

## Examining the Impact of AI on Creativity and Divergent Thinking in Interior Design Education

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### Abstract

This study examines how the integration of Artificial Intelligence (AI) influences divergent thinking and creativity during the design process (DP) among third-year interior design students. Using an empirical approach, 90 fifth-level interior design students in Studio (3) were introduced to AI tools at various stages of a design course. At the beginning of the term, students were assigned team-based projects with complex design requirements. They were encouraged to set clear goals, apply theoretical frameworks, and utilize AI tools during the programming and schematic design phases. Data were collected through the analysis of student work and a post-project survey completed by 72 students. The findings indicate that AI enhanced efficiency, conceptual clarity, and organization, while also supporting divergent thinking and fostering innovation. Students reported greater confidence in exploring a wider range of design solutions. This study contributes to current knowledge by demonstrating how AI can be effectively integrated into the early stages of the design process to support student creativity and project development. It also underscores the importance of aligning AI use with pedagogical goals and structured teamwork strategies. These insights offer a valuable basis for rethinking instructional methods and advancing the use of AI in design education and related creative disciplines.

**Keywords:** AI in Design, Design Process, Creativity, Divergent Thinking, Interior Design, Project Development.

### Article Highlights

1. Integrating AI significantly with teamwork and traditional methods enhances students' creativity and innovation, leading to more dynamic design outcomes. This

integration helps foster originality, enhance efficiency, and stimulate divergent thinking.

2. AI serves as an effective collaborative partner, streamlining workflows and encouraging the exploration of multiple design possibilities.
3. Despite AI's benefits, human collaboration, interpersonal communication skills, and critical decision-making remain essential.

## Introduction

Artificial Intelligence (AI) is transforming how designers generate innovative ideas and develop creative solutions across disciplines, leading to more efficient and effective design outcomes. AI has become a human-computer collaborative tool in design fields such as architecture and interior design. Through its ability to generate diverse design alternatives, AI expands designers' cognitive and interim design imaginative boundaries [1].

As AI tools become increasingly embedded in design workflows, attention has shifted toward understanding how these technologies influence creativity among design students. Montenegro [2] emphasizes the importance of informed and reflective AI use in architectural education and practice, highlighting its potential to augment rather than replace human creativity.

Divergent thinking (DT), defined as the ability to generate multiple original ideas, is central to creativity [3, 4]. In an AI-assisted design environment, DT drives generative processes by enabling students to explore a broader range of design possibilities [5]. However, this process must be balanced with evaluative thinking, which involves assessing the originality, feasibility, and relevance of ideas [4]. The interplay between divergent and evaluative thinking is critical for refining and developing creative outcomes, particularly in complex design contexts [3].

Accordingly, this study investigates how AI integration influences creative problem-solving, idea generation, and collaboration among third-year interior design students enrolled in Studio (3). The study aims to examine the pedagogical potential of AI in

enhancing creativity within design education and to identify its implications for future curriculum development.

## Course Structure and Analytical Framework

To structure the course framework, the systematic search was conducted in the Web of Science database using keywords “AI in design,” “creativity,” “creativity support tool,” and “divergent thinking.” The latter two keywords were automatically suggested by the database. This search yielded 1,962 relevant English-language studies published between 1962 and July 2024.

Then, a bibliometric analysis was conducted to visualize keyword co-occurrence patterns using VOSviewer (Figure 1). This approach enabled the mapping of relationships among key concepts and the identification of emerging research areas, particularly highlighting the central role of DT in the intersection of AI and creativity in design.

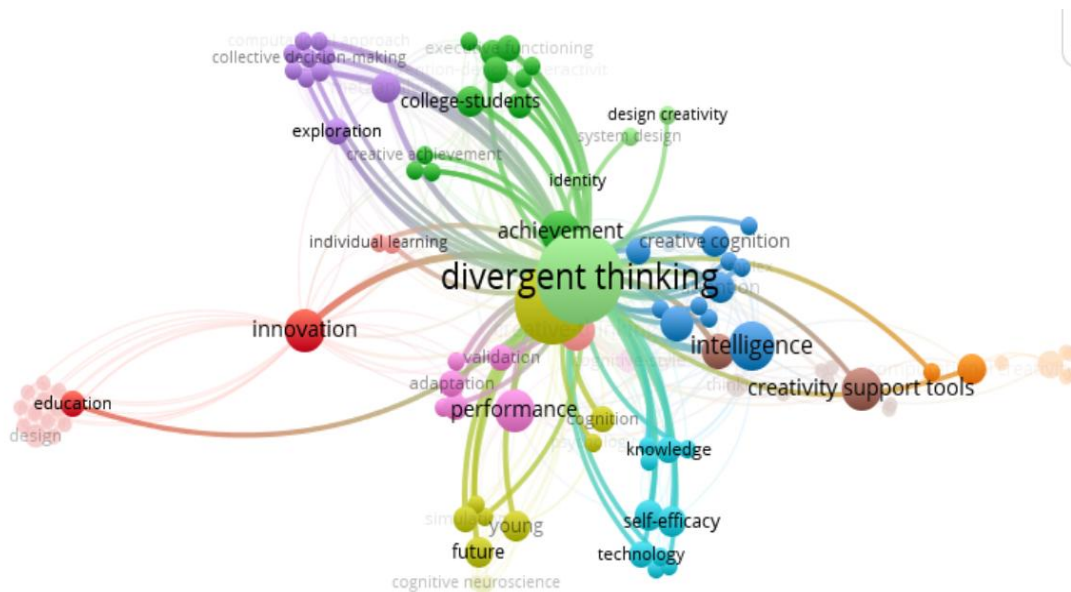


Figure (1): The co-term occurrence analysis reveals correlations among divergent thinking, education, innovation, exploration, teamwork, design creativity, performance, creative support tools, and AI integration

The bibliometric analysis revealed that DT functions as a central concept linking key themes including education, innovation, exploration, teamwork, design creativity, performance, creative support tools, and AI integration (Figure 1). This finding underscores the critical role of DT in integrating AI into the creative design process (DP). This link between AI and DT opens new possibilities for collaborative and adaptive design practices.

According to Said-Metwaly et al. [6], intellectual giftedness significantly strengthens the relationship between DT and creative achievement. Building on these insights, the present study draws on the bibliometric findings to examine how DT shapes the role of AI in design education and influence innovation, creativity, and teamwork among students. This perspective offers insight into how AI can serve as a creative support tool in preparing future-ready designers. This further highlight the importance of considering designers' cognitive capacities when examining how AI may enhance and support design innovation.

## Methodology

This study employed a mixed-methods approach with an embedded experimental design, focusing primarily on students' design work, complemented by questionnaire data for broader insights. The aim was to evaluate the impact of AI integration on student creativity and workflow, using primarily quantitative data enriched with qualitative analysis to explain outcomes and underlying processes. The intervention involved observing and measuring interior design students' use of AI tools during their projects. Quantitative data were collected from post-course questionnaires, while qualitative data were gathered from students' project booklets and researcher observations.

