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Effect of using Design Thinking Methods (DTM) and AI in developing Convergent Thinking in Design Students of Furniture Design Classes

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Abstract

This research examines the effect of Design Thinking Methods (DTM) and AI on the development of convergent thinking among interior design students. The study employed a descriptive analysis involving 107 fourth-semester students in a furniture design class, using questionnaires and analysis of design outcomes. Students applied design thinking stages with AI as a design support tool. Divergent thinking was encouraged during the ideate stage, while convergent thinking was emphasized in synthesizing and refining design solutions. The findings show that the integration of DTM and AI positively enhances students' ability to make coherent design decisions and develop well-structured furniture design concepts.

Keywords: AI, Convergence, DTM, Furniture

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1.0 Introduction

Higher education in art and design, especially the Interior Design Program, faces increasing demands to foster creativity and innovation. The Furniture Design course requires students to complete a semester-long furniture design project. This task demands both divergent and convergent thinking skills, where divergent thinking helps generate various ideas, and convergent thinking helps select and develop the best idea. Although divergent thinking is often emphasised and encouraged in design studios, convergent thinking presents a greater challenge, as it demands critical judgement, decision-making, and the ability to balance creativity with functional, material, and production constraints. As a result, convergent thinking in furniture design education remains relatively underexplored compared to idea generation and creative exploration.

Triatmodjo and Nurcahyo (2024) assert that the Design by Participation method enhances design education by encouraging active student involvement and collaboration. The paper highlights that this approach improves creativity, engagement, and critical thinking. While conceptually strong, it lacks substantial empirical evidence to support its claims. Nevertheless, it offers a useful perspective on student-centred design learning in higher education.

The Design Thinking Method (DTM) is a widely adopted approach in global design education, known for its user-centred and solution-oriented framework. The method allows students to empathise with users, identify key issues, and develop contextually relevant solutions. Previous research (Kelley & Kelley, 2013; Brown, 2008) has shown that DTM effectively enhances creative and innovative thinking.

Along with DTM, AI offers ever-evolving support in the design process. AI enables rapid ideation, visualisation, and optimisation of designs, thus enriching students' creative workflow. Generative AI can enhance productivity and innovation by automating tasks and augmenting human capabilities (OECD, 2025), but its use may also negatively affect creativity and creative confidence if not guided carefully (Habib et al., 2024). Convergent thinking – the ability to distil multiple ideas into actionable solutions – is critical to realising user-centred design.

This study aims to examine how the integration of Design Thinking Methods (DTM) and AI supports the development of convergent thinking in furniture design students. Given the limited research on the use of DTM and AI in promoting convergent thinking in furniture design education, this study examines how these approaches shape students' decision-making and problem-solving skills.

2.0 Literature Review

2.1 Design Thinking Methods
Design thinking is a human-centred approach to problem-solving that involves understanding user needs, generating creative ideas, prototyping, and testing solutions (Fig. 1). The approach consists of five stages: empathise, define, inspire, prototype, and test, which are illustrated in Fig. 2. These stages are iterative and non-linear, allowing designers to revisit previous stages as needed. DTM emphasises deep user understanding and continuous improvement through feedback. In design education, DTM is important because it provides a structured framework that guides students from divergent idea generation toward convergent decision-making. This structure supports students in selecting, refining, and developing design ideas into feasible solutions, making DTM particularly relevant to the study of convergent thinking in furniture design education.
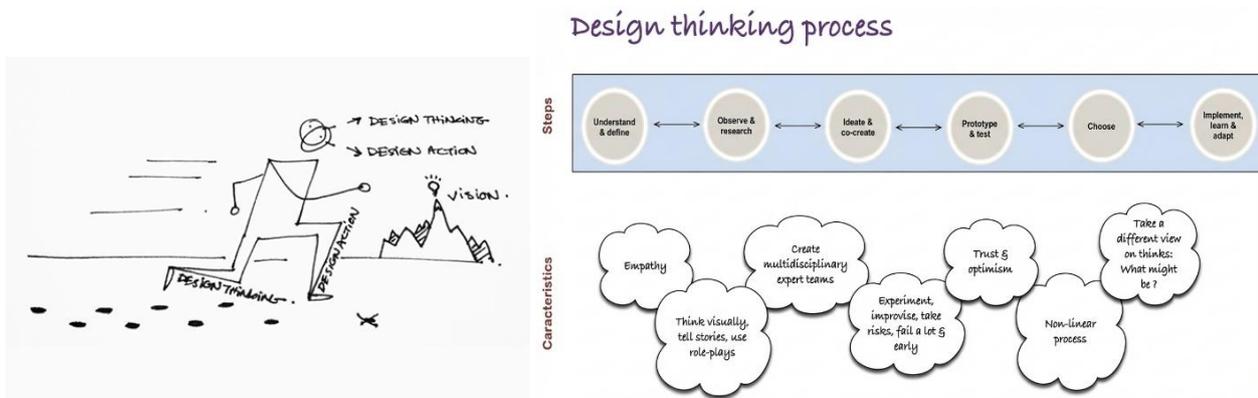

