INFLUENCE OF IMAGE STIMULI ON DESIGN CREATIVITY: EXPLORATION OF GENERATIVE AI IN GROUP IDEATION

Zhengya GONG[1,2], Mengru WANG[2], Sohail Ahmed SOOMRO[2], Siiri PAANANEN[1], Petra NURMELA[1], Jonna HÄKKILÄ[1] and Georgi V. GEORGIEV[2]
[1]University of Lapland, Finland
[2]University of Oulu, Finland

ABSTRACT

With the rapid advancement of AI in design, researchers have proposed that generative AI can enhance human creativity in design, particularly through AI-generated images as stimuli. To explore this, we conducted an exercise in a creative design course. The exercise began with an introduction to creative methods, followed by group ideation using a collaborative sketching method. Each participant then received an AI-generated image stimulus tailored to the design task. Finally, participants developed their best ideas and reflected on the process. The reflections were analysed alongside evaluations of the final ideas by external evaluators, who assessed the novelty and usefulness of 18 best ideas and determined their sources of inspiration. Results revealed that participants generally viewed the AI-generated image stimuli as unhelpful or irrelevant for ideation. Evaluators found that group collaboration significantly contributed to the best ideas, while AI-generated stimuli played a minimal role. These findings underscore the critical role of human interaction in collaborative ideation and suggest that AI tools, while promising, require further refinement to support creativity in group settings effectively.

Keywords: Image stimuli, generative AI, design creativity, ideation exercises

1 INTRODUCTION

Creativity is at the heart of design, driving innovation and problem-solving by generating novel and valuable ideas [1]. Stimuli are essential in this process, providing external triggers that inspire ideation and support creative exploration [2,3]. With the rise of artificial intelligence (AI), generative tools have emerged as transformative assets for enhancing creativity, offering dynamic and diverse stimuli that can reshape traditional ideation processes [4–6]. AI-generated visual stimuli, in particular, hold the potential to influence design creativity. However, research into the specific impact of AI-generated visual stimuli on design creativity remains limited, especially in collaborative contexts.

This paper investigates the role of AI-generated visual stimuli in group ideation, focusing on their ability to enhance design creativity. By examining how these stimuli influence the novelty and usefulness of ideas, this study contributes to a deeper understanding of AI's potential and limitations in design processes. It provides actionable insights for integrating AI tools into creative practice. The subsequent sections of this article will be presented in the following manner. Section 2 provides a background for the current study. Section 3 details the methodology, including the design and implementation of the experiments conducted. Section 4 presents the results, providing an in-depth analysis of the data collected. In Section 5, we delve into a discussion of the findings, highlighting key insights. Finally, Section 6 concludes the paper by summarising the main contributions, addressing study limitations, and proposing directions for future research on AI-assisted design.

2 AI FOR DESIGN CREATIVITY ENHANCEMENT

Design creativity is a cornerstone of innovation, enabling designers to generate novel and impactful solutions, which was defined as "a process by which an agent uses its ability to generate ideas, solutions or products that are novel and useful" [8]. Stimuli play a crucial role in enhancing design creativity by serving as prompts that inspire new ideas and perspectives [2,7,9]. Visual stimuli, in particular, have been extensively used in design processes to inspire ideation, reduce cognitive fixation, and foster

originality [10]. These stimuli can take many forms, such as sketches, photographs, or digital images, providing designers with a reference or departure point for enhancing design creativity.

With the rapid development of AI, it become a versatile tool for enhancing design creativity across domains [5,11–14]. AI's potential in enhancing design creativity has become an exciting focus of exploration [5,6,13,15]. Generative AI, in particular, has introduced new possibilities for producing dynamic and diverse stimuli, which can be integrated into design ideation processes [11,15,16]. For example, researchers explored how simple text stimuli generated by ChatGPT could be used as an inspiration in ideation, which assisted students to develop their ideas [15]. These AI-generated stimuli provide designers with unexpected combinations and novel interpretations that might be able to challenge traditional thought patterns and stimulate innovative solutions. In group ideation, AI serves as a collaborative partner, offering prompts that encourage exploration, and refinement of ideas [11].

