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ORIGINAL ARTICLE

The use of generative AI tools in Design Thinking academic makeathon

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ABSTRACT

This paper examines the integration and influence of Generative Artificial Intelligence (GenAI) tools in a Double Diamond Design Thinking (DDDT) academic makeathon. It analyses students' interaction with these tools in problem-solving scenarios, offering insights into their perceptions and manner of use. The study reveals that text-based GenAI, such as ChatGPT and visual tools such as Midjourney and Dall-E 2, are perceived to be supportive rather than solution-dictating. However, it appears that there is a significant difference between engineering and design students in their approach and their trust in these tools. Moreover, students often use tools like ChatGPT as search engines without fully exploring their capabilities. This paper aims to explore the potential of GenAI in its deeper capacity within the DDDT methodology, and how to maximize its value.

Key words: Generative artificial intelligence; double diamond design thinking; academic makeathon.

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INTRODUCTION

This paper explores the ways by which students of design and engineering use Generative Artificial Intelligence (GenAI) tools to solve real-world problems. It is based on data collected during Shenkar Jamweek's Design Thinking (DT) Sprint Makeathon, an intensive international makeathon where participants from various disciplines engage in design and innovation. The study aims to explore how disruptive GenAI tools were used by students during the process, and to reflect upon the ways in which they might be incorporated in future DT processes to allow innovation and to improve the DT methodology. Shenkar Jamweek is an annual four-day academic makeathon for interdisciplinary problem-based learning. It brings together hundreds of students of design, art and engineering. Shenkar Jamweek focuses on social and entrepreneurial innovation led by the Double Diamond Design Thinking (DDDT) approach (see also Krebs et al., 2022).

THEORETICAL BACKGROUND

The exploration of humans collaborating with General Artificial Intelligence (GenAI) is not a new phenomenon; it has been a concept for a few decades, since the advent of AI itself. Early visionaries in the field recognized the potential of AI to assist people in addressing complex challenges, enhancing decision-making processes, and achieving objectives more efficiently (Licklider, 1960). Nowadays, studies have identified a significant growth in adopting GenAI tools, such as ChatGPT and Midjourney, in various domains, including healthcare, business, the military, and design (Chong et al., 2022). The practical benefits of GenAI tools have been extensively researched recently, revealing their versatility in tasks such as research, ideation processes, texting, and information summarisation (Cardon, 2023). Recent studies have explored various facets of GenAI capabilities, either in comparison to or in collaboration with humans. For instance, research at Cornell University demonstrated that ChatGPT-4 can generate more creative, cost-effective, and superior ideas compared to human students only (Girotra et al., 2023). Additionally, GenAI tools such as GPT-4 have demonstrated exceptional creativity, outperforming 91% of human subjects in the Alternative Uses Test, a commonly employed measure of creativity. The results were evaluated using the Consensual Assessment Technique (Haase et al., 2023).

In team creativity, GenAI has been identified as being useful for extracting significant insights and sentiments from extensive text-based data. They can also contribute to ideation and problem-solving across the complete Double Diamond model (Bouschery et al., 2023). Studies have shown that when humans work with GenAI tools in brainstorming processes, it can potentially lead to results

similar to human-only behaviour in groups. This includes two major effects: a) cognitive stimulation, where people generate new thoughts after hearing others' ideas, and b) "free riding" – a phenomenon of someone doing less work when part of a group (Memmert, 2023).

Research published by Buçinca (2021) has found that when people rely on AI for answers, they might become less thoughtful and take the AI's feedback without questioning it. There are also concerns about depending too much on AI, sometimes accepting wrong suggestions, and doubts about the truthfulness of AI-generated content (Lin et al., 2022). Some studies show that people may share AI-based information online without checking its accuracy (Vosoughi, 2018). If AI explanations are not well designed or suited to the user, they might be ignored or overly relied upon, and users may form oversimplified judgments about the AI's abilities, instead of carefully evaluating its suggestions (Danry et al., 2023; Bansal, 2021). For light users, who are not aware of the AI complexity, it is essential that AI systems are more transparent, i.e., explain what leads them to their output (Mueller, 2019).

