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Navigating the Impact of Artificial Intelligence Tools on Design Learning

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ABSTRACT As Artificial Intelligence (AI) continues to transform various fields and industries, its impact on design education has become increasingly evident. This study investigates how AI influences creativity, critical thinking, and skill development in design learning. It highlights the benefits and challenges of using AI tools by gathering insights from students, educators, and professionals across various design disciplines. The findings indicate that AI enhances creativity and critical thinking by simplifying the brainstorming process while providing possible design alternatives and offering real-time feedback. However, over-reliance on AI tools raises ethical issues such as bias and lack of transparency. This eventually hinders the development of hands-on skill development. This study emphasizes the importance of mindful AI integration in the core design curriculum to balance AI-driven innovation and traditional practices. By navigating the opportunities and limitations of AI, educators, and learners can optimize its role in design education and ensure it serves as a tool for betterment, rather than replacing human originality.

INDEX TERMS Artificial Intelligence, AI tools, creativity, critical thinking, design learning, skill development

I. INTRODUCTION

The field of design is undergoing a revolutionary transformation fueled by increasing integration of AI in every possible domain [1]. AI is no longer confined to science fiction, it is rapidly permeating in diverse industries, and design is no exception. From automated answers for design concepts to generative AI images and analyzing user behavior, AI is altering the paths of design practice [2]. The evolving scenario provides educators with the opportunity to enhance design education to equip students for the future. AI applications are multifaceted, facilitating both design learning and designing itself. There's even a website domain named 'There's an AI for that' [3] which claims to have '16,414 AIs for tasks 14,637 tasks and 4,803 jobs' (till 12th September 2024). The most basic and widely used tools are automated response generators like ChatGPT, Gemini, Perplexity AI, etc.,

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and image generators like Microsoft Designer, Mid Journey and Runway ML. These AI bots and applications can even assist in analyzing vast amounts of data to provide real-time feedback and suggestions to perform effectively [4], [5]. However, it doesn't come without challenges and limitations. These rapid transformations in technology require adaptation in traditional design pedagogy [6]. Traditionally, design learning focusses on critical thinking, creativity and skill development [7], [8] which is why there's a need for curriculums to evolve to utilize artificial intelligence mindfully while fostering these essential attributes. And apart from this, there's an immediate need to understand the impact of artificial intelligence on design process and learning [9]. Many educators and institutes are still adjusting to the developments in AI, while not undermining the essential elements of creativity and critical thinking.

Understanding AI's influence on design education requires careful consideration to ensure that it enhances creativity without jeopardizing human ingenuity [10]. While AI offers potential benefits, there are concerns about its impact on core design foundations like creativity, critical thinking and skill development [11]. Over-reliance on AI tools may hinder students' individual thought process and problem solving abilities [11], [12] . Responsible use of AI involves addressing ethical concerns such as bias, transparency and accountability, among others [11]. The first step to succeed at incorporating AI into any organization or institution is that of really weaving it within the otherwise conventional design learning process. The focus for design learning is on capacity building in terms of skills and knowledge to practice qualitative design efficiently, whereas design thinking refers, more closely to human-centered problem solving through high emphasis on empathy, ideation, and iterative processes [7], [8].

When introducing AI tools to students, it is crucial to ensure they are equipped not only with the technical skills to use these tools but also with a strong understanding of the design thinking strategies that enable the mindful and innovative use of AI. For example, teachers may urge students to practice empathy-based design thinking, critiquing the AI-generated outcome in terms of its concordance with human needs and values. Such ideation techniques as brainstorming and fast prototyping can result in students working out imaginative ideas of employing their AI and human ingenuity workflow integration [13]. This is one area where most human beings have a small problem, and that is their tendency to make life very

easy and convenient, so there is a great chance of over-reliance on AI. Therefore, it is essential to approach AI integration with a critical eye and some sense of ethical importance, ensuring that students remain active decision-makers when deciding on options provided by AI [14].

However, many educators may lack the knowledge or awareness needed to effectively teach these skills. To address this gap, institutions should organize seminars, workshops, and conferences led by AI experts. Such events would provide educators with a comprehensive understanding of AI's capabilities, limitations, and ethical implications, enabling them to guide their students more effectively [15]. One of the key challenges that AI integration in design learning faces is to ensure that for students, AI tools are to enhance and complement yet not replace the traditional design process [16]. Along with introducing students to relevant AI applications, it is also necessary to equip students to critically evaluate AI solutions keeping their limitations and ethics in mind [17]. In order to understand how much impact Artificial Intelligence has on the way students learn to become designers, it is essential to consider both its benefits and potential drawbacks. The use of such tools should also be scrutinized for their effect on how well students learn without being sabotaged by the fact of AI being able make things easier or faster than ever before [18].

As this study aims to explore the impact of integration of artificial intelligence on design learning. The primary research objectives are as follows:

- To assess the influence of artificial intelligence on creativity, critical thinking and skill development in design education, using a mix-method approach that combines structured surveys and qualitative thematic analysis.
- To identify current applications and emerging trends of AI in Design education through comprehensive data collection from students, teachers and industry professionals utilizing both quantitative-survey data and open-ended responses.
- To explore ethical conditions and challenges of AI in Design learning focusing on issues such as bias, transparency and over-reliance on AI tools.

