

Design Thinking with AI

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Abstract. *This research paper focuses on the use of artificial intelligence (AI) applications to enhance the teaching of design thinking, aiming to provide a more effective and captivating educational experience. Design thinking, a creative problem-solving approach commonly taught in universities, emphasizes fostering students' creativity for innovative solutions to complex problems. Typically, workshops employ a straightforward toolkit comprising paper, stickers, markers, and prototyping materials. However, in response to students' pronounced interest in emerging technologies, this study investigates the integration of technology, specifically AI, into the teaching of the design thinking method. Conducting an analysis of scholarly articles published within the last two years, during the rise in popularity of AI applications such as Midjourney or ChatGPT, the paper examines the intersection of technology and pedagogy. The focus is on exploring how each step of the design thinking process can be enhanced through AI, elucidating potential limitations of employing this technology in teaching creative problem-solving, and determining the optimal balance between human creativity and machine learning. The overarching goal is to glean insights into successfully training students in the field of design thinking. It is important for educators to model responsible use of ChatGPT, prioritise critical thinking, and be clear about expectations. Educators need to present students the ethical implications of AI in education underlining the importance of skill and knowledge development rather than reliance on AI systems.*

Keywords: design thinking, generative AI, teaching, creativity, innovation, technology.

Introduction

At the heart of the Design Thinking process lies experimentation. This generates previously unknown knowledge and a deeper understanding of issues and user needs (Al-sa'di & Miller, 2023). For companies to remain competitive, innovation is critical. Experimentation is a fundamental trait to foster innovation in design thinking (Al-sa'di & Miller, 2023). Text-to-image generative AI models can open up opportunities and challenges for fostering innovation (Vartiainen & Tedre, 2023).

Innovation and creativity should go beyond the “ideas first” model, which was historically understood as a recovery or discovery of what was already there but should acknowledge the disruption, we currently experience worldwide that requires different models, such as enactive making, at the centre of learning and seeing humans as makers more than thinkers (Kerr & Frasca, 2016). The user-centric approach prioritizes the requirements of the user, which means that the product must adapt to the user. By contrast the product-centric approach focuses on improving performance and makes users adapt to the product. (Quan et al, 2023)

The traditional product design methods suffer, overall, from several significant disadvantages, mainly due to recent lifestyle and technological changes. Customer needs have diversified and became more complex, the amount of data has grown, real users and survey subjects do not necessarily overlap, using experts can introduce subjectivity, there is a lack of visualization that led to hazy decision making, all of which can lead to waste of resources (Quan et al, 2023). Over the past decades, product design has changed in design concepts and methods due to advancements in manufacturing and technology, with successful products enhancing user

satisfaction and financial gain. Design concepts have moved from “form follows function” to “form follows emotion” and being user-centric. Design methods have likewise shifted from experiential and fuzzy design to intelligent design, joint design, and computer-aided design. Due to the significant progress in deep learning, big data, AI algorithms, a next generation evolution is expected.

Education must evolve to provide the intellectual resources needed by future businesses, which in the framework of Industry 5.0 would mean a synergy between autonomous machines and humans. Both the trainees and the trainers will need to be prepared. Humans must evolve hand-in-hand with the advancement of the available technology (Maddikunta et al, 2022). COVID-19 pushed education worldwide, at least partially, into the online. Some institutions have continued this practice, however they have not fully adapted to the transformation, many of the educators still relying on basic technology to replicate physical lessons – basically holding their physical lessons in front of a screen for the students to follow. This reveals that the education system is changing too slowly (Weng et al, 2023). Tensions have already appeared in the field of education, due to the use of Generative AI. However, this needn’t be seen as a “Ragnarök” for the future of education as we understand it now, but it can be viewed in a positive light (Weng et al, 2023).

Generative AI has a paradoxical nature in education, it could support some practices and destroy them at the same time, such as the multiple-choice tests, that can be generated, solved, and also graded entirely by AI, or essays, that can similarly have an AI generated subject, can be composed by AI, and can be graded by AI (Weng et al, 2023). Some uses of generative AI in the educational system include ideation, inspiration, brainstorming (Moorhouse et al, 2023).

The next generation of students are expected to bring forward a new wave of developments and designs for AI-enabled learning, therefore there must be studied how AI can be implemented and evaluated in a responsible and sustainable manner.