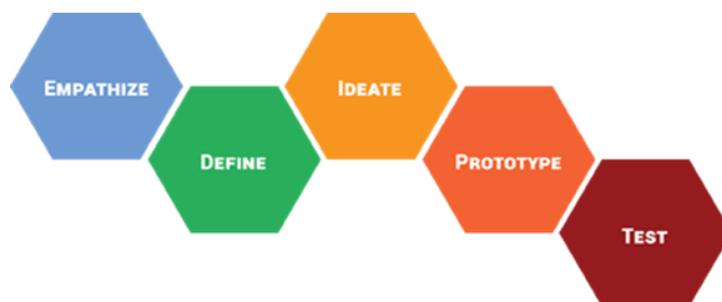Fig. 1: Design Thinking Process Implementation
(Source: Gill, 2003)

Fig. 2: Stages in Method *Design Thinking*
(Source: https://dschool.stanford.edu/groups/Improv_activities_for_Design_Thinking.html.2014)

2.2 Artificial Intelligence (AI)
AI is a computer system that mimics human intelligence, including learning, reasoning, and problem-solving. In interior and furniture design, AI supports visualisation and planning. While it increases efficiency and creativity, AI has limitations in emotional context and data dependency, so it remains a tool, not a replacement for designers.

AI is a branch of computer science that simulates intelligent behaviours on computers. The popularity of AI is evident in its widespread use across all areas of life, from law to health, finance, and education. AI plays an important role in helping all human needs.

According to McCarthy (2007), AI aims to understand the human thinking paradigm. Hence, AI is known as artificial intelligence. Intelligent means having knowledge, experience, reasoning, and good morals. Intelligence in AI technology is structured in computer systems capable of performing human tasks. The way AI works is similar to humans, being able to analyse and use data available in the system. AI operates through processes such as learning, reasoning, and self-correction, offering advantages including efficiency, replicability, affordability, systematic documentation, and improved performance across various applications (Sobron & Lubis, 2021).

In the context of this study, AI is significant because it influences how students generate and evaluate design ideas. When integrated into the design process, AI has the potential to accelerate ideation while simultaneously requiring stronger convergent thinking skills to critically assess and refine AI-generated outputs.

2.3 Divergent and Convergent Thinking
Divergent thinking involves generating many creative ideas, while convergent thinking focuses on narrowing down concepts to find effective solutions. Both are important in design. Techniques such as brainstorming aid divergent thinking, while evaluation and decision-making enhance convergent thinking. Convergent thinking ensures ideas are feasible, user-centred, and appropriate to their context (Sumarta & Handranata, 2017; Hamad & Abdullah, 2022). Convergent thinking is particularly important in design education because it ensures that creative ideas are feasible, user-centred, and appropriate to real-world contexts. This study focuses on convergent thinking as a key outcome of integrating DTM and AI in furniture design learning.

2.4 Furniture Design Class
The Furniture Design study program at ISI Yogyakarta covers three levels, from simple to complex projects. The study's program aims to combine aesthetics, functionality, material use, and production methods. Students start with inspiration and sketches, then proceed with conceptualisation, research, development, implementation, evaluation, and presentation. AI and DTM support a structured yet creative process that guides students from ideation to realisation.

3.0 Methodology
This study used a descriptive research approach to examine how Design Thinking Methods (DTM) and AI are applied in furniture design education and how they relate to students' convergent thinking. Descriptive analysis was chosen because the research focuses on documenting and analysing existing learning practices rather than testing experimental interventions.

The participants were 107 fourth-semester interior design students enrolled in a furniture design course at ISI Yogyakarta. Data were collected through questionnaires and analysis of students' design outcomes. The questionnaire was used to obtain structured data on students' familiarity with AI and their perceptions of its role in the design process. Students' design works were analysed to identify indicators of convergent thinking, such as idea selection and refinement. The data were analysed quantitatively using descriptive statistics.