- To develop recommendations to effectively integrating artificial intelligence in design education, ensuring a balance between AI-driven approaches and traditional design practices.

Through these objectives, this study explores how integrating AI in design learning impacts student's creativity, critical thinking and their skill development while also mitigating arising ethical concerns. It also explores current applications and emerging trends of AI in design education and how it can be effectively integrated into design learning to complement rather than replace traditional design learning processes.

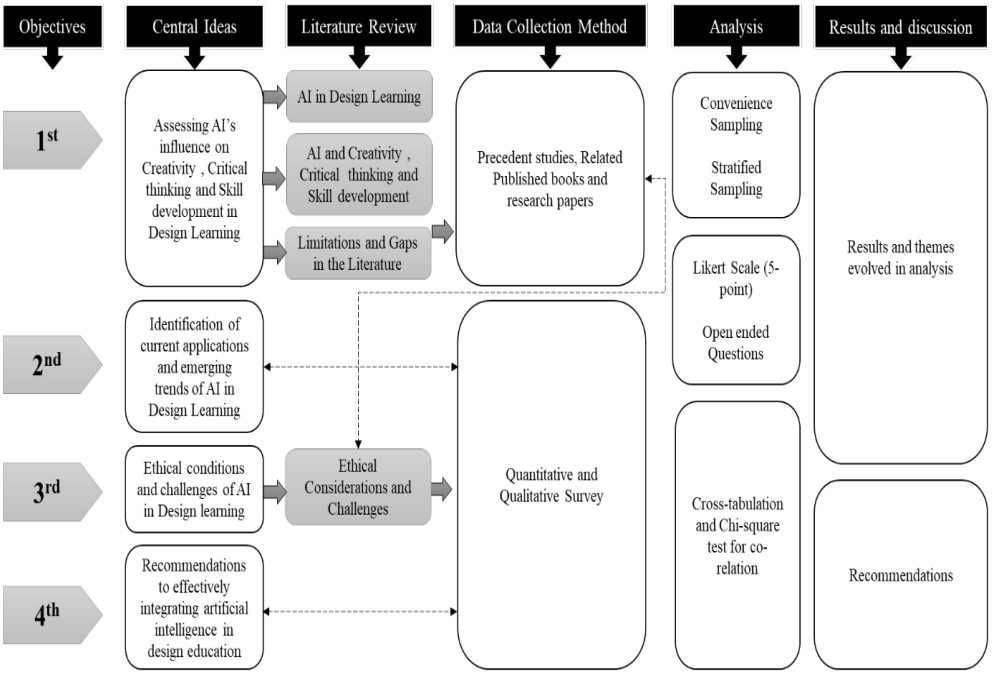

Figure 1. Conceptual Framework for Assessing the Integration of AI in Design Learning

II. LITERATURE REVIEW

A. OVERVIEW OF AI IN DESIGN EDUCATION

The popularity of artificial intelligence in design education is on the rise. The design curricula are rapidly adopting AI tools such as virtual reality settings, machine learning algorithms, and generative design software [19].These tools support both the creative and the technical aspects of teaching design. In the future, learning experiences for future generations

may involve less reading of books and more interaction with bots on interactive platforms [20]. Chatbots could provide unique explanations for topics related to different science , engineering and design domains, changing the role of traditional educational resources like textbooks and classrooms [21]. According to Doulani, an investigation into cognitive learning among design students and its effects by artificial intelligence shows that AI makes cognitive development possible through individualized learning experiences and adaptive feedbacks [22]. The idea of adaptable learning makes it possible to customize lessons more precisely to meet the needs of each student, which may significantly contribute to cognitive growth. But the research emphasizes that rather than using them alone, AI tools must be used in conjunction with traditional pedagogies [22].