### Course-Based Experimental Design:

Fifth-level interior design students from a university in western Saudi Arabia participated in the Studio 3 course-based experiment. First, students conducted group research on design sites, contextual factors, and potential users' needs before receiving

a formal project description. Groups of five to students explored topics including users' health and well-being, sustainability, biophilic design, and Saudi building codes and safety. The content of the search phase was compiled into a single document and shared with all students.

After that, students were divided into teams of four to six members and assigned to large-scale projects to design administrative workplaces that focus on efficient, user-centered office environments supporting productivity and collaboration, with an emphasizing on spatial organization, ergonomics, and environmental comfort. Each team was required to define the functional and aesthetic goals of the project. Students were allowed to use AI tools to generate visual references and conceptual diagrams, as well as to support brainstorming. However, core deliverables such as floor plans, elevations, sections, and final renderings were required to be completed manually to preserve fundamental design skills.

At the beginning of the semester, students received guidance on applying theoretical frameworks, defining clear goals, and using AI thoughtfully, particularly during programming and schematic design phases. Teams documented their AI use in dedicated project booklets to encourage accountability and reflection. The researcher actively monitored progress, providing continuous feedback to support intentional AI experimentation and critical reflection on AI's role within real-world design processes (DP).

### **Questionnaire Design:**

Following the final jury presentations, students completed a post-experiment questionnaire designed to assess their experiences related to creativity, workflow, time management, collaboration, and AI use. The instrument combined both objective measures and subjective reflections to provide a comprehensive understanding of student engagement with AI in a studio context. It further examined AI's influence on creative problem-solving, idea generation, teamwork, and workflow management, thereby capturing the multidimensional impact of AI integration on the design learning

process.

### Data Collection and Analysis:

Data sources included both student project analyses and questionnaire responses collected via Google Forms. A total of 72 students completed the questionnaire by the end of the semester. The responses were analyzed using Microsoft Excel to quantify the influence of AI integration on design creativity and the overall design process (DP). Furthermore, correlation analyses were conducted to examine relationships between variables such as AI usage, design theory application, problem-solving speed, and level of satisfaction. Effect size measures, including Eta ( $\eta$ ) and Eta-squared ( $\eta^2$ ), were calculated to assess the strength of these relationships. These quantitative analyses were complemented by qualitative data from the questionnaire to provide a comprehensive understanding of AI's impact on students' creative workflows and outcomes.

### Results

Table 1 presents the frequency of participants' responses (yes, maybe, and no) for the five study variables: Use of ai, teamwork preference, early-goal setting, design theory application, and level of satisfaction. The data show that most participants reported using AI tools (yes = 47), preferred teamwork (yes = 37), and strongly agreed with early-goal setting (yes = 59). A similarly high proportion expressed satisfaction with their course outcomes (yes = 59), whereas responses related to design theory application were more evenly distributed.

Table (1): Frequency of participant responses for AI use teamwork preference, early-goal setting, design theory, and satisfaction levels

	YES (3)	MAYBE (2)	NO (1)	Invalid
use of AI	47	0	24	0
Teamwork preference	37	23	11	0
Early-goal setting	59	9	0	3
Design theory	34	16	14	7
Level of satisfaction	59	10	1	1

Figure 2 provides a visual comparison of response patterns across the same variables

shown in Table 1. Each bar represents one variable and is divided into segments corresponding to the proportions of yes, maybe, and no responses. The figure highlights that early-goal setting and satisfaction received the highest levels of agreement, whereas design theory application showed the greatest variation among participants. The predominance of yes responses across most variables indicates generally positive attitudes toward AI use, teamwork, and goal-oriented design practices.

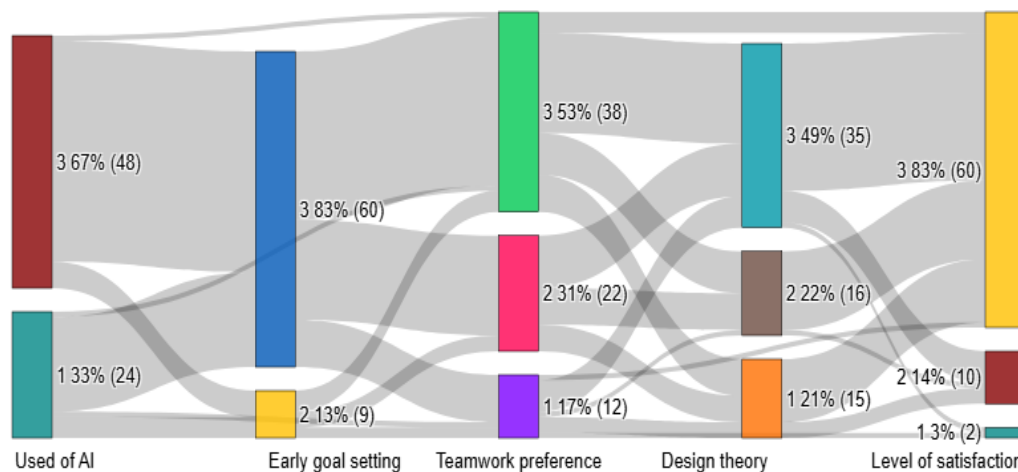


Figure (2): Stacked bar chart showing participants' response patterns across key variables

### Role of AI in Supporting the Design Process (DP):

By the end of the semester, 75 out of 90 students completed the questionnaire; three responses were incomplete and excluded from the analysis. Of the valid responses, 68% reported using AI tools during some phase of the design process (DP). In general, teams that used AI demonstrated a high level of DT as they generated more ideas, a wider range of design alternatives, produced more unconventional solutions, and managed their time more effectively compared to peers who relied on traditional methods.

The collaborative course structure, in which teams worked together, further amplified DT among students using either AI or traditional methods. Teams selected one of four

project types and then chose a specific design focus to develop, completing the programming and concept development phase under tight time constraints. This arrangement fostered knowledge sharing and collective problem-solving, creating an environment supportive of both traditional and AI-augmented creativity. AI usage varied considerably across different design phases (Figure 3): 35% of students used AI tools in the Programming and Concept phase, 16% during the Schematic Design, 7% in the design development phase, and 42% reported using AI across multiple phases.