4.0 Findings
Research has found that integrating DTM and AI can improve students' convergent thinking by supporting structured ideation and effective decision-making. Students who use AI during the ideation stage can generate many visual concepts and repeat them quickly.

Survey data shows a high level of knowledge and interest in AI, especially apps such as ChatGPT, Gemini, and Dreamina. Students use these apps for design reference, idea generation, and layout planning. Most students positively perceive AI as a means of improving design quality and efficiency.

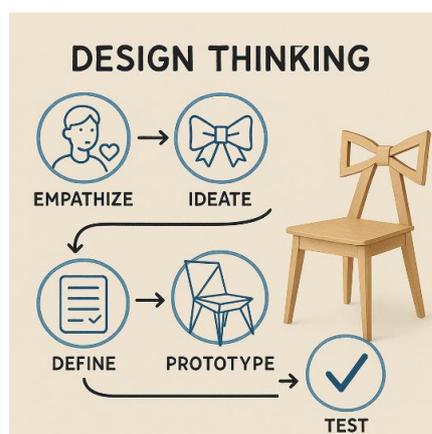### 4.1 Furniture Design Process with DTM in Furniture Design Class

Fig. 3: The process of designing a chair furniture design using DTM and AI (ChatGPT program)
(Source: https://chatgpt.com/c/68541dfb-0644-800a-b4fa-7b5d24e82cd1)

DTM is a user-centric and solution-oriented approach. With the help of AI, students can improve the efficiency and effectiveness of the design process. Fig. 3 shows the design workflow of a chair project, where students applied DTM stages supported by AI tools such as ChatGPT to assist with ideation and decision-making. The resulting design, a dining chair, was produced using the AI image-generation tool Dreamina, as illustrated in Fig. 4. This example demonstrates how AI can contribute to the process and the visual development of the final design.

Fig. 4: "Himo" dining chair design using AI (Dreamina)
(Source: Maramis, 2024)

4.2 Use of AI in the Design Process in Furniture Design Class (Questionnaire Results)
Most respondents knew about AI and could provide a definition and explain its function in a learning context. AI is seen as a tool that can support students in achieving their learning goals more effectively. 69.16% of students reported familiarity with AI, while 30.84% indicated they were not (Fig. 5). The responses also provided insight into students' understanding of AI:
a) Definition: AI is a technology developed to make human work easier, particularly tasks requiring human-like intelligence.
b) Functions: AI is seen as capable of providing answers or results based on questions and available data, and in some cases, generating new or unexpected information.
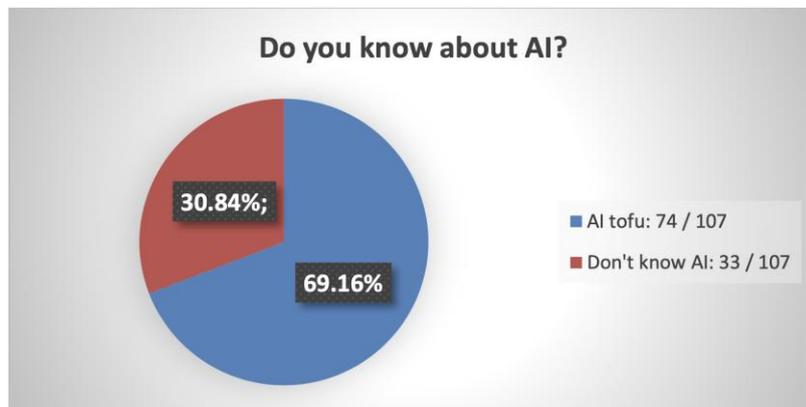