To overcome these challenges, some studies in the field of explainable AI have proposed new ways to enhance Human-AI collaboration and trust. For instance, Danry et al. (2023) introduced AI-framed Questioning. This approach encourages users to think logically by asking questions, rather than just receiving passive feedback from the AI system. The research shows that this method has helped users think more critically. Moreover, transparency in AI systems seems to increase trust in AI. Being open about how AI works and avoiding hidden or 'black box' decisions can make people more likely to use AI (Marrone, Taddeo, and Hill, 2022).

The growing use of GenAI tools has led to new design methods, focusing on speeding up design exploration (Hong et al., 2023; Weisz et al., 2023). But this can sometimes lead to 'design fixation,' limiting creativity (Youmans et al., 2023). A Study by Bouchery (2023) explored the varied usage of AI tools in DDDT methodology. These tools seem to help to extract insights from long texts, generate ideas, and improve problem-solving. AI also allows teams to access more knowledge, enhancing idea diversity and quality. This shows AI's role in various ideation stages, from recognising opportunities to launching products. Tholander and Jonsson (2023) explored AI in design ideation, looking at how it encourages different thinking processes and resembles internet searches. They stressed the move from command-based to natural-language interactions and the importance of human-AI cooperation. AI not only strengthens the key ideas of DT but more importantly, helps overcome traditional human-centred design limitations like scaling and learning the process, and making it fit with DT principles (Verganti, 2020).

Despite the rapid growth of usage of GenAI tools in many areas related to DT processes (e.g., information research, brainstorming, etc.), there is still a significant lack of data regarding its integration and implementation in such processes. Our research serves to fill this gap by providing data collected in the Shenkar DDDT makeathon. Its main research question is how GenAI tools were used during the DDDT process. More specifically, it asks which GenAI tools were used at which stages; what were the patterns of usage; and what was the difference in the utilizations of the GenAI between designers and engineers.

METHODS AND DATA

Shenkar Jamweek makeathon included 705 BA students in their second year: 380 from the faculty of engineering and 325 from the faculty of design (including the school of fine arts). The event lasted four days. Each day was dedicated to a different stage of the DDDT model: empathy, challenge definition, ideation, and prototyping. It focused on solving real-world challenges related to climate change and sustainability, as presented by industrial companies. The students were encouraged to use various GenAI tools such as ChatGPT and Midjourney. They were provided with basic training and were allowed to use GenAI according to their own decisions.

The methodology of this study combines quantitative and qualitative data which were collected in 260 questionnaires (106 by designers and 154 by engineers), filled by the end of each day, and triangulated with documented observations which were carried out during the makeathon. The quantitative questionnaire consisted of 16 questions in the following key areas:

(i) The effectiveness of the general methodology and platform. This set of questions evaluated the students' estimation regarding the utility of the DDDT methodology and Miro's platform.

(ii) The use of specific GenAI tools. These questions focused on the selection of specific GenAI tools, the reasons for choosing them, the ways in which they were used, and the reliability of information generated by them (in the students' view).

(iii) The influence of the GenAI tools on the final products. These inquiries focused on the satisfaction of the students from the results achieved with the GenAI tools. It also referred to their role as supporting or dictating the solutions.

We used two types of questions: the first one was 'scale questions' (on a scale of 1-7). These were analysed using both categorical analysis (grouping responses into negative, neutral, and positive-impact categories) and descriptive statistical analysis (focusing on mean scores and standard deviations). This dual approach was employed to capture the broad sentiment trends as well as the detailed variability within participants' perceptions of GenAI tools. The second type of questions was 'categorical questions'. These explored the different

choices and usage of the GenAI tools among students from various disciplines.

The qualitative assessment was based on feedback questionnaires filled by the students and on external observations held during the second and the third days of the makeathon. These questionnaires included open-ended questions aimed at providing subjective reflections on the function of the GenAI tools during the different stages of the DDDT.

RESULTS

The perception of GenAI as an assistive versus dictating tool

Around 70% of the participating students stated that they had already used GenAI tools in the past. Through our survey we can see that around 80% of the students used GenAI tools in practice during Jamweek (82% of the engineering students, compared to 76% of the designers). However, a Chi-square test for independence ($\chi^2 = 0.4158$, p-value = 0.5190, Cramer's V= 0.0496) indicated no statistically significant difference in perceptions between engineering and design students. A vast majority of them (85%) considered these tools to be merely assisting or guiding tools (on the way to a solution), rather than dictating tools. This perception is supported by Esling & Devis (2020) who suggest that AI can enhance human creativity rather than replace it. Moreover, in their recent paper, Marrone, Taddeo and Hill (2022) asked their students whether AI can match their creativity. The opinions among the students varied, but it seems that their main conclusion was that AI sparks creativity rather than providing it. Notwithstanding, Verganti, Vendraminelli and Iansiti (2020) claim that the purpose of design in its "how" process is shifting "from designing solutions to designing problem-solving loops," hence the AI technology enables leveraging its learning power into better novel solutions.