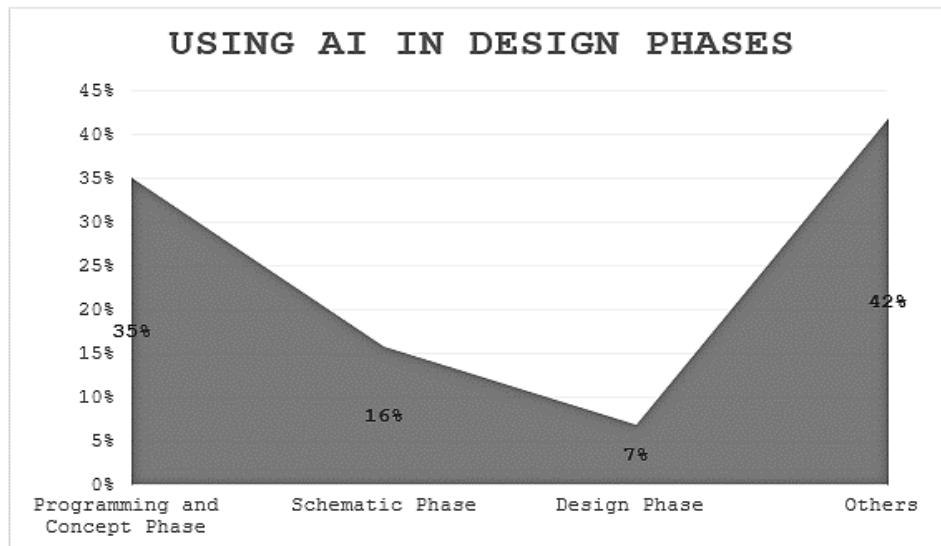


Figure (3): Distribution of AI usage across design Phases (DP)

### Programming and Concept Development Phase:

Approximately 35% of students reported using AI during the programming and concept development phase. This stage is critical for idea generation and initial planning. At this early stage of the DP, students found AI particularly valuable for streamlining tasks such as generating ideas, drafting content, and organizing thoughts, which in turn enhanced their overall workflow. Many students reported that AI assisted them in visualizing their concepts, refining visual elements, and improving image quality, resulting in more coherent and compelling presentations (Figure 4). Other students emphasized its role in facilitating research by suggesting keywords and topics,

depending on their understanding of design principles and strengthening the foundation of their projects.

AI was also commonly used to develop project narratives, format text, summarize information, and refine content. These functions enhanced clarity and improved the quality of written work, and helped students identify visual inspiration aligned with their design visions, streamlining both the research and creative development processes.





Figure (4): Examples of students' work during the programming and concept phase.

### Schematic Design Phase:

AI integration dropped noticeably to 16% during the schematic design, perhaps reflecting limited applications of AI in spatial layout planning or a preference for manual sketching practices at this stage. Nonetheless, AI remained a valued collaborative tool fostering innovation and aiding the understanding of complex issues such as sustainability and functionality (Figure 5).

In this phase, AI helped students define sustainability criteria, select appropriate design features, and integrate environmental considerations into their projects. It also assisted in organizing administrative building layouts by helping to estimate user capacities, ensuring that spatial and functional requirements were met. While some students avoided using AI for sketching or specific content creation, most reported that AI enhanced both efficiency and creative output, enabling clearer communication of ideas and helping them maintain focus on core project goals.

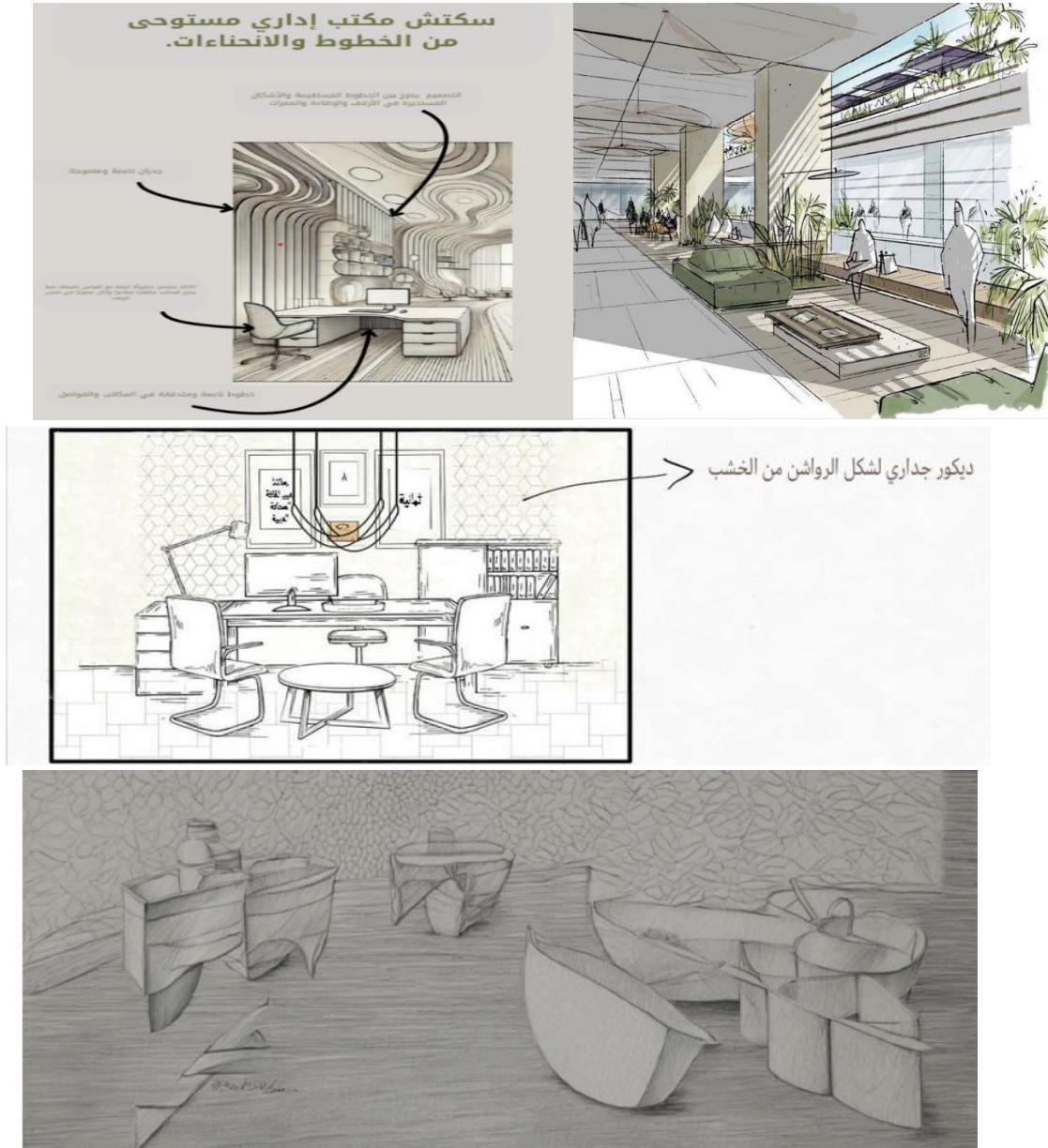


Figure (5): Examples of the students' work during the schematic design phase

### Design Development Phase:

The design development phase showed the lowest level of AI engagement, at just 7%, indicating that students were least likely to incorporate AI during detailed design

development or refinement. This limited use can be partly attributed to the requirement to avoid AI tools in the final project components. Many students used AI during this stage to support collaboration. For example, some students asked AI to generate building facades based on their interior spatial designs (Figure 6). This helped improve the visualization of their projects, especially since collaboration with an architect was not possible within the course.