Fig. 5: Diagram of the number of students who know AI

Just over half of the students became familiar with AI during high school (between 2020 and 2022) or after the COVID-19 pandemic. As shown in Fig. 6, 52.34% of students reported learning about AI during high school, while 43.92% became familiar with it after

graduating from high school or during college (2023–2025). Several key factors were identified as influencing the emergence of AI awareness among students:

a) ChatGPT went viral in 2022 and was officially released on November 30, 2022.
b) Use of AI technology in design (such as interior design, graphic design, architecture, or product design) and gaming
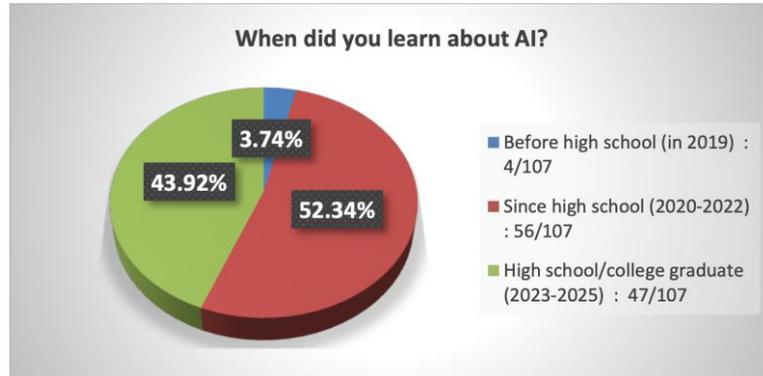c) Educational needs or academic assignments that utilise AI technology.

Fig. 6: Diagram of when students learn about AI

Approximately four-fifths of the students viewed AI positively and recognised its benefits in learning and design, with 80% expressing favourable opinions (Fig. 7). Some respondents were aware of the negative impacts, especially regarding ethics, dependency, and impact on employment. It is important to emphasise using AI wisely, responsibly, and within the context of ethics and human rights.
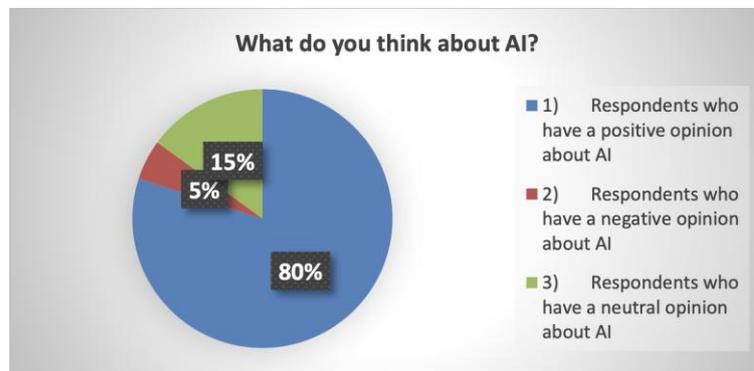

Fig. 7: Diagram of students' opinions about AI

The vast majority of students have a high interest in AI. AI can provide benefits in everyday life, especially in the context of education and design. As shown in Figs. 8 and 9, 90% of students indicated interest in AI. Respondents highlighted several reasons for their enthusiasm:

a) Practical functions: AI helps them carry out tasks, find information, and improve time efficiency.
b) Creativity and design: AI can provide design references, develop ideas, and enhance creativity in the design process.
c) Technology development: AI is a technology that is constantly evolving, becoming more sophisticated, and will play an important role in the future.
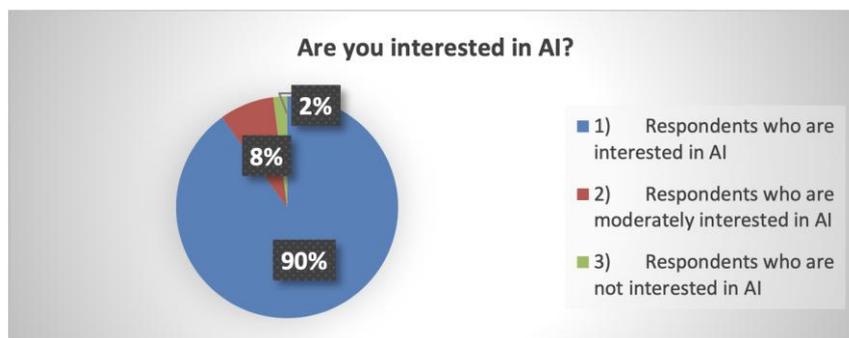