Literature review

In this section I present the main factors standing at the base of my research, analysing the implications and impact of new technologies on the methodology and process of teaching design thinking.

In the past two years researchers have started to investigate ways in which learners, teachers, and administrators can benefit from AI-related approaches in smart learning environments. Such technological advancements need to be better understood, in learning spaces, since they bring some challenges. The surge of generative AI can impact learning and leads to blurred lines between authentic creations of the students, AI-generated content, and intentional plagiarism (Lee et al, 2023).

Generative AI is a part of Web 3.0, which brings advancements in user experiences and technology (Bandi et al, 2023). The reliance on AI is gradually becoming an obligation not a choice (Kooli, 2023). In the past, with emerging technologies, traditional practices have faced disruption of all kinds. ChatGPT is listed among the examples of generative AIs that have made a significant contribution to the field (Weng et al, 2023), while also having gone viral on social media (Cooper, 2023). GPT-3 is the flagship model of OpenAI’s GPT series. It generates human-like text, fluent and coherent, managing to generate question answering, essay writing, conversational responses (Weng et al, 2023). ChatGPT is trained on a large amount of data collected from the internet (Kooli, 2023) and is expected to produce more accurate and fluent outputs in future iterations, and even multimedia (Lee et al, 2023).

The benefits and threats of AI technologies, including ChatGPT, must be assessed to establish the advantages and threats (Rahman & Watanobe, 2023). An explanation for AI not being as widespread as it could be revolves mainly around lack of knowledge and skills on the subject (Tsydlo & Sendra, 2023). In education, more than half the guidelines provided by universities focus on ChatGPT and not other programs (Moorhouse et al, 2023), while Midjourney has been relatively underutilized for educational purposes, in comparison to ChatGPT, despite its potential benefit. (Lee et al, 2023). However, Midjourney has been used in various education-related research such as those conducted by Paananen et al (2023), Vartiainen & Tedre (2023), or Tsydlo & Sendra (2023). Both ChatGPT and Midjourney are tools that can change education (Chiu, 2023) which is why they will be the tools analysed in this paper. One concern of using ChatGPT is the challenges it brings, regarding its potential use in education and research (Rahman & Watanobe, 2023). Blind reliance on generative AI tools could negatively impact education and research, because of the ease with which it offers answers, which even the CEO of OpenAI, Sam Altman, warns against. Students, teachers, and researchers alike should be aware of its limitations. Also, if the training data is biased against certain people or cultures, the output might be discriminatory, which would raise the question of who is accountable (Rahman & Watanobe, 2023).

Text-to-image synthesis has gathered momentum with applications such as Midjourney, that was created by the eponymous independent research lab (Lyu et al, 2022). Midjourney generates images from written descriptions (Bandi et al, 2023), and, like other similar programs, relies on natural language processing, deep learning (Generative Adversarial Networks), and up-scaling algorithms (Göring et al, 2023). According to the analysis done by Tsydlo & Sendra (2023), Midjourney results as the most suitable generative AI tool for methodological innovation in training. Midjourney has been relatively underutilized for educational purposes, in comparison to ChatGPT, despite its potential benefit (Lee et al, 2023).

Forming prompts for the generation of an image can stimulate new ways of thinking and expand the imagination of future designers (Tsydlo & Sendra, 2023). Midjourney can be used by both specialists and the broader audience. It engages human intuition and machine intelligence both to work synergistically, and delivers qualitative and creative images, guiding designers to become intelligent designers. Midjourney plays a key role in the discover (Design Research) and develop (Design Generation) of the Double Diamond model (Yin et al, 2023).

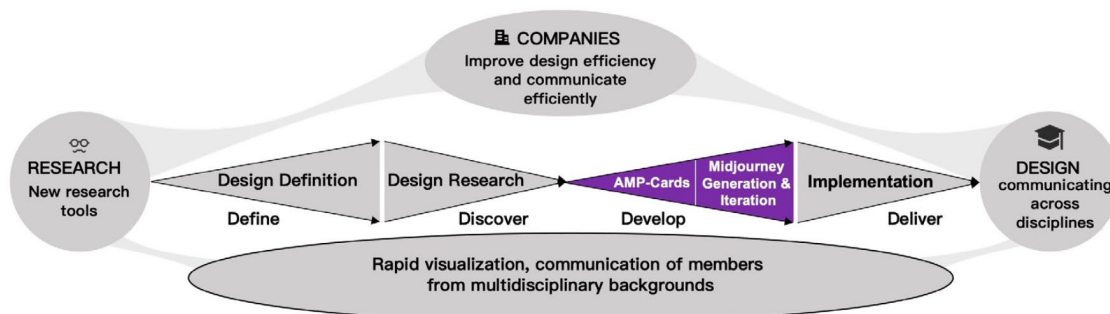


Figure 1. The implications of Midjourney on the design process

Source: Yin et al, 2023.