The link between the quality of the final product and use of GenAI tools, as perceived by the students

Among the students, 86% of the engineers (significant) and 73% of the designers stated that they think their final product was worthy of use as a valuable solution for the host organisation (based on counting "positive" scoring of 5-7 range on a 1-7 scale). Moreover, a strong link was found between the students who highly evaluated their project quality and their belief in the GenAI effectiveness in helping find a good solution (based on a count of 'positive' scores ranged from 5 to 7 on a 1-7 scale, the results of the Chi-square test for engineers were as follows: $\chi^2 = 8.6797$, p-value = 0.0032, Cramer's V = 0.2796. For designers, the results were $\chi^2 = 3.1112$, p-value = 0.0777, Cramer's V = 0.2050). A similar strong link (between high evaluation of the results' quality and the perception of GenAI effectiveness) was found also among the students' mentors (faculty staff). Similar results appear in a study published by Amani, White et al. (2023). In this study the researchers asked both faculty members and students to evaluate the potential effects of ChatGPT on their critical thinking, problem solving, teamwork, etc. Its conclusions show numerous commonalities in the responses provided by the two groups of participants.

Table 1 and 2. Evaluation of project quality for the organization and the impact of GenAI tools on the project results amongst Design and Engineering students

		Design students	
		The results' value for the organization	
		Not valuable	Valuable
The impact of GenAI on final results	Positive impact	10%	50%
	No impact	17%	23%

		Engineering students	
		The results' value for the organization	
		Not valuable	Valuable
The impact of GenAI on final results	Positive impact	4%	61%
	No impact	8%	27%

The manner of use of GenAI along the DDDT stages

Jamweek DDDT Sprint dedicated its first two days to research and empathy (mainly convergence work-mode, which explores the problem domain), and the two last days to ideation and prototyping (mainly divergence work-mode in creating a solution). Esling and Devis (2020) define these two work-modes as follows: convergent thinking involves applying knowledge and logic to find a single parameter answer led by a specific set of questions with only one correct answer (in our case, problem definition). Divergent thinking involves a framework that encourages the generation of a diverse range of ideas in response to a given question or stimulus (in our case, finding a solution).

In the Jamweek research and empathy stages, of the students who declared they used GenAI tools, 67% used only textual AI tools (ChatGPT), while 19% used solely visual GenAI tools (e.g., Midjourney and DALL·E 2), and 14% used both textual and visual tools. In the ideation and

prototype stages, though, the adoption level of visual and textual GenAI tools increased from 19% to 30%, leaving the use of textual AI tools on 55%, while the solely visual GenAI tools remain at 16% (Chi-square test shows non-significance as $\chi^2 = 8.5189$, p-value = 0.0141, Cramer's V= 0.1336). In both stages there was no significant behavioural difference between design students and engineering students. Students used visual GenAI tools for specific tasks, such as visualising ideas to quickly validate and continue developing their solution.