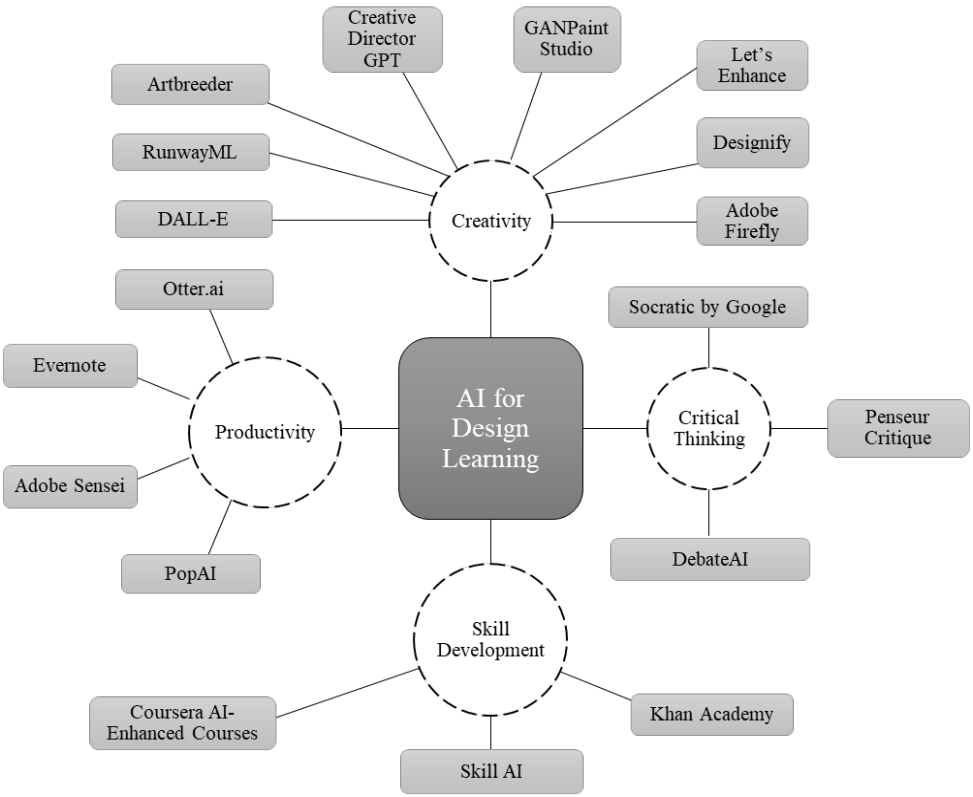

Figure 2. A number of AI applications and Platforms aiding Creativity, Critical Thinking, Skill Development and Pedagogical approaches for Design Learning

B. AI AND CREATIVITY IN DESIGN

In design education, creativity is fundamental, and there is ongoing debate about how AI can either foster or inhibit creative processes. Generative design software, for instance, uses AI algorithms to create a wide range of design options based on specific parameters set by the user. This allows students to explore numerous design possibilities and make more informed decisions [13]. In addition, machine learning algorithms can analyze large datasets to detect patterns and trends that inform design decisions [23]. AI tools are increasingly being used to improve creativity and open up new ways of ideation and exploration of design. Gmeiner et al examined AI powered design tools for manufacturing and found possibilities for supporting designers co-create with AI, emphasizing that using these tools help deepen one's understanding of the design process while at the same time inspiring solutions through automation of mundane tasks as well as generation of alternatives which may not have come to human designers' minds during development stages [23] .

According to Tholander and Jonsson, the generative machine learning models can be used in design ideation where they act as a valued partner enabling sketching, thinking about ideas, iterating them thus enhancing student's creative output in design disciplines greatly [13] .However, there are problems faced by this integration in design learning. Saritepeci and Yildiz Durak found out that even if integrating AI has a positive touch on creativity and reflective thinking abilities; it remains necessary for teachers to help students thoroughly judge AI results as well as maintain authority over direction of their personal projects [24]. According to Luckin and Cukurova AI can be supportive with educating about design; however, students may become overly reliant on tools provided by AI to perform tasks that normally need manual input [2]. As a result, if not complemented by real-world hands-on activities this may cause shallow understanding about principles of designing.

C. AI'S IMPACT ON CRITICAL THINKING

Another significant skill connected to design education is critical thinking. AI tools have the ability to enhance critical thinking by simulating real-life design problems and providing input [25]. With convenient availability of such tools, designers might test their ideas against probable difficulties or even make modifications after receiving constructive feedback through AI.

Still, AI has some negative effects on critical thought development. Zhai *et al.* [11] warn that too much reliance on AI dialogue systems would limit learners' independence in thinking. Woinaroschy [14] points out that while artificial intelligence can improve originality through new ideas and answers, it is vital to maintain a balance so as not to rely too heavily on technology. The key issue is utilizing AI as an enhancing tool rather than replacing human creativity.

According to Baidoo-Anu and Ansah [4], AI aided design leaves the space for critical thinking since it provides multiple points of view and possibilities so that learners can avoid rushed decisions based on one idea only. As pointed out by Luckin and Cukurova, there should be a consideration of deep learning and critical engagement for educational technologies including AI that are based on the learning sciences. One implication of Luckin and Cukurova's idea [2] is that if teachers do not employ proper pedagogical strategies, some students may accept AI recommendations without fully understanding their principles or consequences thus negatively affecting their capacity for critical thinking. Another challenge lies with the algorithmic bias inherently identifiable in AI which affects the quality as well as degree of neutrality in the feedbacks and advices offered to learners. Bolick and da Silva [12] warn against the use of such tools within educational settings claiming that they might perpetuate existing biases or inhibit creativity.

D. AI IN SKILL DEVELOPMENT AND PEDAGOGICAL APPROACHES

Labadze *et al.* [21] argue that AI chatbots in education can be effective in supporting skill development by providing learners with immediate, individualized feedback. The infusion of AI into design instructions challenges traditional design learning methods. To efficiently blend both methods, advanced technologies must be used along with traditional teaching strategies which may aid in improving student learning [15]. It is about integrating artificial intelligence tools into the syllabus as well as training teachers to use them effectively. In their research, Dall'Asta and Marco [19] delve into AI machine learning proposing a shift away from conventional design education through effective and innovative approaches enabled by it. They stress upon how these changes require educators to take up new ways of teaching that employ AI tools if they want their students to keep pace with the evolving needs of the profession. In addition, a study

conducted by Saritepe and Durak [24] shows that even though automation may boost these abilities, there is need for adopting blended approaches which combine both AI tools as well as traditional design pedagogy.