Midjourney offers an innovative research tool that stimulates ideas, enhances design efficiency, and reduces the cost of software learning for designers significantly, while lowering the bar for design expression and boosting communication in interdisciplinary teams – knowledge from various disciplines can be integrated to tackle design problems (Yin et al, 2023). It has the

benefit of having a low-floor (next to no training required), high-ceiling (scalable results with good quality), wide-walls principle (broad range of applications), with a low barrier of entry (Vartiainen & Tedre, 2023), which means that the skill gap between novice and advanced designers is reduced and creativity is no longer inhibited by lack of skill development.

Generative AI tools are becoming more and more accessible and have begun to impact education more and more (Chiu, 2023, Kooli, 2023). Generative AI offers an opportunity to reimagine and change the future of education. ChatGPT is already being cited as co-author or publisher of journal articles, so the transition is already here (Weng et al, 2023).

Chatbots such as ChatGPT have evolved significantly with the growth of AI and are now used in various industries, such as customer service, health, finance, education (Kooli, 2023), content generation, translation, chatbot responses, question answering, programming code (Rahman & Watanobe, 2023). Generative AI has the potential to transform creative industries among other fields (Bandi et al, 2023).

For researchers, ChatGPT can effectively support the research process and improve writing by correcting typographical errors, improving the grammar, suggesting vocabulary, recommending improvement strategies, which allows researchers to allocate more time to experimentation and implementation. It can also summarize published work on a topic and provide ideas and clues (Rahman & Watanobe, 2023). Programmers can use ChatGPT to obtain easy-to-understand explanations, pseudocode, generate solutions based on a problem description, error checking, debugging code, code optimization, as well as daily practice, personalized support, learning resources in general (Rahman & Watanobe, 2023). Educators can use ChatGPT for various teaching and research tasks (Rahman & Watanobe, 2023), which could make the teacher-generative AI relationship more difficult to predict but also more dynamic.

Higher education institutions worldwide had to develop guidelines for generative AI tools such as ChatGPT due to ethics-related concerns (Kooli, 2023) associated with academic integrity, cheating, and plagiarism (Moorhouse et al, 2023). The first reaction of some was to outright ban them and control the students' environment (Moorhouse et al, 2023), while others imposed various degrees of control (Weng et al, 2023), with some requiring its use to be cited, with the purpose it was used for, how it was used, and how the output was changed (Moorhouse et al, 2023). The regulations on the matter are still a work in progress (Weng et al, 2023), due to anxiety and scepticism among some educators (Johnson, 2023, King & Prasetyo, 2023) caused by it being a new technology that has the potential to transform learning (Johnson, 2023, Weng et al, 2023) and fears of automation and difficulty of predicting future skills (Vartiainen & Tedre, 2023).

The technology does indeed have some problems such as the potential to mislead students, or students using it to complete their homework, offer inconsistent or wrong answers through hallucination, lack of development of critical thinking in students or cheating (Johnson, 2023), perpetuation of existing biases and discrimination, manipulation with the result of unreliable or biased results (Kooli, 2023).

However the technology also has strengths such as quickly generating reasonable answers, advancing learning, further explaining concepts (Johnson, 2023), or automating repetitive and tedious tasks, assisting in data analysis, as well as igniting new forms of learning and assessment. Paradoxically, a ban could lead to the Streisand effect, meaning an increase in awareness and interest, and to psychological reactance, meaning restriction could lead to motivation because people do not like being told what to do. Previous bans have also been imposed on older technologies such as smartphones or devices in classrooms, with positive outcomes springing from the educators' initiative to integrate instead of banning them – this could minimise their negative

impact. Due to these paradoxes generative AI could be seen as a transformative resource for teachers and students alike. An update in policies and guidelines, along with examples of how students could use the tools to brainstorm, develop concepts, and critique information sources, would be most beneficial (Weng et al, 2023).