Fig. 8: Diagram of student interest in AI

Nearly all students reported direct experience using AI in various activities, particularly those related to academic tasks, design, and learning. As illustrated in Fig. 9, 95% of students stated that they have used AI, while only 5% have never used it. These findings indicate that AI is increasingly recognized as a multifunctional tool with significant potential in educational contexts and creative fields such as design.
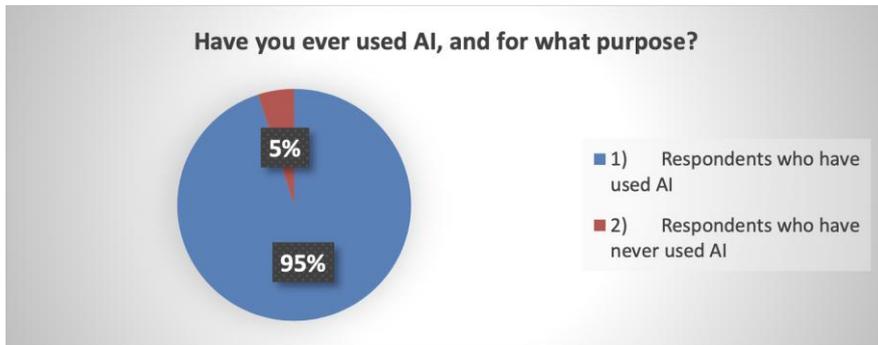

Fig. 9: AI usage diagram

The respondents who had experience using various popular AI apps use them to support learning, task preparation, information retrieval, or visual design processes. As shown in Fig. 10, ChatGPT emerged as the most widely recognized and used application among students, followed by Gemini and Copilot. Some respondents also use other apps such as Perplexity, Dreamina, Leonardo AI, and OpenArt. This shows that AI has become an important part of students' academic and creative activities, and has great potential to continue to be developed and optimally utilized.
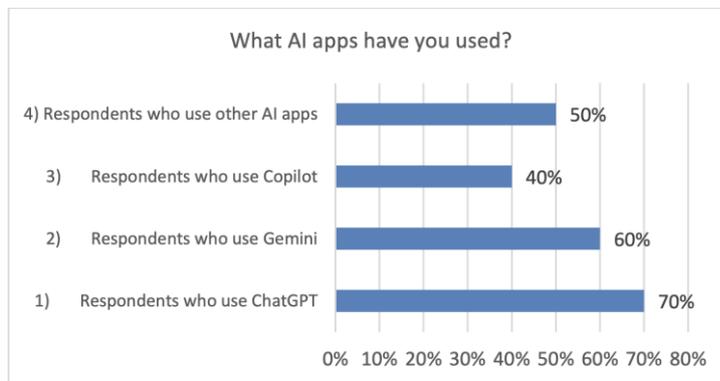

Fig. 10: Diagram of AI applications that have been used

A large majority of respondents identified AI apps such as ChatGPT, Gemini, and Copilot as the most well-known AI applications. As illustrated in Fig. 11, ChatGPT was the most frequently recognised, followed by Gemini and Copilot. Students noted that these AI tools serve various specific purposes, including searching for information, completing assignments, and finding design references. Categories of AI apps recognised by design students:
1) AI apps for searching information and answers: ChatGPT, Gemini, Perplexity, etc.
2) AI apps for creating drawings and designs: Leonardo AI, OpenArt, Dreamina, etc.
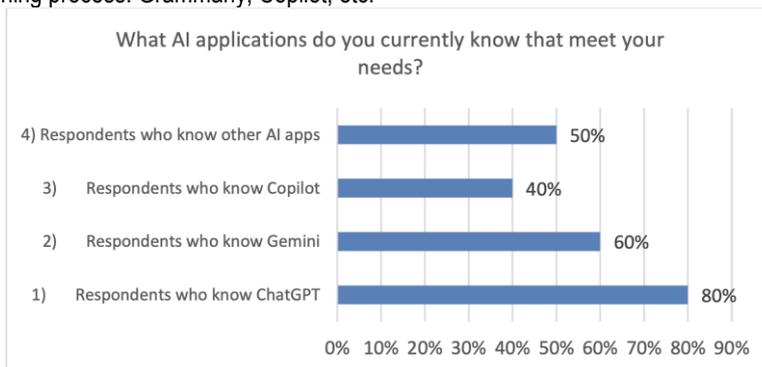3) AI apps to help the learning process: Grammarly, Copilot, etc.

Fig. 11: Diagram of AI applications that meet the needs of design students

Analyse the needs of AI in interior and furniture design:

1) AI as a tool: around two-thirds of respondents agreed that AI can be a useful tool in the design process, especially in finding design references, inspiration, and visualisation.
2) Human creativity is still important: While AI can help, a majority of respondents emphasised that creativity and skills are still important in interior and furniture design.
3) Limitations of AI: A smaller proportion of respondents noted limitations of AI. Respondents mentioned that AI still has limitations in understanding complex design concepts and thought processes.
4) Judicious use of AI: the majority of respondents agreed that AI should be used judiciously and not replace the role of designers.