Figure (6): Examples of students' work during the design development phase. The image on the left was generated by students using AI, while the image on the right shows their actual design during this phase, used to reflect the exterior scenes from their interior design.

### **Beyond the Design Phases:**

Beyond the design phases, interestingly, the “Other” category recorded the highest percentage of AI usage, at 42%, suggesting that students frequently used AI tools outside the structured design phases (Figure 7). This included activities such as rendering, preparing presentations, and producing documentation. Such tasks often encouraged creativity as students explored multiple ways to visualize, communicate, and refine their ideas.

Visualization emerged as a particularly significant area in which AI played a pivotal role. Students reported using AI to rapidly generate visual representations, test

alternative layouts, and enhance image quality. Through this, AI supported a divergent design approach, allowing students to explore variations, reimagine spatial arrangements, and iterate creatively without the limitations of manual techniques. Some students noted that AI helped them conceptualize the overall form of their designs and refine details more effectively, while others appreciated its ability to clarify design elements and provide a structured framework for presenting ideas.

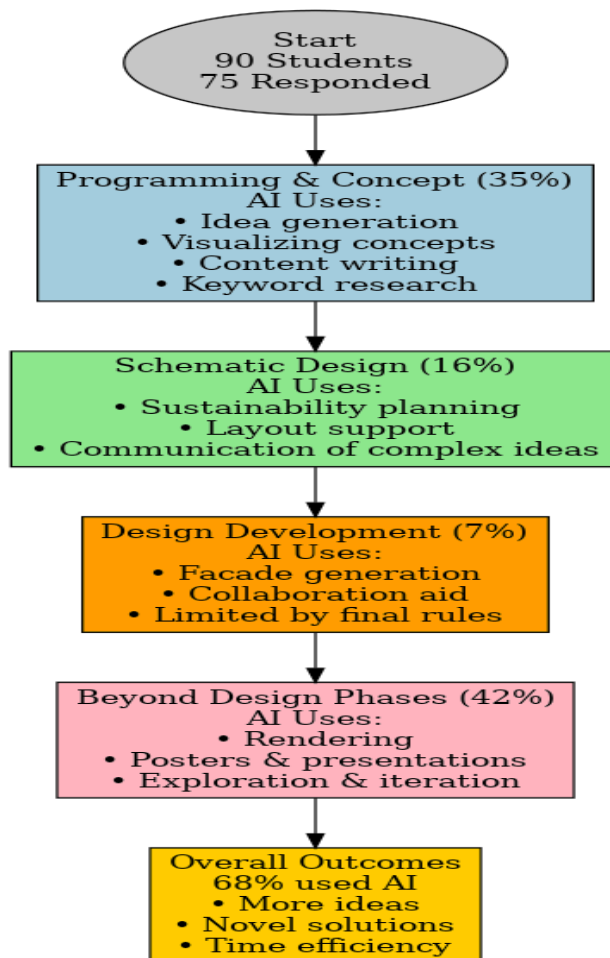


Figure (7): Summary of student AI usage across the interior design process, as reported by students in Studio 3. Percentages reflect the proportion of students who used AI in each design phase. The bullet points summarize what students reported in their survey responses. The diagram was created by the author using AI-assisted tools for content synthesis and visualization

### The Use of AI and Students' Level of Satisfaction:

A point-biserial correlation (Table 2) was conducted to examine the relationship between AI use and Level of satisfaction. There was a positive correlation between use of AI and Level of satisfaction, although this relationship was not statistically significant ( $r_{pb} = 0.21$ ,  $n = 72$ ,  $p = .072$ ).

Table (2): Point-biserial correlation analysis between AI use and students' level of satisfaction

	$r_{pb}$	$df$	$t$	$p$
Value	0.21	70	1.83	.072

### Other Factors Supporting Design Creativity:

Students identified several factors that supported their creativity throughout the DP. Thirty-two percent used design software to enhance their projects, while 43% relied on traditional ways to enhance creativity. Among those who reported using additional resources, several platforms and methods were frequently mentioned as beneficial. Pinterest emerged as one of the most widely used tools, offering visual inspiration and supporting conceptual development. Many students appreciated how the platform allowed them to explore different design styles and extract ideas for their projects. Some specifically noted that finding images on Pinterest assisted them in refining their concepts and strengthening their overall design approach. Additionally, YouTube tutorials and the Miro board platform were cited as useful for creating mood boards and organizing design ideas.

Peer discussions and expert consultations were important, as sharing feedback helped refine designs and explore new directions. Instructor guidance, including critiques and notes, provided structure and helped overcome challenges. Students also emphasized the role of lighting, color, and aesthetics in shaping their ideas, aiding clearer project goals and cohesive designs. Learning new design software improved final presentations and visualization techniques. These varied tools and collaborative experiences encouraged DT by expanding the range of ideas generated and evaluated, supporting the study's goal of understanding how AI and creativity aids enhance ideation and

evaluative thinking for more innovative, well-informed design outcomes.

### Teamwork Preference and Student Perspectives:

Students were asked whether they preferred working in teams. Fifty-three percent reported they preferred working in teams, 32% preferred working independently, and 15% were undecided (Figure 8). Students who choose to work in teams emphasized the value of working with different perspectives, shared responsibilities, and greater efficiency. They described teamwork as a driver of creativity, problem-solving, and motivation. These insights echo the study's focus on DT, as exploring multiple perspectives often leads to richer outcomes and better prepares students for innovation-driven teamwork.

On the other hand, students who preferred working independently pointed to challenges such as unequal participation, communication difficulties, and creative conflicts, which sometimes hindered the benefits of group collaboration. Many students reported feeling frustrated when compensating for less engaged teammates, causing stress and delays. Scheduling difficulties and resistance to feedback also hindered progress. These issues highlight the need for structured collaboration frameworks balancing creative freedom and accountability, vital for fostering both individual and group problem-solving in design education