E. ETHICAL CONSIDERATIONS AND CHALLENGES

It is necessary to consider the ethical aspects of design education in regards to the incorporation of AI systems. Kim et al. present how learning design should include the student-AI collaboration aspect, focusing on issues such as bias, transparency and accountability [9]. They observe that ethics and responsibility must be ensured in the use of AI tools by educators which teaching students. AI models are trained on extensive data collection that's why they can duplicate or even amplify the biases present in those datasets due to their size [26]. More so, it is argued that ethical application of AI in design must be based on an examination of both the training data and algorithm used otherwise it may lead to biased AI resulting in unfairness and limit students' creativity and decision making during design process [27]. It is therefore imperative to come up with policies and regulations that are relevant with respect to proper conduct of AI usage within design education.

Based on the literature review regarding the impact of AI on creativity, critical thinking, skill development and ethical considerations in design learning, multiple hypotheses emerge to guide further research. These hypotheses are rooted in the very foundation laid by the literature and aim to explore nuanced effects ad point of views of AI integration in design learning:

Hypothesis 1: The integration of AI in design education enhances creativity and critical thinking when used as a supportive tool rather than a replacement for traditional methods.

Hypothesis 2: Emerging AI applications in design education offer significant benefits but require careful consideration of ethical implications to avoid biases and ensure transparency.

Hypothesis 3: Effective AI integration in design education supports skill development by providing personalized feedback and augmenting traditional learning without diminishing the importance of hands-on practice.

These hypotheses are further explored in Methodology and Results, forming the route of this study.

III. METHODOLOGY

A. RESEARCH DESIGN

Following (Figure 3) the research onion framework, open ended questions and survey-based approach was utilized to examine how AI tools influence design learning. Highlighting Pragmatism, the outmost layer indicates the philosophical underpinning of this study, while focusing practical approaches and valuing qualitative and quantitative methods to find the answers of research questions. The next layer suggests that the research employs both deductive (theory-driven) and inductive (data-driven) reasoning approaches to form conclusions. The third and fourth layer indicates the application of mixed method approach following the structured survey and open-ended questions to gather a comprehensive set of data. Time horizon of the study is cross-sectional, indicating that data is collected at a single point in time instead of a prolonged period of time.

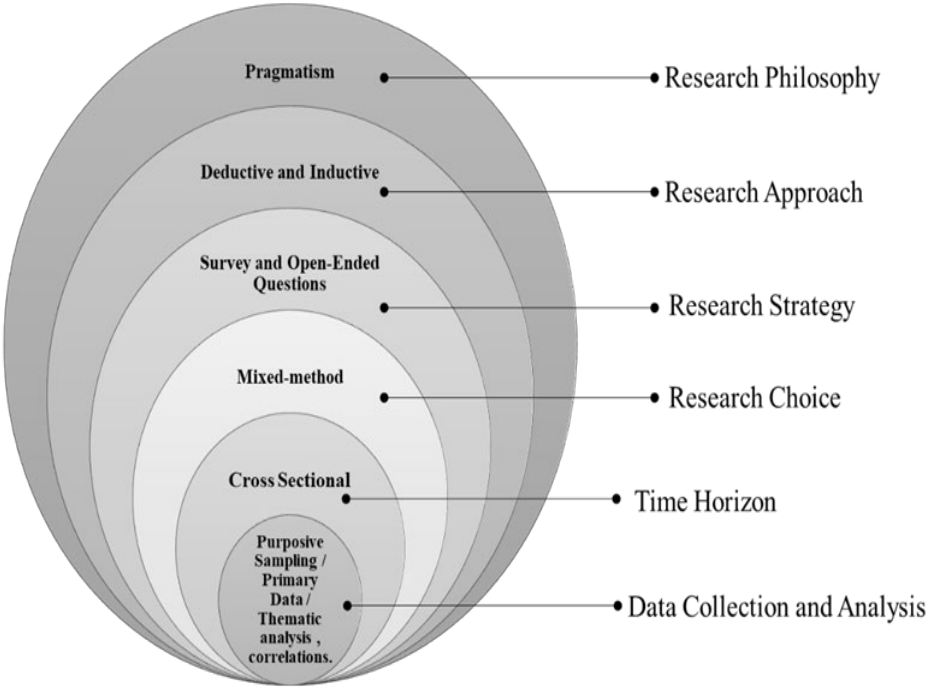

Figure 3. The Research Onion Model for this Study

The present research intends to explore the function of AI devices in design by examining their influence on ingenuity, efficiency and learning environment. The cross-sectional survey design was chosen for the research and it allows collecting data from a variety of designers and students at one point in time. The survey consists of questions related to demographics, knowledge and use of AI instruments, as well as attitudes towards these tools during the designing process and education. This way, it is possible to analyze how AI devices are viewed and used across different design disciplines and professional levels. Lastly, data collection is done through primary data sources and purposive sampling where participants were selected based on the specific criteria relevant to this study.

