

Generative Artificial Intelligence (GAI) as a Teaching and Learning Method to Support creativity in product Design

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ABSTRACT:

Generative Artificial Intelligence (GAI) is an advanced branch of AI focused on creating content such as images, text, music, and video based on input data. In the design field, it is increasingly embraced by designers and design students as an innovative tool to explore ideas and execute complex projects efficiently. However, debates arise about its impact on human creativity, originality, and the critical thinking abilities of users due to reliance on repetitive patterns.

The research study if the GAI affect positively in product design process, and The research assumes if it doesn't affect negatively on critical thinking so it has positive role in fostering innovation among design students by Using "Descriptive-experimental research methodology "by study supported by a student questionnaire, the research measures its effects on innovative abilities and critical thinking within design education.

Findings reveal that when used appropriately, (GAI) does not harm creativity but rather enhances innovation, teaching, and learning processes. It is recognized as a valuable tool to improve the efficiency and effectiveness of design stages.

The study concludes that integrating (GAI) into design education is essential. It supports innovation, enables active learning, and aligns with technological advancements. Proper application ensures that students and educators benefit from AI tools, promoting a more effective and technology-driven educational experience.

Introduction :

Art plays a crucial role in human culture and personal development, fostering creativity, critical thinking, and emotional expression (Meena & Monika, 2023). Therefore, art education is essential as it ensures individuals can engage with and benefit from artistic experiences, promoting cultural awareness and empathy (Martínez-López de Castro et al., 2022).

GAI is described as a revolutionary tool poised to redefine teaching and learning methodologies, highlighting its potential to create personalized content and transform learning environments (Blake, 2023). It plays an indispensable role in multiple critical aspects such as assessment, student performance prediction, intelligent tutoring, and learning management, greatly enhancing the efficiency and quality of education (Crompton & Burke, 2023).

The application of (GAI) in education presents paradigms-shifting strategy that can significantly improve learning outcomes. GAI has the potential to completely transform the way that education is provided and received through personalized learning, intelligent teaching, and accessibility. The idea of personalized learning is made possible by GAI and enables a unique educational experience based on each student's requirements, preferences, and development.

GAI can deliver tailored material and support by analyzing massive quantities of data and modifying instructional tactics in real time to increase engagement and improve learning results. . GAI augments the role of human educators by enhancing the effectiveness of tutoring sessions and explaining complex ideas, answering queries, and providing tailored feedback. This clever assistance encourages greater comprehension and aids students in overcoming obstacles to learning. The effect of GAI on accessible education is particularly noteworthy. Online platforms powered by GAI can close the educational gap in underserved or rural.

Despite the widespread adoption of Generative AI (GAI) among those involved in education, art, and

design, it continues to face several significant challenges. These include concerns regarding academic integrity, student polarization, reliability, and the quality of design outcomes. One of the most contentious issues is its potential impact on innovation and originality in design, as well as on students' skill development. In particular, GAI may hinder critical thinking abilities such as research, problem-solving, and decision-making. Overreliance on GAI can lead to a decline in students' analytical and creative capabilities.

Additionally, the technology raises concerns about its influence on the effectiveness of brainstorming, a crucial process for design students and practitioners in generating unique and original ideas. This study employs "Descriptive-experimental research methodology to examine the motivations behind the use of GAI by individuals in the design field and its effects on both creative and critical thinking strategies. It draws on the perspectives of GAI users—including designers, students, and educators in art and design—and explores the extent to which its negative impacts can be mitigated or transformed into constructive approaches. The study also aims to identify how the positive aspects of GAI can be harnessed to enhance the organization and effectiveness of the design process and its related skills, ultimately leading to improved outcomes.

- Literature review:

GAI utilizes machine learning, neural networks, and other techniques to analyze patterns and information in training data, thereby generating new content such as text, images, and music (Gong et al., 2023; Lim et al., 2023; Ooi et al., 2023; Yu & Guo, 2023) that closely resemble human-created content (Farrelly & Baker, 2023).

Generative AI models have experienced exponential growth in recent years (Gonzales, 2023), and have gained attention for their promise to revolutionize a wide range of industries, from entertainment and marketing to healthcare, finance, research, and the creative arts (Vujović, 2024).

Since being introduced in 2014 by Goodfellow and his colleagues, generative adversarial networks (GANs) have quickly developed and attracted interest

In 2016, GANs began to garner a lot of attention from the research community, particularly for uses in computer vision. Researchers first used GANs to produce realistic images, improve image quality, and perform image-to-image transformations. This development created new opportunities for making accurate and visually appealing material.