Currently, teachers still believe in the traditional school education, as a baseline for the required knowledge and skills for future living (Chiu, 2023). The quality of the instruction provided by the teachers will depend on their knowledge and judgement (Jeon & Lee, 2023). The perspective of the teachers on generative AI is crucial for the educators making sense of their use for learning, teaching, administration, assessment, to make young children understand what AI is, what it can and cannot do, what impact it can have (Chiu, 2023).

Teachers will need to become more proficient in using ChatGPT and other AI resources, to gain more control over creating and adapting lesson materials (Jeon & Lee, 2023), and should teach students how to use generative AI, by guiding them to use an appropriate vocabulary and mentioning what tasks to use it for (Paananen et al, 2023). Therefore, teachers will need to become facilitators, mediating and supporting learning with AI technologies (Chiu et al, 2023). A central role in this shift will be represented by the quality of the questions both educators and students will ask. To obtain quality results, good questions will need to be asked, which the students will need to do as well. The teachers highlighted the importance of teaching their students how to craft their own questions, making the students active investigators, escaping the passive role (Jeon & Lee, 2023). Especially for novices, teacher support is more important because of their weaker expertise (Chiu et al, 2023).

Educators should adopt interdisciplinary teaching to make sense of ChatGPT's answers, that can compile prompts from various resources (Chiu, 2023). ChatGPT can answer questions better than teachers, in some cases, so the teachers should no longer be viewed as know-it-alls but as learn-it-alls and should adopt a growth mindset, because of the interdisciplinary aspect of learning with generative AI. A growth mindset leads to innovation and easier adoption of new technologies, and helps educators promote interdisciplinary teaching and instil it in their students. Implementation approaches for this type of learning are design thinking, STEM learning etc (Chiu, 2023).

Design thinking is a method of solving complex problems using creativity. It was first used in business in the early 1990's and a methodology was developed by IDEO to support the multidisciplinary teams working with it. From the analysis of recent written articles, we can conclude that AI has already been introduced in various frameworks, not necessarily related to design and creativity. Quan et al (2023) mentions some user research examples: Kansei engineering in which words are gathered from various sources, selected in various manners, designing questionnaires based on the words, building the relationship model that links user affections and product parameters; the KANO model, that establishes five types of qualities (must-be, one-dimensional, attractive, indifferent, reverse) that a product can display, with data acquisition made by using the KANO questionnaire; quality function development or QFD that decomposes requirements and then builds the design process; and finally TRIZ that functions by defining the specific problem, abstracting it to a more general level, mapping solutions to address the general problem, and concretizing the general solution for the specific problem (Quan et al, 2023).

The effects of using AI language model tools such as ChatGPT in product design, on which the research is limited, is not well known because they have been insufficiently investigated in academic literature. ChatGPT can be used to improve the design of technological innovation in the context of, among others, undefined user needs. Therefore implementing the potential of tools such as ChatGPT in Design Thinking could be promising, to increase efficiency and creativity (Al-sa'di

& Miller, 2023). Image generation can be a part of the design process, should limitations be considered, with generative AI tools having the potential to enrich the design process (Paananen et al, 2023). Integration of traditional product design methods and big data and AI algorithms could be the best direction for product design (Quan et al, 2023). The artistic process can be augmented by using AI technology, keeping the human as the mastermind behind the work. Creativity lies not in the final result but in the interaction with the generative AI and the process.

Methodology

The research methods used are an analysis of the articles on the topic of use of generative AI in creative processes with the focus on teaching design, published over the last 2 years on the platform Web of Science. Also, the author's personal experience as a practitioner and a design thinking facilitator contributed to evaluating the information and proposing an enhanced framework for design thinking with technology.

The articles related to the topic of use of generative AI were selected according to two principles, namely, the publishing language (English) and their date of publishing (2022-2023). The Web of Science platform was chosen because the articles published here have geographic representation, as well as influence and impact. The articles were selected to reflect the characteristics of AI from multiple points of view, as well as its impact on various categories of educational fields, in order to better understand the influence of the introduction of AI in the academic system. This includes the benefits and threats of generative AI, the ethical concerns of using AI in the educational system, the perception of AI use in education from the perspectives of the teachers, the students, and the administration of the schools.