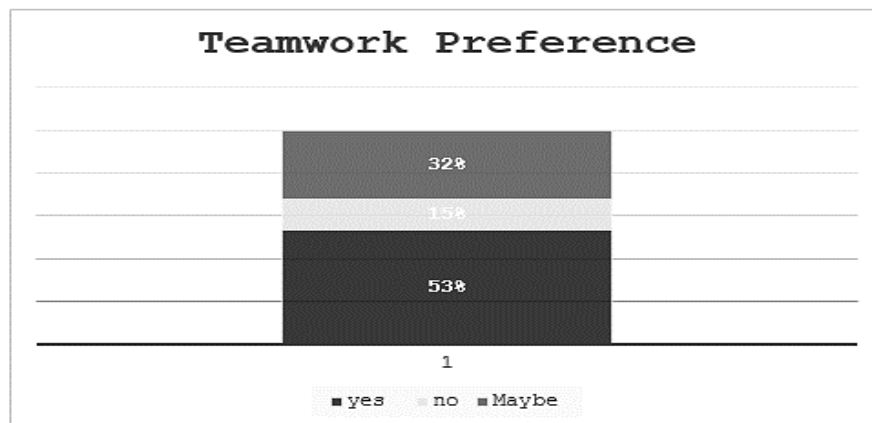


Figure (8): The diagram illustrates the teamwork preference among students

### Teamwork Preference and Students' Satisfaction Level:

Table 3 summarizes the descriptive statistics of participants' satisfaction level across different teamwork preferences. Participants who preferred teamwork (Yes) and those who were neutral (Maybe) reported similar mean satisfaction scores ( $M = 2.84$  and  $M = 2.86$ , respectively), both of which were higher than those who did not prefer teamwork (No;  $M = 2.58$ ). The median score of 3 across all groups indicates a generally high level of satisfaction, while the higher standard deviation observed in the "No" group ( $SD = 0.79$ ) suggests greater variability in their responses.

Table (3): Descriptive statistics of students' satisfaction levels according to teamwork preference

Teamwork preference	Frequency	Mean	Median	Std.	Minimu	Maximum
Level of	No (1)	12	2.58	0.79	1	3
	Maybe	22	2.86	0.35	2	3
	Yes (3)	38	2.84	0.37	2	3

Figure 9 presents a violin plot comparing the distribution of satisfaction scores across the three teamwork preference categories (No, Maybe, Yes). Each "violin" represents the probability density distribution of satisfaction responses within that group, with wider sections indicating a greater concentration of responses. The central marker indicates the median, and the shaded area represents the interquartile range. The plot reveals that participants who preferred teamwork and those who were neutral displayed higher and more concentrated distributions of satisfaction levels, while the "No" group exhibited a wider and more dispersed distribution. This visual pattern supports the descriptive results, suggesting that teamwork preference is positively associated with higher satisfaction.

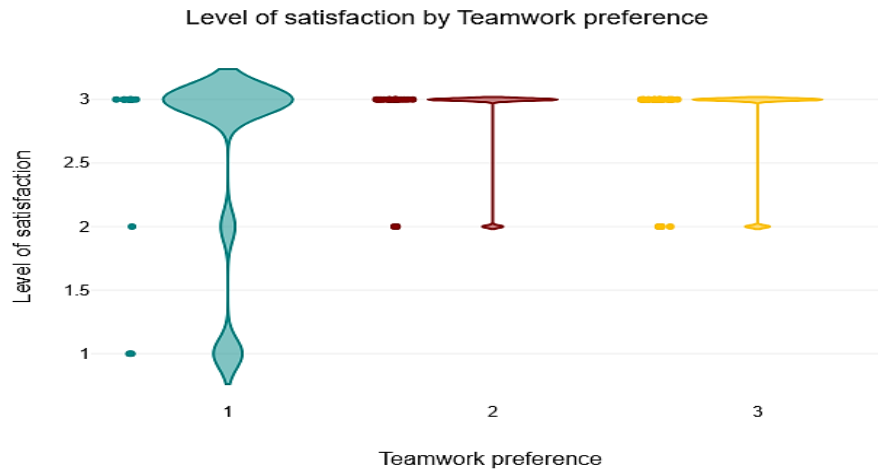


Figure (9): Violin plot of satisfaction score distributions across teamwork preference categories

The correlation coefficient reflects the strength and direction of the linear relationship between teamwork preference and level of satisfaction. The coefficient ( $\tau = 0.07$ ) suggests a negligible positive correlation. This means that, generally, as Teamwork preference increases, Level of satisfaction also tends to increase. It's important to note that correlation does not imply causation, meaning that we cannot conclude from this result whether one variable influences or causes changes in the other. The result of the Kendall's Tau correlation (Table 4) showed that there was a negligible, positive correlation between Teamwork preference and Level of satisfaction. The correlation between teamwork preference and level of satisfaction was not statistically significant,  $\tau = 0.07$ ,  $p = .549$ .

Table (4): Kendall's Tau correlation between teamwork preference and students' level of satisfaction

	<i>r</i>	<i>p</i>
Teamwork preference and Level of satisfaction	0.07	.549

### AI in Facilitating Collaboration:

Many students described AI as a “third collaborator.” AI helped streamline several aspects of teamwork which assisted in improving the efficiency of group work. It assists in breaking complex design tasks such as formatting and summarizing information, thereby lightening the workload and simplified task distribution.

Therefore, AI functioned as a shared ideation platform. The findings showed that AI supported both design thinking (DT) through generating multiple novel ideas and evaluative thinking by helping teams organize and refine these ideas. This contributed to stronger creative outcomes and underscored AI's potential to become meaningfully integrated into design education as a tool for fostering innovation and problem-solving in group contexts. At the same time, students acknowledged that AI could not replace the essential human dimensions of collaboration, such as face-to-face communication, trust-building, and collective decision-making.

### **Early-Goal Setting and Its Impact:**

Eighty-seven percent of students reported that early-goal setting made the design process (DP) more focused and manageable by reducing distractions, encouraging intentional decision-making. It provided clarity, direction, and a structured framework that streamlined creative workflows. Setting goals early helped students visualize ideas, anticipate development stages, reduce trial and error, and improve overall efficiency. This practice also supported DT by providing a clear conceptual direction within which innovative ideas could be explored.

Students emphasized that early-goal setting made the DP more focused and manageable by reducing distractions, encouraging intentional decision-making, and minimizing unnecessary revisions. The structure provided by well-defined goals allowed for both consistency throughout the project and flexibility for exploration. Some students linked this clarity directly to enhanced DT, suggesting that clear parameters fostered more creative and targeted idea generation.

Moreover, goal setting enhanced problem-solving and decision-making by enabling students to critically evaluate and iteratively refine their designs in alignment with initial objectives. This reflective practice facilitated the incorporation of complex design considerations such as accessibility, sustainability, and user experience from the beginning, leading to more thoughtful and inclusive outcomes.

Importantly, students did not see goal setting as limiting creativity. Instead, it was

viewed as a cognitive framework that balanced expansive idea generation with focused decision-making. Having defined goals empowered students to explore diverse possibilities, iterate purposefully, and confidently develop their design concepts.

Beyond technical benefits, goal setting also contributed to increased confidence and satisfaction, with students feeling their projects were more purposeful and aligned with their design intentions. Many described their final designs as reflective of personal growth and identity as designers.

Overall, early-goal setting emerged as a powerful cognitive and creative strategy that supported organized and thoughtful design development, fostered creativity within meaningful boundaries, encouraged reflective practice, and led to more cohesive, innovative, user-centered outcomes, as well as deeper ownership and professional growth among students.