However, there remains a gap in understanding how AI-generated visual stimuli influence design creativity. This is especially relevant in group ideation, where the interplay between human creativity and AI-generated inputs can yield unique insights. Therefore, the research aim of the current study is to explore and evaluate the impact of AI-generated image stimuli on design creativity in group ideation. By investigating this intersection, the research aims to provide valuable contributions to both the theoretical understanding and practical application of AI in design creativity.

3   METHODS

3.1 Participants

Approximately 30 participants, enrolled in master's or PhD programs across various disciplines, such as engineering, took part in the exercise. However, some participants did not complete the exercise; therefore, they were excluded from the analysis. Therefore, only 18 participants were included. The participants had an average age of 25.06 years (SD = 2.64). Among them, two participants identified as female, two preferred not to say, and the rest of 14 participants, identified as male.

3.2 Task and material used

The task in the exercise is to design an inclusive playground structure for children with disabilities who use a wheelchair. Such play areas might suit wheelchair access and various children's age groups. The playground might be of any type, indoor or outdoor. Moreover, we requested images from AI image generators, such as Dall-E and Midjourney, to generate images for the same task (the prompt is the task description). The images were used as stimuli to identify the influence of AI-generated images on ideation and design creativity (Figure 1).

Figure 1. Examples of AI-generated image stimuli

3.3 Procedure

At the beginning of ideation, the instructors randomly assigned the image stimuli generated by the AI tool to participants, as illustrated in Figure 2. Each participant had a different image stimulus. Then, the instructor explained the Collaborative Sketching method and ensured all participants understood its application thoroughly. Three participants as one group were then tasked with utilising this method to generate ideas about the mentioned task, which involved three key steps (Figure 2): 1) Sketching: Each participant sketches and annotates three ideas on paper using different pen colours for differentiation (10 minutes); 2) Sharing: Participants pass their forms to another team member for further input. The team members freely add relevant sketches or annotations to others' forms (10 minutes x 2) and 3) Developing: Each participant selects one idea from their form and further develops it into what they consider the best idea (10 minutes).
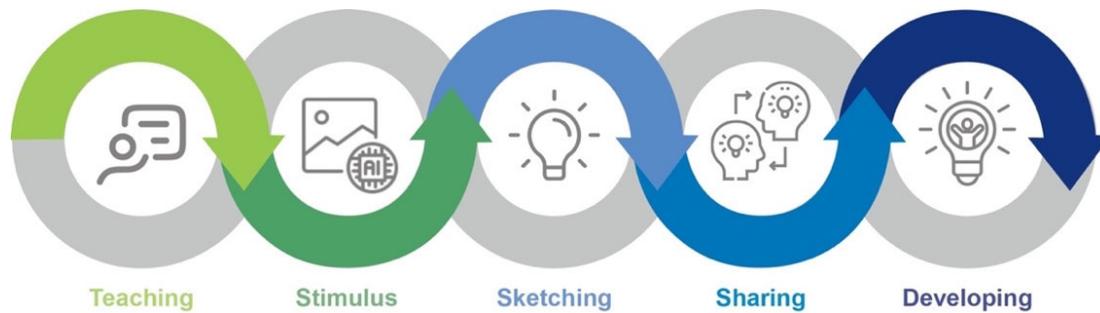
Figure 2. Procedure of the class exercise

3.4 Measurement

We recruited another group of master's students from a different university as evaluators to evaluate the design creativity of the final ideas that each participant developed and selected as their best ideas. Moreover, they were also invited to evaluate the source of the contribution, such as from group members or image stimulus, by reviewing all worksheets. Furthermore, we collected participants' reflections on the exercise and attempted to obtain clues regarding the influences in the ideation process.

3.4.1 Source of contribution

Six evaluators evaluated the source of the final ideas; each evaluator evaluated six ideas, and each final idea got two evaluations. First, they were asked to review all worksheets and materials used and obtained from the exercise, such as the image stimulus, the group worksheets and the final idea. Then, they had to evaluate the source of the contribution of the final ideas, either from the group members, the image stimulus, both of them or neither of them. When a final idea obtained evaluations from two evaluators, the instructor (first author) evaluated the idea to ensure the source of the contribution of the idea.

3.4.2 Design creativity

The evaluators were also invited to evaluate the design creativity of the final ideas from two perspectives, novelty and usefulness, from 1 (low) to 5 (high). Before the evaluation, they were introduced to the concept of design creativity and participated in an exercise as training, including idea generation and evaluation. That means they were clear on how to evaluate an idea's design creativity. In addition, the instructor also evaluated all final ideas, and we measured the correlation between the three evaluations of ideas, reported in Section 4.