Based on the methodology proposed by IDEO, the article explores the implementation of generative AI in the design thinking process, by integrating the findings in the researched articles with the 5 steps of design thinking: empathise, define, ideate, prototype, and test.

The main research question was: what is the best mix of AI applications which can be used by students learning design thinking?

Results and discussions

The design thinking methodology, according to IDEO, consists of 5 steps: empathise, define, ideate, prototype, and test. Design has been taught as conceptual and putting ideation first, including in Design Thinking. The authors in recent studies suggest putting making-thinking at the beginning of the process instead of ideation (Kerr & Frasca, 2016). Product display helps users understand the designed product, with sketches and prototypes serving to visualize ideas. While traditional methods require designers to draw or model, big data and AI algorithm-driven methods do not require these skills but can offer more complex results such as videos and interactions.

1. Empathize

The first step of the design thinking process is empathy. It is based on a deeper analysis of the real needs of the end user, done after applying observation and exploratory interviewing. This step is deeply rooted in the capacity of the one who leads the process to connect and profoundly understand the complexity of the problem they are facing. Therefore it is hard to employ technology to optimize it and it cannot be automated. Participants in a study made by Al-sa'di & Miller (2023) were hesitant to rely on AI tools in the Empathy stage (Al-sa'di & Miller, 2023). Reasons against using generative AI in this stage would be that the AI system could have erroneous training (biased data) leading to biased results, lack of expertise leading to inaccurate results, lack of comprehension of context that can lead to misinterpretation of data, lack of creativity and critical thinking that can

limit the scope of research and the potential for new discoveries, lack of empathy and emotions (Kooli, 2023).

ChatGPT could aid students of design thinking with writing assistance and suggestions, as well as fact checking and access to information. Additionally, it could help with data entry, formatting. The responsibility is still with the human.

2. Define

In the same study mentioned at the empathy stage, participants highlighted the value of ChatGPT in the Define stage, where it was used for data analysis among others. Customer feedback can be analysed to identify the most common pain points, thus sparking the problem statement for the Ideation phase (Al-sa'di & Miller, 2023).

In this stage, students have to produce artifacts such as: descriptions of personas and customer journey mapping, tools that help them put the information collected during the empathy stage in a structure. For this step, Generative AI applications could be used to create the visual boards and portray the ideal client for whom they design. Prompts should be created, which can then be entered in the chat to generate art with the help of the AI system (Lyu et al, 2022). To generate an image in Midjourney, one must first create the prompt. This is interpreted by the Midjourney bot to produce an image, by breaking the prompt into elements that are then compared to its training data. Then, the image is generated. Personal images can be added, as well as other pictures from the internet. If the prompt is well written, the result can be unique and interesting. Midjourney suggests a series of characteristics that the desired output image can have, for the user to implement in the prompt. A description can be very simple, such as a single word, or complex, with several phrases (Tsydlo & Sendra, 2023), using natural language (Yin et al, 2023). Images can also be added to the description, either personal or from the internet. If the description is very simple, Midjourney uses its default style. Grammar is not important but choice of words matters, with synonyms sometimes giving a better desired result. The fewer the words, the greater their impact. The missing concepts will be randomized – if the description is vague, the image will have more variety but will lack specific details (Tsydlo & Sendra, 2023). The text prompt can be altered by the user until the desired outcome is obtained (Göring et al, 2023). The accuracy and standardization of the prompt influences the quality of the generated images, therefore it is important that the right command and prompt are given (Yin et al, 2023).

The skill of prompting is related to the skill of asking good questions, however it is becoming a skill in itself. New services such as prompt sale have even begun to emerge (Lyu et al, 2022). Creating good prompts requires intuition as well as experience (Lee et al, 2023). A prompt can have various degrees of complexity. To get the desired result, the input can be built upon or the prompt could be changed entirely. In general the longer and more detailed the prompt, the more accurate the result, and the shorter the prompt, the more vague or unexpected the result (Paananen et al, 2023). Sometimes reformulating the design task through the prompt can bring more creative solutions (Paananen et al, 2023). Prompting has also been used in game-based learning with some success, leading to increased problem-solving skills (Lee et al, 2023).