B. DATA COLLECTION

Survey questionnaire was distributed through Google Forms to participants from different design fields such as Graphic Design, Fashion Design, Architecture Design, Visual Communication Design, Textile Design, Product Design and UI/UX Design where 224 responses were received. This study targeted various roles (students, educators and professional practitioners) with diverse range of experiences (0-2 years, 3-5 years, 6-10 years and 11+ years). The participants were recruited through professional networks and academic affiliations. The survey included some multiple-choice questions as well as open ended ones and many of 5-point Likert-scale type. The Likert scale statements assessed participants' agreement regarding the impact of AI tools on creativity, critical thinking, skill development and ethical considerations etc., while open ended questions gave qualitative insights into what AI was specifically being employed by users along with recommendations regarding integration of into design pedagogy.

C. DATA ANALYSIS

To analyze the quantitative data, SPSS software was utilized. Demographic data and AI tool usage patterns were summarized by descriptive statistics, consisting of crosstabs with frequencies. Categorical variables, such as experience levels and familiarity with AI tools, were examined with chi-square tests to determine the relationships between them. In addition, the use of crosstabs to explore connections between demographic characteristics (e.g., role, design domain) indicated that these trends exist. By applying these tests, it was determined whether or not there is a

significant relationship between AI tools familiarity and their perceived impact on creativity or skill development among other categorical variables. This assisted in establishing the importance of various aspects where AI tools play an essential role. Open ended questions provided deep insights through thematic analysis. Common themes were identified by coding the responses such as; particular types of AI software that were used plus its benefits/challenges observed. Recommendations for incorporating artificial intelligence into design education were also coded and analyzed towards giving useful insights for educators and institutions.

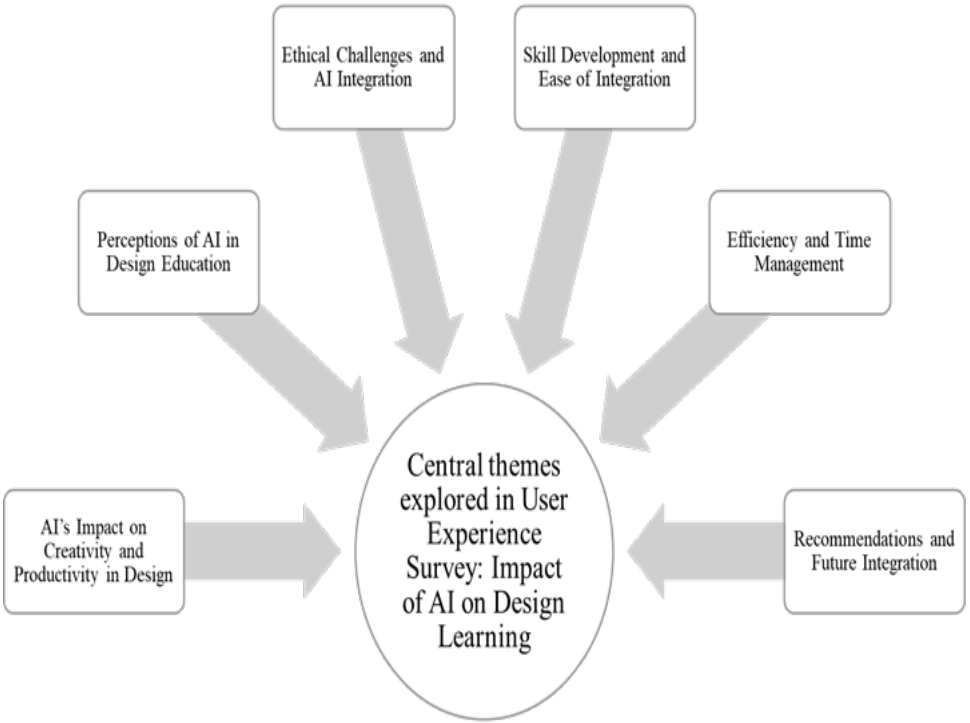

Figure 4. Central themes Explored in the Quantitated and Qualitative Data of Users' Experience with AI and Design Learning

IV. RESULTS

The purpose of this survey was to examine how AI tools are perceived, their prevalence and impact in terms of creativity, critical thinking, skill development and ethics in design learning. This study aimed to find out

about current ways of integrating AI tools into design processes and education, along with challenges and opportunities through a survey of data gathered from students, teachers and practitioners across different design fields.

Two hundred and twenty-four respondents participated in the survey with 55.8% indicating as female while 44.2% were male. Age-wise, the biggest group of respondents (41.5%) were aged between 18-25 years old; followed by 34.4% who were aged 26-30 years; while those aged between 31-35 years made up 20.1%. Only 3.6% belonged to the 36-45 year age group whereas just 0.4% were aged 50 years and above. In terms of occupation, field professionals formed the largest percentage (51.8%) followed by students at 37.9%. Lastly, a small fraction (10.3%) were educators.