3.4.3 Reflections of participants

The reflection that each participant provided underwent thorough analysis through a multi-step approach. This involved iterative readings, coding, and categorising data extracts, followed by restructuring organised data under thematic headings. A thorough examination was carried out to carefully select specific themes from the data, which were subsequently subjected to comprehensive comparison and scrutiny. Consequently, the data was systematically organised into four thematic categories: role of AI-generated visual stimuli in ideation, role of group members in ideation, influence of group ideation methods, and other thoughts and reflections, which were discussed in Section 5.

4 RESULTS

We first measured the correlation between three evaluations of the final ideas, then we counted the number of the final ideas inspired by group members, and visual stimuli from two metrics of design creativity. In addition, we reviewed the documentation that they updated as their reflections.

4.1 Correlation between evaluations

Kendall's W was run to determine if there was an agreement between three evaluations of the final ideas. The level of novelty and usefulness amongst the 18 patients who were rated was determined according to a 5-point from 1 (least) to 5 (most). The three evaluations statistically significantly moderate agreed in their evaluations [17], $W = .532$, $p = .014$.

4.2 Novelty and usefulness contribution
To address the novelty dimension of design creativity, evaluators identified six final ideas as primarily inspired by group members, one idea as originating from the visual stimulus, two ideas as influenced by a combination of group collaboration and visual stimuli, and nine ideas as derived from the participants' initial ideas (Table 1). Regarding the usefulness dimension, fourteen ideas were attributed to contributions from group members, two ideas were influenced by both group members and the visual stimulus, and two ideas emerged without any discernible input from these sources, as shown in Table 1. In addition, there was no difference in the novelty and usefulness scores in the four contribution sources.

Table 1. Novelty and usefulness contribution

Source of contribution	Group members	Visual stimulus	Both of them	None of them	Total
Novelty	6	1	2	9	18
Usefulness	14	-	2	2	18

4.3 Refection of ideation
We collected 15 instances of reflective documentation from 18 participants, while the other 3 individuals just submitted their worksheets without including any thoughts on the exercises. Among the 15 documentations, approximately half the participants (8) mentioned the visual stimuli in their reflection, with the majority expressing the visual stimuli as an inspiration for generating ideas is meaningless, and only one participant expressed that the visual stimulus helped him to recall his memory. More than two-thirds of the participants (11) expressed their gratitude to their group members and expressed how their ideas were developed and improved by group members. In addition, 10 participants also mentioned that the group ideation method helps them to have a fun and instructive exercise.

5   DISCUSSIONS
5.1 Role of AI-generated visual stimuli in Ideation
Students expressed negative opinions about using AI-generated visual stimuli to inspire playground designs, particularly those aimed at inclusivity for children with disabilities. Most of the participants felt the images lacked real-world relevance or did not align with the specific design requirements. For instance, one student described an AI-generated stimulus he got that seemed tailored more for able-bodied children and struggled to relate it to accessible playground features. Another participant pointed out that AI-generated designs sometimes appeared limited in creativity, as they didn't address complex, real-world problems as effectively as human creativity might. The AI images sometimes inspired alternative interpretations, leading to novel ideas like wheelchair-accessible merry-go-rounds or custom wheelchair sports equipment. However, the consensus seemed to be that, while AI-generated visuals could occasionally spark new ideas, they were not as inspiring or practical as direct human-centred brainstorming for inclusive design. In addition, our findings revealed that only 6 out of 18 final ideas benefitted from the generative AI image stimuli. In terms of novelty, one final idea drew inspiration solely from the visual stimulus, while two ideas were enhanced by both group input and the visual stimulus. Regarding usefulness, only two ideas benefited from both group members and the visual stimulus. These results suggest that generative AI may have a limited capacity to enhance design creativity through the images it generates.