In 2017, the educational sector also began investigating the possibilities of GANs in content creation. The idea of adaptive learning systems utilizing GANs in education first surfaced in 2018. These systems used GANs to produce personalized learning materials based on individual student data. GAN-powered adaptive learning systems aimed to maximize learning results by creating customized content and modifying the degree of difficulty of learning materials.

In 2020, GANs expanded their influence to encompass educational virtual reality (VR) and augmented reality (AR) activities. Realistic virtual worlds, characters, and objects were created using GANs, which improved the immersion and interaction of educational experiences.

In 2021, GANs were still being investigated for use in creating intelligent tutoring systems.

These systems used GANs to provide personalized feedback and support to students, adjusting their education depending on different learning preferences and development. The application of GANs in education is growing, with novel approaches to content creation, individualized instruction, immersive learning, automated grading, and intelligent tutoring.

As follow (Figure -1) show this figure how Artificial Intelligence can be divided into sub-fields

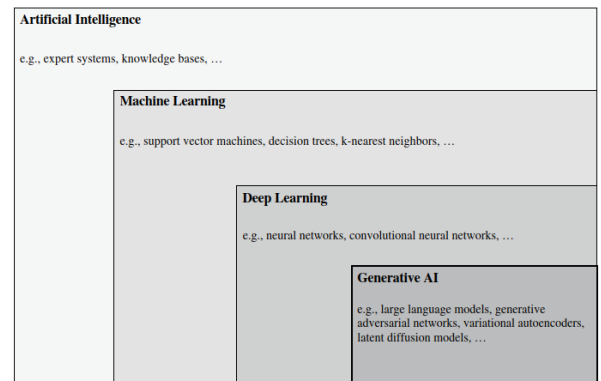


Figure 1, An illustration of how Artificial Intelligence can be divided into sub-fields (Banh & Strobel, 2023).

The use of Generative AI (GEN-AI) has become increasingly widespread among designers, students, and educators interested in the study and practice of design. This is largely due to its capabilities in reducing the time required for various stages of the design process and providing supportive tools that enhance the efficiency and effectiveness of completing design tasks. However, despite its growing adoption, the use of GEN-AI continues to raise important questions regarding its impact on individual skills and the designer's creative capabilities. Some of the key concerns include:

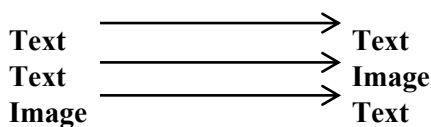
- To what extent does it affect the designer's drawing and design skills?
- Does it negatively influence the designer's ability to engage in brainstorming during the ideation process?
- Does it hinder the designer's capacity to develop and evaluate design concepts?
- Does it impact the ability to critique and analyze ideas effectively?

Therefore, it is important to examine the extent of GEN-AI's impact on these critical aspects, while also acknowledging its undeniable positive contributions to the development of design education and practice. GEN-AI has emerged as an indispensable tool, and in the following section, we explore its most significant capabilities in the field of product design and its contributions across different stages of the design process.

1 - The power of GEN-AI in product design process

Investment in the development of Generative AI (GEN-AI) has become a major global focus, driven by the rapid emergence and continuous updates of numerous applications. The scale of investment in GEN-AI has increased dramatically—from a total of \$0.84 billion USD in 2019 to \$25.23 billion USD in 2023. This reflects the growing recognition of its transformative potential across various fields, including design.

Every day, new GEN-AI applications are launched or improved, many of which have direct relevance to the design process. Prominent examples include ChatGPT, Gemini, Claude AI, Co-Pilot, and Leonardo, among others. These tools are now being widely integrated into different stages of the design process, particularly for tasks such as idea generation, concept visualization, content development, and even technical implementation.



"The following diagram Figure 2 - illustrates how generative artificial intelligence works. It utilizes various types of input—such as text, audio recordings, images, structured data, or 3D signals—and processes them through an AI model to generate different types of output, depending on the intended purpose."