AI is a valuable tool in interior and furniture design, offering efficiency and support throughout the process. However, it cannot replace human creativity, intuition, and experience. When used wisely and in context, AI can enhance design outcomes while still requiring active designer involvement.

1) Advantages of AI according to respondents:
   a) Time efficiency: Accelerates design and rendering processes, increasing productivity.
   b) Inspiration and creativity: Offers unexpected ideas that support unique, innovative outcomes.
   c) Reference and information: Provides extensive data on design, materials, and trends to aid decision-making.
   d) Visualisation: Helps quickly and accurately visualise design ideas.
2) Disadvantages of AI:
   a) Lack of emotional touch: AI struggles to reflect personal or cultural nuances in design.
   b) Data limitation: Its knowledge is restricted to existing input, lacking depth in traditional or local design.
   c) Technology dependency: Overreliance may reduce manual skills and creative thinking.
   d) Technical flaws: AI-generated designs may overlook ergonomics or user expectations.

Research Findings:

1) Approximately four-fifths of the furniture design students became familiar with AI around 2022 through education and technology trends, particularly in digital and game design. While many understand AI as a human intelligence-based innovation tool, some students still require further introduction from lecturers to enhance tech literacy.
2) Students generally view AI positively, recognising its support in completing tasks, finding information, and saving time. However, they also emphasise the need for ethical, responsible use to maintain academic integrity and learning independence.
3) Students consider AI useful, especially in creative writing and idea generation, thus supporting productivity and creativity in design.
4) ChatGPT, Gemini, and Copilot are the most widely used apps for searching information, completing assignments, and exploring design ideas.
5) AI is considered helpful in the interior and furniture design process, especially regarding efficiency and quality improvement. However, human creativity remains an irreplaceable key element.
6) The advantages of AI include speed, idea reference, and design visualisation. The disadvantages lie in the lack of emotional and cultural understanding and the risk of manual skill degradation if overused.

5.0 Discussion

5.1 Furniture design with DTM in developing convergent thinking
AI-assisted chair design process steps:
1) Using AI with ChatGPT and DreaminaAI apps
2) Inputting a command: create a dining chair that takes inspiration from the bow tie on the back of the chair, but is made implicitly so that only the shape is visible. The material uses oak wood with indigo blue upholstery, and the seat also uses a comfortable shape to sit on. The chair legs are also unique because they use cantilevers. Height: 90 cm (including a backrest shaped like a bow tie, width: 45 cm, depth: 50 cm, seat height: 45 cm, is realistic and uses a white background.
3) Fig. 12 shows the resulting image from the prompt:

(a)   (b)

Fig. 12: (a) ChatGPT result chair; (b) DreaminaAI result chair
(Source: Maramis, 2024)

4) The process of developing ideas from previous AI has resulted in a chair image in Fig. 13:

Fig. 13: Himo Chair Idea Development Process
(Source: Maramis, 2024)

5) Improvement and assessment of rationality in design should be made so that it makes sense and is clear in the manufacturing process, as illustrated in Fig. 14.
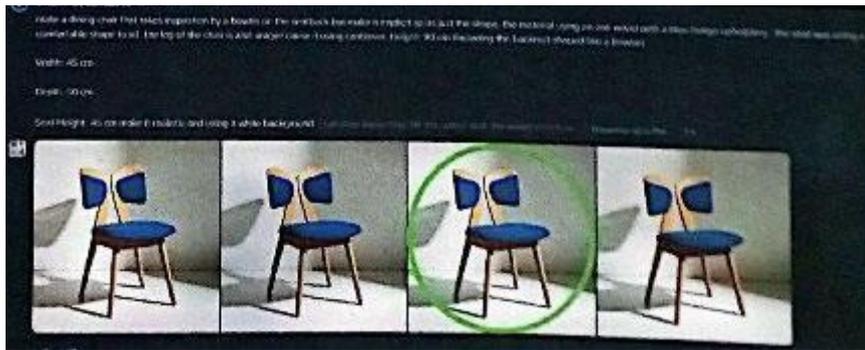

Fig. 14: Improvement of Chairman Himo's Ideas
(Source: Maramis, 2024)

6) Advanced ideation work: adding the command "*fill this space white with a wooden structure*".Fig. 15 shows the development of the idea.