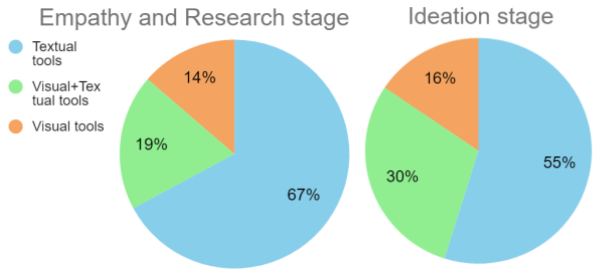

Fig. 1. GenAI tools usage in different stages of Jamweek DDDT Sprint

GenAI tools as opportunities or threats

Students combining textual (e.g., ChatGPT) and visual GenAI tools (e.g., Midjourney, DALL·E 2) reported higher satisfaction (average rate 5.1/7, SD 1.5), compared to those using only textual (average 4.7/7, SD 1.6) or visual tools (average 3.5/7, SD 2.1). The Kruskal-Wallis test showed significant differences in GenAI tool satisfaction (H=11.9465, p=0.0025), with the type of tool usage accounting for 5.9% of satisfaction variance (Eta-squared=0.05856). Engineers generally seem to have slightly higher satisfaction levels for most of the GenAI tools compared to designers. Furthermore, some design students have expressed their concerns over the GenAI and their unwillingness to use those tools, declaring: "They are taking our jobs," or "We are not going to cooperate with this concept since it might harm our creativity," or "No need for AI tools in order to create fashion." These concerns might explain why only three quarters of the designers used GenAI tools in practice during Jamweek, although they were heavily encouraged to do so, as they feel like technophobes who fear AI technology they do not understand (McClure, 2018), and therefore, have no incentive to learn AI technologies, as they are afraid of losing their jobs (Brynjolfsson and McAfee, 2015). Having said that, according to Esling (2020), since AI enhances human creativity rather than replacing it, it is suggested that AI be treated as an assistive tool rather than a threat to human creativity.

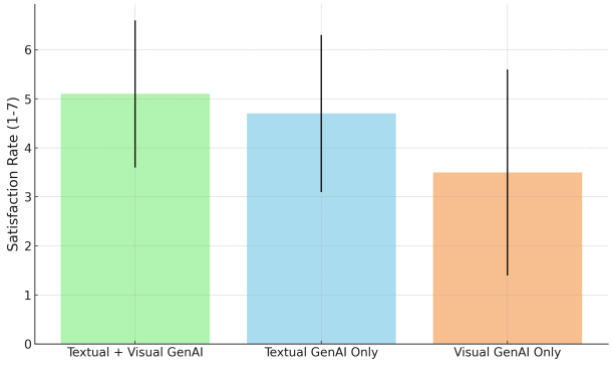

Fig. 2. Students' satisfaction with different GenAI tools

The use of GenAI as an advanced search-engine

The qualitative feedback on the reasons and methods of using GenAI tools indicates that students tended to prefer text-based tools over visual ones during the Research and Empathy phases. They reported that it facilitated their research initiation and accelerated their information gathering and testify that they did it in order "to discover more about the challenge", "to get a broader understanding of the topic", "to get access to a lot of information across the web" and "to narrow the range of information and focus the thoughts." Other answers referred to the unique combination of speed, accuracy, and ease of use. These qualitative answers and our quantitative survey indicate that most of the students (around 75%) used ChatGPT as a 'traditional' digital search engine, that is to say, used it as a means to achieve information and get direct answers as they would have done with any other regular search engine. Another 10% used it as an 'advanced search engine' (for example, to gather information and ideas to enhance the usage of other GenAI tools rather than merely data collecting).

Only 15% of the students went beyond these traditional uses of a search engine and employed it in more productive ways that take advantage of its capacities. One example of such a use is the approach of an 'object to think with'. This approach employs the GenAI tools to foster reflective and critical thinking and concept comprehension (Papert, 1980).

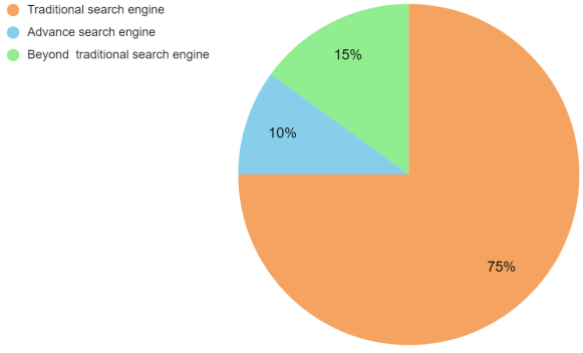

Fig. 3. Students' satisfaction with different GenAI tools

In our opinion, this manner of use misses an enormous potential that lies in GAI. To name just a few examples: using ChatGPT in a Socratic way (Chang, 2023) would allow the students to improve their creativity and learning techniques; prompting critical thinking questions relying on provoking positions, rather than finding facts and information (Brown & Kelly, 1994; 2007). Moreover, conducting certain types of conversations may provide ongoing feedback for the user (Baidoo-Anu and Owusu, 2023). While the research phase of DDDT indeed requires gathering information, we believe that using GenAI tools can expand the meaning of 'information' and 'research' in crucial ways. It can also replace the usual process of information-driven use and solution-driven use. This understanding can lead to changes in the DDDT model when it is conducted by GenAI tools.

