 students how to use GAI in conceptual design. Through surveys and interviews, we examined students' creativity in the mood board design process and the final products, comparing them to those created without GAI. Our findings revealed that most students (17 out of 20) believed GAI boosted their creativity, although expert evaluations of their works did not reflect this. Additionally, we noted that students found using GAI more enjoyable for design tasks but felt it limited their ability to express themselves fully. They stated that they achieve creativity through iteratively interacting with prompts and generated images. In this section, we delve deeper into how GAI impacts creativity and suggest a new interface design aimed at further enhancing design creativity.

GAI Increases Creativity in the Process, not in Products

The apparent discrepancy in our results regarding the impact of generative AI (GAI) on creativity resonates with Oppenlaender's (2022) perspective that in text-based generative art, creativity is not solely found in the final digital image. Instead, it arises from the ongoing interaction between humans and AI, such as through prompt engineering. This suggests that humans initiate the creative process, but the AI system contributes its own inputs, requiring individuals to continually adjust their approach to guide the system toward meeting their creative goals and needs (Audry, 2021). In practical terms, this dynamic interaction often involves refining text prompts and selecting or modifying generated images as part of an iterative process.

The idea of evolutionary creativity, first introduced by Simonton in 1999, is particularly intriguing. Thoring and Muller expanded on this concept within design contexts in 2011, and its integration with generative AI (GAI) components has been further developed by Thoring and others in 2023. Evolutionary creativity in design is based on two key processes: "Variation" and "Selection." Variation refers to the creation of new ideas through techniques such as "mutation" or "recombination," like mixing existing designs in new ways to produce original designs. Modern technology is adept at creating a wide range of variations through random mutations and combining elements of existing designs. However, it struggles with more advanced tasks like extending beyond current design parameters or combining different design elements to create completely new ideas. Creativity in this context is realized by repeatedly applying "variation" and "selection" to refine and choose the best ideas.

Implications: Process Management Space to Enhance Creativity

The findings from our study led us to suggest a new user interface for generative AI (GAI) tools to foster creativity in design education. Presently, most GAI applications offer a basic generation space where users can input prompts in various forms, such as text, images, or a combination of both, along with options to adjust prompt weights, settings, styles, and other parameters. Following the input, the system generates several images (for example, Midjourney produces four images based on the prompt). However, these applications lack a dedicated area for organizing and managing prompts and the resulting images. Such a feature is crucial for the design iteration process, where the ability to refine and experiment with different prompts and images plays a significant role in enhancing creativity.

In Figure 3, we introduce a design for an interface that incorporates a management space, allowing for improved organization and tracking of prompts and the history of generated images. Within this management area, both the prompts and their corresponding images will be documented and displayed. This setup enables the images generated from prompts to be reused in subsequent variation cycles, facilitating an iterative process that continually refines and develops the design concepts. Additionally, this management space offers a platform where instructors and fellow students can engage in the selection of images and prompts, providing a valuable opportunity for design critique and collaborative learning.

Figure 3. An interface design of how management space interacts with generation space to better enhance design creativity.

Conclusions and Limitations

In this study, we developed a workshop and home task for integrating GAI into a CAD course. We found that the students have positive perceptions of GAI's influence on creativity, mainly via the design process of iteratively interacting with prompts and images. While their artifacts were not rated as more creative. This result led to further discussion on product and process creativity, and we proposed an interface design for prompt management to achieve evolutionary creativity.

This study has several limitations that must be considered when interpreting the results. These limitations stem from the exploratory nature of the research, the sample size, and the variables examined in the study. First, the exploratory approach employed in this research indicates that the results are preliminary and may require more accurate exploration and recursive processes. While the approach is valuable for an initial understanding of the problem and identifying potential relationships among variables, future research should employ more robust research designs, such as random experimental designs, to confirm the findings and better understand the causal relationships among variables. The sample size of 20 students may be another concern, and more evidence needs to be collected in future studies.

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