### **Early-Goal Setting and Level of Students' Satisfaction:**

Table 5 presents the descriptive statistics for participants' level of satisfaction categorized by whether they established design objectives and considerations early in the design phase. Participants who indicated that they established design objectives (Yes) reported a higher mean satisfaction score ( $M = 2.88$ ,  $SD = 0.37$ ) compared to those who were uncertain (Maybe,  $M = 2.44$ ,  $SD = 0.53$ ). The median score of 3 among the "Yes" group and 2 among the "Maybe" group reflects higher satisfaction among participants who clearly defined their design goals. Overall, the results suggest that early-goal setting and design considerations are positively associated with satisfaction outcomes.

Table (5): Descriptive statistics of students' satisfaction levels according to design objectives and considerations

Design objectives and		Frequency	Mean	Median	Std.	Minimum	Maximum
Level of	Maybe	9	2.44	2	0.53	2	3
	Yes	60	2.88	3	0.37	1	3

As shown in Table 5, participants who reported setting clear design objectives early in

the process exhibited higher satisfaction scores than those who were uncertain. This trend is visually supported in Figure 10, where the violin plot demonstrates a more compact and higher satisfaction scores among the “Yes” group.



Figure (10): Violin plot of satisfaction distributions across early-goal settings

A Kendall’s Tau correlation analysis was conducted to examine the relationship between early-goal setting and students’ satisfaction levels. The results indicated a moderate positive correlation between early-goal setting (design objectives and considerations) and level of satisfaction (Table 6), and this relationship is statistically significant,  $\tau = 0.41$ ,  $p = .001$ . This finding suggests that students who established early-goal design (objectives) and considerations early in the design process (DP) tend to report higher levels of satisfaction with their design outcomes.

Table (6): Kendall’s Tau Correlation between early-goal setting and students’ level of satisfaction

	<i>r</i>	<i>p</i>
Design objectives and considerations and level of satisfaction	0.41	.001

### Application of Design Theories:

The study found that 53.8% of students reported using design theories in their projects, while 24.6% did not, and 21.5% were uncertain, indicating varying levels of engagement and interpretive flexibility in applying theoretical frameworks. For those who applied design theories, they served as a cognitive tool that helped organize spatial

and aesthetic decisions, streamline the creative process, and support critical decision-making. The use of design theories was associated with improved visualization, clearer organization, and better alignment with project requirements. This structured thinking supported divergent exploration within defined boundaries, enabling innovation while maintaining design coherence.

### **Key Design Theories Frequently Employed Included:**

- **Biophilic Design:** Emphasizes natural elements like daylight, greenery, and organic textures to enhance user well-being, comfort, and sustainability by connecting indoor spaces with nature.
- **Color Theory:** Used for selecting palettes that promote psychological comfort or reflect brand identity, with some students applying color psychology (e.g., blues and greens for calmness in healthcare environments).
- **Balance, unity, and harmony:** Foundational principles for achieving visual coherence and spatial consistency, especially in open-plan or multi-use spaces.
- **The Golden Ratio:** Applied for mathematical precision in spatial proportions, improving balance and formality.
- **Environmental Control Theory:** Guided management of lighting, temperature, and airflow to ensure spaces are visually appealing, comfortable, and energy efficient.
- **Sustainability Principles:** Implemented through material choice, natural ventilation, and energy-conscious design, reflecting ecological responsibility.
- **Functionalism:** Ensured designs aligned strictly with user needs, focusing on function over decoration in layouts and circulation.

Applying design theories also functioned as a collaborative language within teams, fostering better communication, critique, and more professional, cohesive, and intentionally structured outcomes that bridged concept and execution. Conversely, students who did not use formal theories often relied on practical or intuitive approaches, such as experiential knowledge, or creative instinct, sometimes expressing uncertainty regarding the integration of theoretical concepts. This approach reflects an

alternative dimension of DT rooted in tacit knowledge and improvisation.

Overall, the findings suggest most students consciously utilize design theories to enhance DP and outcomes, while a significant minority approach design intuitively or through practice-based perspectives. These diverse pathways underscore the broad value of DT in design education, embracing multiple routes to creative and effective solutions. Table 7 presents descriptive statistics, indicating that overall satisfaction was high, with the “Maybe” group reporting the highest mean satisfaction score ( $M = 2.94$ ).

Table (7): Descriptive statistics of students’ satisfaction levels according to design theory application

	Design	Frequency	Mean	Median	Std.	Minimum	Maximum
Level of satisfaction	1	15	2.8	3	0.41	2	3
	2	16	2.94	3	0.25	2	3
	3	35	2.77	3	0.49	1	3

Figure 11 present that the “Maybe” group’s satisfaction scores are more tightly clustered near the upper end of the scale, indicating higher and more consistent level of satisfaction. In contrast, the “Yes” and “No” groups display more dispersed distributions, reflecting greater variability despite having similar median satisfaction values. This pattern suggests that both constructed and flexible use of design theories are generally associated with positive satisfaction outcomes.

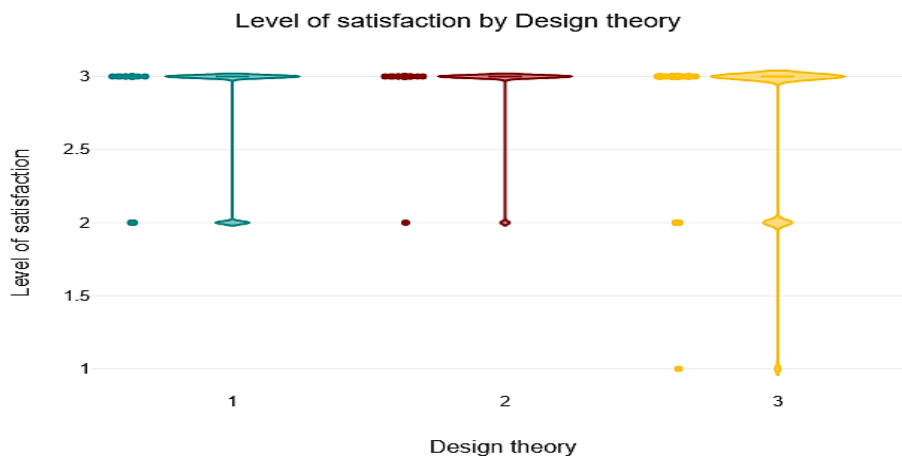


Figure (11): Violin plot of satisfaction distributions across design theory application categories

An analysis was conducted to investigate the relationship between the use of design theories and students' satisfaction levels. The results indicated no clear association between design theory use and satisfaction, with a Kendall's Tau coefficient ( $\tau = -0.05$ ). Although the direction of the relationship was negative, it was not statistically significant ( $p = .65$ ; Table 8). Therefore, no meaningful relationship between the application of design theories and satisfaction levels was identified in this study.