3. Ideation

Generative AI tools such as ChatGPT and Midjourney are best used in the Ideate phase of the Design Thinking process. In the Ideation phase, ChatGPT can help generate unexpected ideas, new or starting from existing ones, and refine them based on user feedback, thus giving designers a wider range of options and rendering the designed products more creative and innovative (Al-sa'di & Miller, 2023). The opportunities for enriching idea generation in product design, by visualizing impossible ideas were also observed by Vartiainen & Tedre (2023) and by Paananen et al (2023),

both noting that the participants in their experiments consider that generative AI tools are good for Ideation but can become a limiting factor in the design process, if overused. On the other hand, generative tools could support an imaginative mindset, enriching the design process (Paananen et al, 2023).

Efficient communication is a challenge in interdisciplinary teams, due to lack of mutual understanding, which can slow down progress. Midjourney could bridge this gap. In an experiment, the multidisciplinary team that used Midjourney spent less time in discussions and more time on the visual output, and there was no need for translation of the abstract language between the specialists (Yin et al, 2023).

In an experiment by Lyu et al (2023) a group of artists and non-artists were invited to experiment with text-to-image AI systems, to generate paintings, to discuss process coding and visual perception. Midjourney generated the most qualitative samples, matching the text descriptions best. Therefore this was the tool used in the continuation of the experiment. The participants were first-time users of Midjourney, and they had different experiences with the program according to their artistic or non-artistic background. Despite variations in results, this proves that Midjourney can be used by both categories with some success and that the author no longer needs to be skilled in the tools of the trade to create high-quality images. (Lyu et al, 2022).

4. Prototyping

By integrating generative AI in the design process, user satisfaction was increased as well, since the user feedback was integrated into the design process with the aid of ChatGPT, making the redesigned prototypes more user-friendly and intuitive, as well as reducing project time by streamlining the design process through suggestions of modern design elements (such as colour schemes, typography) and feedback. However human expertise is critical in the Prototype stage, because AI can fail to see the nuances of the human user experience (Al-sa'di & Miller, 2023).

5. Testing

Testing prototypes with target users helps create a tangible experience of innovation. Feedback is essential, without it informed design decisions cannot be made. As in the previous stage of Prototyping, in the Testing phase human touch is essential, generative AI tools are only as good as the creative, expert human behind them (Al-sa'di & Miller, 2023).

Conclusions

In future design, the emphasis falls on understanding design systems, more than on the skills of the designers. The abilities related to design and multidisciplinary knowledge of the designers are more valuable. With AI generative tools designers can preserve their energy to focus on researching design inspirations across a broader spectrum. Tools such as Midjourney can efficiently generate a plethora of abstract solutions for designers, reducing their workload, which allows them to focus on innovation and collaboration. Using image-based generative AI can enhance divergent thinking and productivity due to its ability to generate many examples in a short time. Throughout the process, data can be collected through various methods, such as opinion mining or sentiment analysis, extracted from texts available online such as opinions or reviews.

Integrating visual generative AI tools such as Midjourney in design thinking education could be advantageous, since it could represent a valuable tool for the students, helping them express their ideas regardless of their creative ability. Prompt engineering, which is the development of writing prompts and prompting strategies, has become a critical skill in handling generative AI, that could enhance learning outcomes and self-regulation skills including in STEAM. The log data that captures the students' learning process could be a valuable tool for

educational research, should the prompt data and timestamps be collected for pattern recognition and recording experiences. Design education has an interdisciplinary nature and could be integrated with the potential of image-centred generative AI.

Overall, teaching design thinking with technology might have a positive impact on students, supporting them in developing new skills, practicing creativity and critical thinking. Also, the use of generative AI applications such as Chat GPT or Midjourney facilitates the making-thinking process, in which thinking is more than an inner processing of representations derived from sensorial information but is an activity that loops between a body in action and an environment. In this case design thinking with technology puts making at the core of creativity in an academic practice, encouraging new ways of teaching creativity and collaboration between students from different backgrounds.

We should also not ignore the pillars of concern regarding using AI technologies in education, which are: plagiarism, biases, discrimination, privacy, and difficulty in assessing tasks. Also, in the adoption of generative AI, symptoms of irritability, anxiety, and sadness can appear, with a continual form of use nonetheless, which can affect staff and student wellness (King & Prasetyo, 2023). Text prompting is a skill that has a learning curve. This could help students understand their own process, skill, abilities. Problematic use of internet and social media also exist, although they have not been recognized as forms of addiction.

The lack of available data published in the past 2 years on the topic of practicing design thinking with AI is one of the potential limitations of this research study.

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