Asking their level of familiarity with AI tools, 12.1% of the respondents claimed that they were "very familiar" about this technology. Only 18.5% admitted to have used AI tools sometimes or more often among them while 81.5% denied ever utilizing them. On the other hand, higher percentage were noted among those who claimed to be "somewhat familiar" where 37.8% used these tools often or always. Interestingly enough even among least acquainted participants, 61.2% mentioned some experimentation with an AI tool. There was an evident correlation between knowledge on usage ($p = 0.000$), according to which as one acquires more knowledge about these tools; they tend to use them at a higher frequency. Among those aged between 18-25 year-olds, AI tools familiarity was at its peak as 65.6% reported moderate-high acquaintance levels. This group was closely followed by 26-30-year-olds who were within the similar ranges of familiarity (57.1%). However; familiarity decreasing trends were prominent with older age groups where participants aged 31-35 only accounted for 33.3 percent.

From gender perspective, moderate-high degree of understanding about such technologies accounted for females as well as males respectively at 62.4% versus 65.7% though gender-wise distributions exhibited no remarkable co-relation.

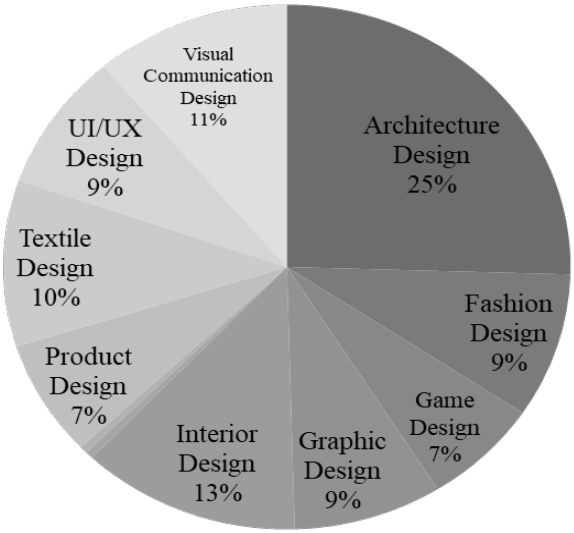

Figure 5. Participants' Diversity in Design Fields

A. IMPACT OF AI ON DESIGN WORK/PROCESS

In terms of creativity and productivity, most respondents see AI tools as an advantage to their design work. As specifically cited below; 52.7% claimed that AI tools had improved their creativity while 61.6% felt that these tools were enhancing their productivity. Although half of them (50.9%) agreed that AI tools were making the design process more efficient, there were varied opinions on whether or not traditional methods could be effectively replaced by such devices as only 50.9 % concurred.

On the other hand, 54.1% believed that the understanding and analysis of design problems is aided by AI tools among others although 29.1% remained neutral on this matter. The level of confidence when using such technologies is moderate since (49.1%) admitted they were confident while 55.8% indicated that project duration had been lowered by employing AI tools. Nonetheless, there is a lack of common agreement whether or not greater improvement in design learning or quality of projects can be attributed to AI tools with only 55.0 % agreeing or strongly agreeing about these factors. Overall, even though productivity and creativity are perceived to be promoted by AI devices, its relevance towards replacement of traditional procedures and significant enhancement of design quality remains debatable.