Table (8): Kendall's Tau Correlation between design theory use and students' level of satisfaction

	<i>r</i>	<i>p</i>
Design theories and level of satisfaction	-0.05	.65

### Overcoming Challenges and Harnessing Opportunities of AI in Design:

Balancing aesthetic creativity with functionality was one of the major challenges. In this section, 69% of the students reported that the design issues were solved quickly, while 22% were unsure, and 8.5% reported difficulties. Although the students described their work as rich in creativity during the DP, they encountered challenges related to spatial organization, software limitations, conceptual indecision, and group dynamics. Many generated multiple ideas but struggled to consolidate them. AI-based concept generation tools, informed by case studies, mood boards, and user data, were able to synthesize research into thematic directions by suggesting visual patterns, spatial typologies, or stylistic references to stimulate ideation and focus.

Students faced technical difficulties with software like Revit and 3ds Max, including limited training and slow performance, causing frustration and delays. Time-consuming rendering and modeling further burdened progress. A persistent issue was finding suitable 3D furniture models aligned with design concepts and spatial needs. AI-powered asset management tools that can suggest context-appropriate models by style, size, and function could boost efficiency and let students focus on design thinking over digital logistics.

Time management worsened these difficulties. With overlapping tasks during critical stages like sketching and revision, many felt overwhelmed, limiting exploration and

refinement. AI tools automate repetitive tasks like daylight simulation and material rendering can improve efficiency, freeing time for ideation, reflection, and conceptual development, key components of DT. Students using AI reported better time control and success meeting deadlines than those relying on manual processes. These students balanced technical execution with creative exploration better, showing AI's role as practical support for managing complexity without sacrificing design quality.

Such AI tools can monitor task distribution, encourage equitable participation, and support decision-making by visually presenting multiple proposals, promoting consensus and constructive critique. Despite challenges, students adapted through trial and error, feedback seeking, and iteration, behaviors aligning with DT principles of generating multiple ideas, exploring alternatives, and learning experimentally. Thoughtful AI integration in studios can amplify these behaviors by reducing technical and logistical burdens while expanding creative capacity.

### **Student Satisfaction with Final Design Outcomes:**

When asked about satisfaction with their final design output, 84.5% of students responded positively, 14.1% indicated “maybe,” and a small percentage expressed dissatisfaction. These responses offer insights into not only the effectiveness of the DP but also how students engaged with DT, embraced challenges, and pursued growth throughout the course.

Students expressing satisfaction often attributed their success to their effort, willingness to experiment, and openness to feedback. Many reported a sense of achievement in how their design thinking evolved, especially through exploring unconventional ideas and refining them over time. This process of generating multiple ideas, testing alternatives, and selecting the best solutions is central to DT. One student noted, “I didn’t know 3D Max at first, but I exceeded my expectations and learned a lot in a short time. I’m satisfied with what I presented as my first attempt at using the program.” This reflects the adaptability and exploratory mindset essential to both DT and design innovation.

Learning new digital tools, especially complex software like 3ds Max, was another key factor in students' satisfaction. Those who embraced unfamiliar programs often achieved results beyond expectations. This learning curve expanded their technical skills and encouraged them to think differently about visualizing and communicating ideas, another hallmark of DT.

Collaboration significantly shaped positive outcomes. Working in groups exposed students to diverse perspectives and problem-solving approaches, enriching their design thinking. As one respondent shared, "Cooperation within our group played a big role in improving the results. Each member contributed their ideas and experiences, leading to a well-coordinated and refined final project." This exchange of viewpoints supports divergent exploration and broadens the creative scope.

Students also emphasized the importance of instructor feedback, which provided structure for critique and reflection. Many credited instructors with helping them refine ideas and push conceptual boundaries while staying grounded in practical design principles. One participant remarked, "The instructor's keen attention to important design details and her willingness to solve our problems significantly improved my project." Such mentorship guided purposeful iteration and thinking beyond initial solutions.

Peer recognition and meeting self-set goals further contributed to satisfaction. Achieving a balance between aesthetics and functionality, often cited, reflected an ability to navigate complex design constraints while delivering cohesive and expressive outcomes.

Among less satisfied students, time constraints were a common concern, especially for those who did not use AI tools. Many reporting lacking sufficient time to fully realize their vision, with one noting, "I feel that the time towards the end didn't allow us to showcase everything as we had envisioned." The lack of AI support may have limited their ability to iterate efficiently or produce polished visuals within deadlines.

Others who were uncertain or dissatisfied expressed a desire for further refinement or

believed their final output could be stronger with more time or support. Although these comments reflected some frustration, they also revealed a growth mindset and willingness to learn. As one student said, "I think my project still needs more refinement, particularly in the final presentations."

Overall, the responses suggest that students embracing DT strategies, exploring multiple solutions, collaborating, iterating feedback, and experimenting with new tools, were more likely to be satisfied with their work. Combining this mindset with AI-supported tools also enabled students to manage time more effectively and deliver higher-quality outcomes.

The findings highlight that satisfaction is influenced not only by outcome quality but also to the process of discovery, experimentation, and learning. Even among less satisfied students, there was recognition of growth and eagerness to apply experiences in future design challenges. As design education evolves, fostering DT, especially when combined with intelligent AI support, can lead to richer, more fulfilling student outcomes.

### **Perceived Speed of Problem-Solving and Satisfaction:**

Table 9 presents descriptive statistics for participants' satisfaction levels based on their perception of how quickly analytical problems were solved. Students who answered "yes" (problems solved quickly) had the highest mean satisfaction score of 2.90 (SD = 0.31), reflecting a strong positive view of their design experience. Participants who responded "maybe" and "no" reported slightly lower mean satisfaction scores of 2.69 (SD = 0.60) and 2.67 (SD = 0.52), respectively, with greater variability in their responses. The overall mean satisfaction across all groups was 2.83 (SD = 0.41), indicating a generally positive satisfaction trend regardless of problem-solving speed perception.

Table (9): descriptive statistics of students' satisfaction levels according to perceived problem-solving speed

	n	Mean	Std. Deviation
Yes (3 )	49	2.90	0.31
Maybe (2)	16	2.69	0.60
No (1)	6	2.67	0.52
Total	71.00	2.83	0.41

The effect size measures (Eta  $\eta = 0.24$ ; Eta-squared  $\eta^2 = 0.06$ ) indicate a moderate effect of problem-solving speed on satisfaction (Table 10). This indicates that while the speed of solving analytical problems is not the only factor influencing satisfaction, it contributes to differences in satisfaction levels across groups.