Information veracity and user trust

To the question "Did you validate the results provided by the GenAI tools in order to ensure data reliability?" 40% of the students admitted that they had not done so. However, our survey shows a significant difference between designers and engineers: 65% of the design students did not validate ChatGPT's results, compared to only 28% of the engineers (χ^2 = 11.3626, p-value = 0.00075, Cramer's V= 0.3635). This can come aligned with Ahmed's paper (2003), which examines the differences between the ways by which novice designers approach design tasks. It indicates that novice designers (such as our design students) tend to focus on gaining a better understanding of the challenge, and adopt numerical data as accurate, without questioning it. Engineering students, who are traditionally trained in analytical and verification methods, might be more inclined to validate AI-generated results, as opposed to design students, who may adopt a more exploratory approach.

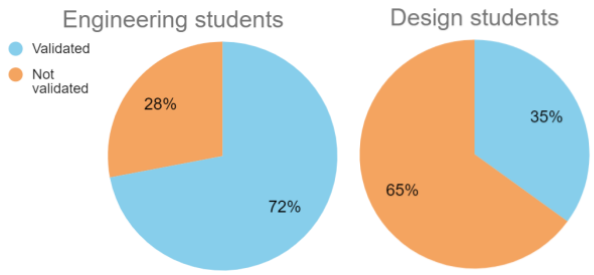

Fig. 4. Validation of the results provided by the GenAI tools by engineering and design students.

DISCUSSION AND CONCLUSIONS

The extensive use of GenAI tools by students during Jamweek underscores the feasibility of integrating such technology within the DDDT methodology. This is consistent with a recent study suggesting the synergy between GenAI and DDDT, as mentioned earlier in this paper (Bouschery et al., 2023). Furthermore, our study reveals that the incorporation of GenAI into these learning environments (DDDT-based academic makeathons) appears to enhance students' perception of the quality of their own work. However, the influence of these tools, particularly language models like ChatGPT, on the students' creative process is not exhaustive, and it deserves further exploration. Our study shows that they perceived GenAI as an assistive or guiding tool rather than a solution-dictating tool. They used ChatGPT as a search engine without exploring and exhausting its deeper capacities, and they used visual GenAI to improve their presentations. This is a 'traditional' use of an AI tool that misses its full potential faculty. We also found a significant difference between engineering students, who were more sceptical and mostly challenged and cross-checked the GenAI results, and design students, who mostly accepted the GenAI and aligned with the results. This might be related to the designers' state of mind of openness to new concepts, but it could also imply that there is a fear from the new disruptive technology, which aims to replace designers, a claim which was indeed expressed by some of them.

Our study suggests that GenAI tools can improve some aspects of DDDT, particularly finding and gathering information rapidly and designing presentations effectively. Having said that, the integration of GenAI tools in higher education has a greater potential yet to be explored in terms of their ability to radically improve the entire process of DT as a method. DT, through its divergent and convergent stages, offers a structured yet flexible framework for product development. Integrating GenAI into this process adds a new layer which enables new perspectives. For instance, GenAI tools can emulate the thinking of Einstein, Picasso or even fictional characters like Sherlock Holmes. With this set of capabilities, the GenAI can create a new interactional environment which provides completely new dialogue and dynamics between the user and the 'machine', opening new possibilities for incorporating these tools in various ways to improve creative and innovation processes.

Since the use of GenAI tools is still in its very early stage but evolving very rapidly, it is the role of academia to educate students to adjust their mindset when working with GenAI tools, i.e., how to better design the manner of interaction between human and AI interface. As shown in our study, without proper and careful guidance, a misuse of interaction can lead to mistrust, and loss of potential value. So, educators have to take responsibility and continuously push for adopting radical GenAI tools, through the adaptation of new forms of interaction with them, since they evolve to become a "partnering entity" in the world of higher education.

Limitations of the study

While we tried to provide some fresh insights on the use of GenAI tools in DDDT process, our study has several limitations. First, it relies on self-reported data from questionnaires, which may be subject to biases. Second, its focus on one specific event limits the generalizability of the findings. Additionally, given the rapid evolution of AI technologies, some aspects of this research might quickly become outdated.

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