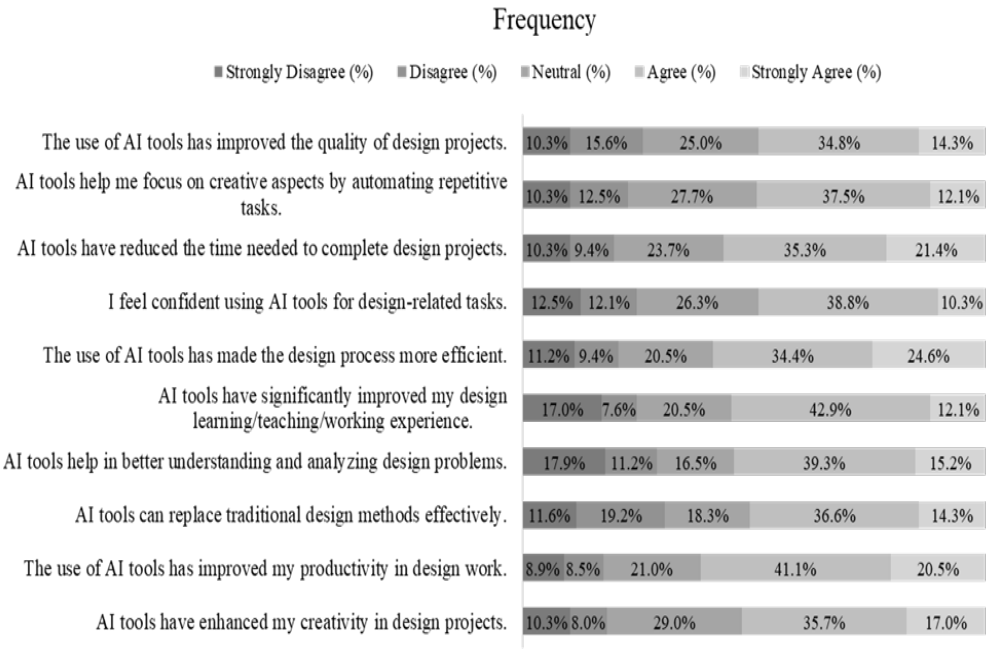

Figure 6. User Responses regarding Impact of AI on Design Work/Process

B. PERCEPTIONS OF AI IN DESIGN LEARNING

When it comes to user perceptions regarding use of AI in design Learning, 59.4% of respondents agree or strongly agree with the concept that "Modern design education needs AI tools" while 66.6% think students can benefit from AI tools inclusion in curricula. Despite the fact that there have always been concerns over AI replacing conventional design techniques, a mere 50.9% are in support of this.

The existence of AI tools for learning purposes is accepted to some extent by 56.7% who either partially accept them or fully endorse them. Additionally, about 28.6% disagree or strongly disagree on the adequacy of training on their use of AI, implying perceived insufficiency. Slightly more than half of the people are wondering why most students find it so hard associating AI tools with Traditional Design Learning as were found out by this research study which showed 58.5%. To sum up, although there is general consensus on the need to integrate AI tools into design education, issues related to ethics and adequacy of training still remain paramount and

should be addressed during implementation and integration of AI technologies.

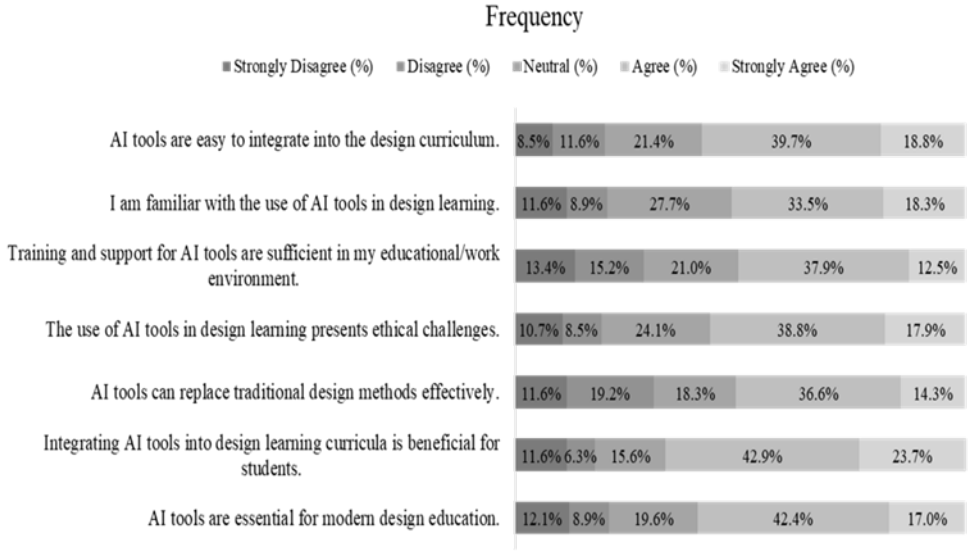

Figure 7. User Perception of Integration of AI in Design Learning

C. KEY QUALITATIVE INSIGHTS

To explore the responses to the open-ended question in the survey, "What specific tools have you used, and how have they impacted your process?" a thematic analysis was conducted for understanding underlying themes and patterns. Some of the initial codes showed several commonly used AI tools, such as ChatGPT, Midjourney, Adobe Illustrator (Generative AI), AI Meta, Microsoft Copilot, Prome AI, DALL-E, Coohom, Playground AI, Adobe Firefly and Canva among others. Different impacts on design process were then associated with these tools including; speeding up workflows, improving efficiency, brainstorming support, visual assistance and increasing presentation quality.

Three major categories were identified from the other codes; AI Adoption, Functional Impact and Types of AI Tools. There was widespread AI adoption with a lot of respondents incorporating tools into their workflows for efficiency improvement in task execution time. But there were mixed perceptions about AI's role in creativity. Instead, some people considered it as an important additive to their creativity while others saw it causing

potential decrease in originality. It has also been pointed out that there are different degrees of AI usage among those surveyed. Some individuals utilized numerous tools heavily while others had either little or no knowledge at all about Artificial Intelligence. For instance, AI adoption is driven by such specific use cases as 3D renderings and design visualizations, which shows how these tools respond to certain needs along the design process.

The survey also gathered recommendations for educators and institutions looking to adopt AI tools in their design programs. Recurring themes emerged from the analysis, highlighting the need for strong support system to overcome the challenges for a smooth AI integration.

V. DISCUSSION

This research highlights the evolving and complex role of AI in design learning. While tools like ChatGPT, MidJourney, RunwayML and others significantly enhance creativity, productivity, and efficiency, they also pose risks like over-reliance and ethical concerns. It is essential to integrate traditional practices with AI to bring balance into learning.