5.2 Role of Group Members in Ideation
The students highlighted how group collaboration added substantial value to the ideation process. Many participants noted that input from team members encouraged them to refine, enhance, or rethink initial concepts. One student, for instance, described how a team member's suggestion of incorporating a vertical adjustment feature for wheelchair-bound children added an interactive layer to their merry-go-round design. Another participant shared that feedback about safety considerations, such as adding a net around a sports area, improved the practicality and inclusiveness of their design. A few students reflected on the challenges of balancing conflicting ideas within their groups, though they generally found that these discussions led to more robust, well-rounded solutions. The diversity of perspectives within teams—especially when members came from different cultural backgrounds—fostered ideas from various perspectives and made the collaborative process feel more dynamic and inclusive.

However, our results indicate that group members contributed more to ideas' usefulness than their novelty. Specifically, seven participants were inspired by group members and integrated these

contributions into the novelty of their final ideas. Additionally, almost all participants (16 out of 18) incorporated input from group members to enhance the usefulness of their final ideas. The other two participants did not get help from group members or visual stimuli.

5.3 Influence of Group Ideation Methods

The primary group ideation technique utilised was collaborative sketching, where participants exchanged drawings with minimal verbal communication. This approach encouraged students to focus on visual expression and document their ideas carefully to ensure clarity. Students noted that working in silence allowed for more personal reflection on the design before sharing with the group. One student pointed out that this method shifted their attention from spoken ideas to the importance of written explanations and visual clarity in sketches. Additionally, several students found that building on each other's ideas without direct verbal exchange helped refine concepts in ways that might not have occurred otherwise. However, some felt that collaborative sketching led them to latch onto their initial ideas without extensive exploration, as they were working with time constraints. In these cases, students acknowledged that while collaborative sketching was effective in generating initial designs, they might have benefited from more time or additional ideation rounds for further creativity.

5.4 Other Thoughts and Reflections

Beyond the specifics of AI stimuli, the contribution of group members, and the group ideation method, students shared insights into their broader learning experiences from the exercise. A recurring theme was the value of time and iterative thinking in ideation; several students felt that the limited time frame led to a focus on first ideas, which sometimes restricted creativity. They also noted that, despite the fun and engaging nature of the activity, a few ideas ended up being similar due to the time pressure. Additionally, the exercise prompted some students to reflect on inclusivity in design more broadly. Designing for children with disabilities challenged them to consider practical adjustments like additional safety mechanisms, accessible entry points, and features catering specifically to wheelchair-bound users. Students appreciated that working on such designs cultivated empathy and sensitivity to different users' needs. They concluded that this exercise not only highlighted collaborative ideation's advantages but also underscored the importance of considering functionality and accessibility in their designs.

Although AI-generated visual stimuli had limited influence on design creativity compared to peer contributions, we responded points to opportunities for future exploration. Rather than using static prompts, future research could examine how AI-generated stimuli might evolve throughout the ideation process. Embedding AI in an iterative feedback loop—where new visuals are generated in response to group discussions—could help tailor outputs more closely to the design context and needs of the team. Further investigation is also needed into the specific characteristics of AI-generated images. Analysing aspects such as visual complexity, perceived realism, and relevance to inclusive design could shed light on why certain images failed to inspire. This understanding may guide the development of more effective and context-sensitive AI tools. By identifying and addressing the creative limitations of current generative models, future systems could better support ideation in both educational and professional design settings.

5.5 Limitations

Our research has several limitations. First, the study was conducted in a real-life exercise scenario in a course rather than a controlled laboratory environment, making it susceptible to various external influences. Additionally, the sample size was limited, which may have influenced the outcomes. Another limitation is that we focused exclusively on visual stimuli generated by Generative AI without prompting participants to interact directly with AI tools. This decision was intentional, as our primary objective was to examine the effects of basic inspiration rather than the intricate operational aspects of Generative AI systems. However, it is worth noting that such models can sometimes exhibit tendencies toward hallucinations or fixations.

6   CONCLUSIONS

This paper examines the impact of AI-generated visual stimuli on group ideation, with an emphasis on their potential to foster design creativity. The findings demonstrated that visual stimuli (AI-generated) might have limited potential to enhance design creativity in terms of novelty and usefulness. Alternatively, most of the participants believed that group members contributed more novel and useful

ideas than the visual stimuli during ideation. In addition, they emphasised and enjoyed the group ideation method, which is a fun and fantastic exploration which encouraged educators to explore less used but functional group ideation methods in engineering and design product education.