Fig. 15: Himo Chair Advanced Ideas
(Source: Maramis, 2024)

7) Prototype making and the example of chair transformation, as illustrated in Fig. 16.

Designers can use DTM and AI to develop innovative chair designs according to user needs. AI enhances the efficiency and quality of the design process. Tools like DreaminaAI assist with visual and 3D design, while ChatGPT supports text-based tasks such as generating design descriptions, specifications, and ideas, even though it cannot produce visuals directly.

The impact of AI and DTM on students' coherent thinking in furniture design is reflected in several ways:
1) Increased Creativity: AI helps generate innovative ideas.
2) Data Analysis: AI analyses user preferences, trends, and materials.
3) Greater efficiency: Repetitive tasks are automated, allowing more focus on creativity.
4) More User-Centred: DTM can help students understand user needs and preferences, resulting in user-centred design.
However, effective use of AI and DTM requires strong analytical and evaluation skills to ensure coherence and quality.

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Additional benefits include improved problem-solving, better collaboration between students, lecturers, and practitioners, and support for more sustainable, environmentally friendly furniture design.

Fig. 16: Himo Chair Design Transformation
(Source: Maramis, 2024)

5.2 Designing furniture with AI in developing convergent thinking

Survey results show that integrating AI into furniture design education supports interdisciplinary learning by combining computer science and design. Most students became familiar with AI around 2022 through school and tech trends, particularly in design and gaming. While many use AI tools like ChatGPT, Gemini, and Copilot for academic and creative tasks, some students remain unfamiliar, highlighting the need for greater technological literacy.

Students are generally positive about using AI because it can help them complete assignments, find information, and save time. However, students are also aware of AI's shortcomings, so its use must be wise and ethical, upholding the values of honesty and independence.

From the above, it can be concluded that the combination of DTM and AI positively influences students' coherent thinking in the furniture design process. AI stimulates visual exploration and creative ideas, while DTM provides structure and direction, resulting in more meaningful and user-centred designs. This finding is consistent with previous studies that highlight the role of structured design frameworks, such as DTM, in guiding students from creative exploration toward feasible solutions (Brown, 2008; Kelley & Kelley, 2013). Students who use AI during the ideation stage can generate many visual concepts and repeat them quickly, supporting divergent exploration as described in studies on divergent and convergent thinking in design (Sumarta & Handranata, 2017).

In interior and furniture design, AI can improve efficiency, inspiration, and visualisation, but human creativity remains irreplaceable. While AI offers speed and support in idea development, it also has limitations in emotional and cultural understanding and may reduce manual skills, a concern also noted in previous discussions on creativity support tools and the risks of uncritical technology use (Habib et al., 2024). AI should therefore function as a supportive tool rather than a replacement for designers. The systematic application of DTM helps students organise ideas more logically, while AI expands visual exploration. Together, these approaches enhance convergent thinking by supporting reflection, decision-making, and the development of coherent design solutions.

6.0 Conclusion and Recommendation

The study concludes that integrating DTM with AI significantly enhances the development of convergent thinking among furniture design students. DTM offers a powerful framework for identifying user needs and refining ideas, while AI accelerates the ideation process by providing various visual references and interactive feedback.

Design students benefit from the synergy between human creativity and machine intelligence. AI contributes to rapid idea generation and visualisation, while DTM ensures that the final design solution is user-centred and practically feasible. However, effective outcomes depend on the careful and ethical use of AI, guided by human supervision. The research was conducted within a single furniture design class at one institution, which may limit the generalisability of the findings.

This study recommends:
1) Embedding AI tools in the design curriculum to introduce students to digital ideation and visualisation early on.
2) Train design educators to guide students in using AI tools responsibly and creatively.
3) Encourage collaboration between design and computer science departments to develop AI tools and databases tailored to interior and furniture design education.
4) Further education is needed for AI to be used ethically and optimally in design education. Emphasise the balance between AI-assisted design and the development of individual creative identity. As AI continues to shape the creative industries, AI-assisted design should be used in design education.

Acknowledgement

Papers' Contribution to Related Fields of Study

This study contributes to design education by showing how DTM and AI can together foster structured creativity and convergent thinking. This research provides empirical evidence to support curriculum innovations in interior and furniture design programs. It also offers practical insights for integrating AI as a design tool while preserving human intuition and cultural sensitivity. The findings are relevant for educators, curriculum developers, and design practitioners who want to balance technological innovation with fundamental design thinking principles.

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