A. AI'S ROLE IN ENHANCING CREATIVITY AND CRITICAL THINKING

One of the most notable findings is that AI can support both creativity and critical thinking. Several respondents shared that different AI tools help them generate alternative design options and help streamline the initial design process. Many even said that AI tools encourage exploring design solutions that stimulate innovative ideas. This ultimately leads to high quality work. As Gmeiner et al. suggests, generative AI facilitates human-technology collaboration by capturing user-generated content within the artwork [23].

However, there is the problem that too much dependence on artificial intelligence may hinder real independent creative thought. Over-reliance may lead into a situation where the designer's role becomes just one of choosing from a pool of options generated by AI rather than being actively involved in creating. This is consistent with Woinaroschy [14] who insisted that while AI can increase originality the balance between automation and human creativity has to be kept at a proper level.

Furthermore, AI tools were seen as to stimulate critical thinking through mirroring real-world design problems and giving feedback on resolution. This results into openings for students to examine their choices regarding designs against several parameters. Nevertheless, some respondents stated that there is danger for learners accepting suggestions from AI without comprehending them deeply or analyzing them critically enough. This indicates an urgent need of teaching users how to evaluate outcomes from Artificial Intelligence effectively.

B. SKILL DEVELOPMENT AND PEDAGOGICAL INTEGRATION

The integration of AI tools into the design curriculum can significantly enhance skill development through personalized feedback and improvement of technical skills such as rendering, visualization and design iteration. It was emphasized by all respondents that learners are able to do project work efficiently with help from AI, thus enabling them to handle complex tasks. As some participants indicated however, there ought not to be any replacement for hands-on activities necessary in order to have a complete comprehension about principles of design.

The results suggest that the best way forward may be through a blended approach which combines AI-enhanced learning with traditional pedagogical approaches. These findings align with the work of Saritepeci and Durak [24] who claimed that utilizing AI effectively promotes skills acquisition but not a substitute for traditional design teaching methods.

C. ETHICAL CONSIDERATIONS

The role of AI in design education has been brought up as a major ethical issue. While AI's potential to democratize design processes by making advanced tools more accessible was noted, but on the other hand, bias, accountability and transparency concerns were also raised. There is a chance that AI automated responses might incorporate biases during training into their algorithms and thus affect the output of designs [12], [28]. Prior studies suggest that if AI systems are not carefully managed, they will end up perpetuating existing prejudices.

The other important ethical issue is the need for transparency in AI decision making processes [26]. As such, this creates a dilemma for design teachers on how to make sure that AI tools are responsibly used in education contexts. Therefore, the importance of an all-inclusive training program on both technical and ethical dimensions of AI was underscored by the study

participants indicating an active role for educators to guide students through such complicated matters.

D. RECOMMENDATIONS FOR AI INTEGRATION IN DESIGN EDUCATION

To maximize the benefits of AI tools in design learning while minimizing the challenges, several recommendations emerged from the qualitative data:

1. Institutions should prioritize providing extensive training and support so teachers and students can effectively use AI tools.
2. Course design should focus on fostering critical thinking, ethical AI usage, and an integrated approach that preserves human creativity and decision-making.
3. Curriculum designers should focus on integrating AI into mundane tasks like data analysis and visualization leaving more inventive tasks like hands-on practice and innovation to develop creative problem-solving skills.
4. Educators should be mindful of potential bias and decreased student engagement using AI tools. Regular assessment and improvement are crucial to ensure AI tools enhance, not replace human ingenuity.

E. LIMITATIONS AND FUTURE RESEARCH

While this study provides valuable insights, it has some limitations that should be considered. First, it is challenging to assess the change in attitudes and practices over time since the data collection follows a cross-sectional design. Additionally, the sampling mainly consists of students and young professionals hence it may not fully reflect the opinions of seasoned teachers and field experts. This sample might need to reflect better on the experiences of seasoned teachers or corporate leaders. Further studies may include longitudinal studies with diverse participant groups to improve generalizability. Lastly, further research to explore the specific ethical problems could be carried out to develop preventive measures against these threats.

F. CONCLUSION

This study demonstrated the transformative impact of AI on design education, while also highlighting both its advantages and disadvantages. According to the existing studies, artificial intelligence provides several

benefits that may improve critical thinking, creativity, and productivity. However, significant attention must be paid to ethical challenges such as bias, accountability, and transparency as well as over-reliance on AI tools. Thus, design instructors must integrate AI tools with traditional hands-on pedagogical approaches to ensure students still develop essential skills of creativity, critical thinking, and problem-solving. A balanced approach that combines human-centered and AI-driven learning could be crucial to preserving the foundation of design learning. Additionally, regular ethical checks of the long-term effects on design education will be necessary for optimal integration. Educators should communicate about the responsible usage of AI to promote human-centered design learning only to be enhanced by technology.

CONFLICT OF INTEREST

The authors of the manuscript have no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

DATA AVALIABILITY STATEMENT

The data associated with this study will be provided by the corresponding author upon request.

FUNDING DETAILS

No funding has been received for this research.

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