ACKNOWLEDGEMENTS

REFERENCES

[1] Gong Z., Nanjappan V., Lee L.-H., Soomro S. A. and Georgiev G. V. The Relationship Between Culture and Design Creativity at the Individual Level: A Case Study Based on Design Tasks. *International Journal of Design Creativity and Innovation 2023.*

[2] Borgianni Y., Maccioni L., Fiorineschi L. and Rotini F. Forms of stimuli and their effects on idea generation in terms of creativity metrics and non-obviousness. *International Journal of Design Creativity and Innovation 2020*;8:147–64. https://doi.org/10.1080/21650349.2020.1766379.

[3] Borgianni Y., Rotini F. and Tomassini M. Fostering ideation in the very early design phases: How textual, pictorial and combined stimuli affect creativity. *Proceedings of the 21st International Conference on Engineering Design (ICED 17)*, Vancouver, Canada, 21-25, 2017, p. 139–48.

[4] Berni A., Borgianni Y., Rotini F., Gonçalves M. and Thoring K. Stimulating design ideation with artificial intelligence: present and (short-term) future. *Proceedings of the Design Society 2024*; 4:1939–48. https://doi.org/10.1017/pds.2024.196.

[5] Magni F., Park J. and Chao M. M. Humans as Creativity Gatekeepers: Are We Biased Against AI Creativity? *J Bus Psychol 2024*; 39:643–56. https://doi.org/10.1007/s10869-023-09910-x.

[6] Scala J. L., Bartłomiejczyk N., Gillet D. and Holzer A. Fostering Innovation with Generative AI: A Study on Human-AI Collaborative Ideation and User Anonymity. In *58th Hawaii International Conference on System Sciences 2025*.

[7] Gonçalves M., Cardoso C. and Badke-Schaub P. Inspiration choices that matter: the selection of external stimuli during ideation. *Des Sci 2016*;2: e10. https://doi.org/10.1017/dsj.2016.10.

[8] Chakrabarti A. Design Creativity Research. In: Raghavan NRS, Cafeo JA, editors. *Product Research: The Art and Science Behind Successful Product Launches*, Dordrecht: Springer Netherlands; 2009, p. 17–39. https://doi.org/10.1007/978-90-481-2860-0_2.

[9] Gong Z., Gonçalves M., Nanjappan V. and Georgiev G. V. Priming uncertainty avoidance values: Influence of virtual reality stimuli on design creativity in ideation. *Computers in Human Behaviour 2024*; 158:108257. https://doi.org/10.1016/j.chb.2024.108257.

[10] Gonçalves M., Cardoso C. and Badke-Schaub P. What inspires designers? Preferences on inspirational approaches during idea generation. *Design Studies 2014*; 35:29–53.

[11] Gong Z., Paananen S., Nurmela P., Gonçalves M., Georgiev G. V. and Häkkilä J. AI Role In Ideation for Design Creativity Enhancement. *DS 136: Proceedings of the Asia Design and Innovation Conference (ADIC) 2024*: 046–54.

[12] Ivcevic Z. and Grandinetti M. Artificial intelligence as a tool for creativity. *Journal of Creativity 2024*; 34:100079. https://doi.org/10.1016/j.yjoc.2024.100079.

[13] Jia N., Luo X., Fang Z. and Liao C. When and How Artificial Intelligence Augments Employee Creativity. *AMJ 2024*; 67:5–32. https://doi.org/10.5465/amj.2022.0426.

[14] Fu Y., Bin H., Zhou T., Wang M. and Chen Y. Creativity in the Age of AI: Evaluating the Impact of Generative AI on Design Outputs and Designers' Creative Thinking 2024.

[15] Gong Z., Soomro S. A., Wang M., Latif U. K. and Georgiev G. V. Text Stimuli Created by Generative AI in Ideation: An Exploratory Study. *Proceedings of NordDesign 2024*, The Design Society; 2024, p. 496–503. https://doi.org/10.35199/NORDDESIGN2024.53.

[16] Chen L., Sun L. and Han J. A Comparison Study of Human and Machine-Generated Creativity. *Journal of Computing and Information Science in Engineering 2023*; 23:051012.

[17] Schmidt R. C. Managing Delphi Surveys Using Nonparametric Statistical Techniques. *Decision Sciences 1997*; 28:763–74. https://doi.org/10.1111/j.1540-5915.1997.tb01330.x.