Table (10): effect size of problem-solving speed on students' satisfaction

<i>Eta</i> ( $\eta$ )	0.24
<i>Eta</i> <sup>2</sup> ( $\eta^2$ )	0.06

The boxplot presented in Figure 12 visually corroborates the statistical findings related to problem-solving speed and satisfaction. Specifically, the “Yes” group’s boxplot is positioned higher on the y-axis, indicating higher satisfaction levels, and it has a narrow interquartile range, suggesting that responses were more consistent within this group. Conversely, the “Maybe” and “No” groups have boxplots located lower on the y-axis with wider boxes and whiskers, signifying greater variability in satisfaction among these participants. The moderate overlap in the distributions matches the medium effect size ( $\eta^2 = 0.06$ ) reported, reinforcing the conclusion that participants who perceived faster problem-solving generally experienced greater and more stable satisfaction levels

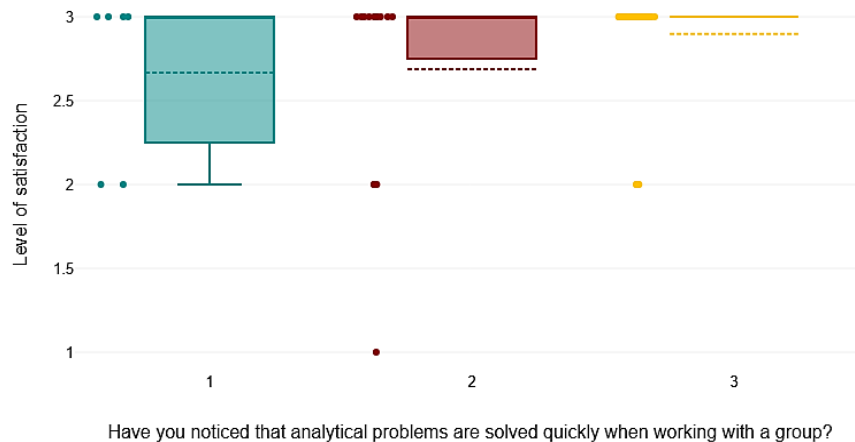


Figure (12): Boxplot illustrates the relationship between perceived problem-solving speed and satisfaction

## Discussion

AI plays a central role in the early stages of design process for interior design students. Especially during the brainstorming and conceptual development phases, AI helped students expand their creative boundaries and visualize complex spatial ideas. For instance, when students focused on interior environments, AI tools facilitated exterior visualization, allowing them to better understand and communicate the overall context of their designs. In situations where interdisciplinary collaboration was not feasible due to time constraints or curriculum limitations, AI served as a practical substitute for collaborative outcomes. It enabled students to visualize and develop their ideas independently. However, it is important to recognize that AI cannot fully replicate the nuanced and relational aspects of human collaboration, which involve trust, communication, and shared decision-making.

Despite these benefits, students encountered notable challenges, particularly in sourcing and modeling furniture items that aligned with their design intent. Many reported spending considerable time recreating furniture pieces manually or searching for suitable models. Similar findings were reported by Angelina et al. [7], who highlighted that AI image generators have the potential to significantly expedite the design process (DP) if they are further developed. They stressed that, by reducing the

time spent searching for design alternatives, such tools have the potential to accelerate architectural workflows. Before beginning the actual design or building phases, this would allow architects and students to focus more on generating and testing creative design concepts in digital settings. With the aid of AI-powered early-stage digital explorations, designers can effectively create, visualize, and plan spatial arrangements across different project scales. Additionally, these technologies enable users to generate and present a variety of design options, however, their efficacy still depends on the user's ability to express objectives through textual prompts.

The integration of AI was also found to have a strong connection to DT, a key process in creative problem-solving that involves generating multiple ideas, exploring alternatives, and iterating toward novel solutions. Students used AI to generate, visualize, and refine a broad array of design concepts, particularly during the programming and conceptual phases. This ability to rapidly generate and test various options enabled students to move beyond traditional constraints and explore a wider range of ideas.

Statistical analyses further supported these qualitative observations. Students who established early design objectives and considerations reported significantly higher satisfaction levels (Kendall's  $\tau = .41$ ,  $p = .001$ ), suggesting a moderate positive relationship between goal-setting behavior and perceived design success. Similarly, students who reported that analytical problems were solved quickly had higher satisfaction scores ( $M = 2.90$ ) than those who perceived slower problem-solving ( $M = 2.67-2.69$ ), with a medium effect size ( $\eta^2 = 0.06$ ). These results indicate that early planning and goal setting positively contribute to students' satisfaction and perceived design success.

Students who engaged in this iterative process reported high levels of satisfaction with their final design outcomes. Specifically, 84.5% of the students expressed satisfaction with their work. They attributed this satisfaction to the freedom to experiment and the ability to use AI for visualization, conceptual development, and presentations preparation. These behaviors, which involve testing alternatives, seeking feedback, and

refining solutions, are core components of DT. They were amplified by the strategic use of AI in the design workflow.

Moreover, the study found that AI supported not only ideation but also evaluative thinking. It helped students structure their creative processes, clarify abstract concepts, and compare multiple solutions. Many students described AI as a supportive tool that assisted them in making better-informed decisions. However, while AI facilitated technical productivity, students emphasized the continued importance of interpersonal collaboration. They recognized the value of feedback from peers and the instructor in refining design direction and fostering critical reflection.

AI-assisted visualization also encouraged students to conceptualize complex spatial forms, test variations, and take creative risks. The ability to communicate ideas more effectively through visualization contributed to greater confidence and a more dynamic design environment. Students felt more empowered to explore nontraditional solutions and refine their ideas through experimentation, which led to more original and diverse design outcomes.

In the future, AI could assist students by generating 3D models from images and providing matching digital assets. Furthermore, future AI system could generate furniture selections schedules for students by using companies' websites to identify suitable pieces and compile the necessary information, thereby reducing time spent on tasks that do not require creativity and human decision. Students pointed out that AI could offer significant assistance with report writing and documentation, two tasks that are usually less creatively stimulating and require more time during the DP. Students would be able to concentrate on honing their creative concepts and reduce tedious manual work as a result.

Therefore, it is essential to emphasize that AI cannot replace individual creativity or design decision-making process. Rather, AI can assist with routine tasks and free up cognitive capacity for higher-level conceptual thinking. When used responsibly and with an understanding of its limitations, AI empowers students to achieve higher-

quality outcomes while fostering creativity, innovation, and satisfaction, as evidenced by the positive trends found in both qualitative observations and statistical analyses.

### **Limitation**

The study acknowledges several limitations that affect the integration of AI into interior design education. One primary challenge relates to technical difficulties encountered during the research, including slow software performance, difficulty finding appropriate 3D models, and inadequate training in AI tools. Moreover, the study is constructed on specific groups of students from a single university which limit the generalizability of the findings.

### **Conclusion**

This study demonstrates that integrating AI, with limited usability into interior design curriculum, can significantly enhance students' creative process. AI serves as a supportive partner that streamlines the workflow and encourages exploration of multiple design possibilities, leading to more cohesive and innovative outcomes. When AI is aligned with pedagogical objectives, it enhances collaboration, supports creativity, and guides students toward more innovative outcomes. It shifts design education from traditional teaching methods toward a more dynamic approach. Even though AI was effective and improving students' outcomes and efficiently, it cannot replace genuine human collaboration, which emphasize the importance of retaining interpersonal communication skills alongside technical development.

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