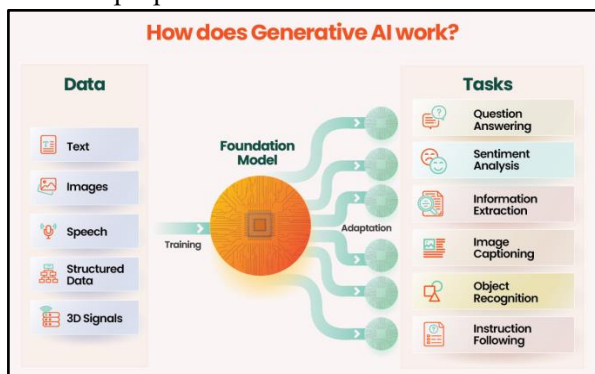


Figure 2 - GEN-AI Model

<https://www.tredence.com/generative-ai-101>

Accordingly, generative AI techniques offer direct benefits across all stages of the design process. The inputs and outputs of each stage can, in one way or another, be supported through GEN-AI applications, facilitating faster and more efficient completion of design tasks.

Design Thinking is a methodology that describes the activities of innovation. It is a system that utilizes the designer's intuition, skills, and methods to meet user needs through unique and innovative products. This approach is built on deep understanding and direct observation of users' needs and desires, focusing on exploring ambiguous problems, gathering insights, analyzing knowledge, and generating solutions.

The **Design Thinking process** consists of five key stages:

1. **Empathize** – In this stage, designers conduct research and gather information about users, their behaviors, and their thought processes. This includes understanding the problems they face and empathizing with their experiences.
2. **Define** – Here, the data collected during the Empathize stage is analyzed to clearly define the problem. This includes market research, material studies, analysis of existing products, and user feedback. The goal is to formulate a precise understanding of the problem and its root causes.
3. **Ideate** – In this stage, designers engage in brainstorming to generate creative ideas and potential solutions that address the identified needs. This phase encourages divergent thinking and exploration of multiple concepts.
4. **Prototype** – Designers then develop a preliminary model or prototype by implementing selected ideas from the Ideate stage. This allows for physical or digital representation of the proposed solution.
5. **Test** – Finally, the prototype is tested with users in a real or simulated environment.

User feedback is collected and analyzed to improve and refine the design further.

Throughout each of these stages, generative AI can influence and enhance both inputs and outputs. For example, it can assist in user research, analyze trends and feedback, generate a wide range of design alternatives, and simulate user interactions. The following diagram Figure 3 - illustrates the impact of generative AI on the inputs and outputs of each design thinking stage.

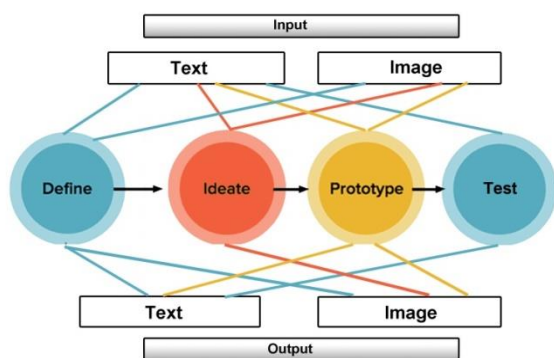


Figure 3 -GAI Impact on input and output of design process-
Researcher Own Work

During each stage of the design process, a range of methods, techniques, and theoretical approaches are employed to achieve specific outcomes. Within these practices, designers inevitably engage in **critical thinking**—whether intentionally or unintentionally, and whether directly or indirectly—as each stage demands particular cognitive strategies to reach successful results.

Critical thinking is one of the most essential skills a designer applies throughout the design process. It does not imply negativity or constant criticism; rather, it enables designers to identify weaknesses or flaws in their reasoning and decision-making processes. By addressing these issues, more effective and informed outcomes can be achieved.

Moreover, critical thinking involves analyzing issues based on objective evidence rather than personal opinions, assumptions, or biases. In the context of design, it allows practitioners to respond quickly, make sound decisions, and solve problems

more efficiently—ultimately leading to innovative and user-centered solutions.

Classifications of critical thinking skills can be presented as Eniss (1985) summarizes them in three main groups as follows:

- 1 -Defining and clarifying the problem .
- 2 -Inference of information .
- 3 -Solving the problem and drawing reasonable conclusions

Afaneh (፳፻፲፱), defined critical thinking skills in five skills ,

- 1 -The skill of predicting assumptions .
- 2 -The skill of interpretation .
- 3 -The skill of evaluating discussions
- 4 -The skill of deduction
- 5 -The skill of induction .

These are the same skills as the Watson & Glaser model, as they are presented in the model as follows :

- 1 -Identifying the assumptions
- 2 -The interpretation
- 3 -Inference
- 4 -Conclusion
- 5 -Evaluating the arguments .

As for Facione's classification, it is as follows :

- 1 -Interpretation
- 2 -Analysis
- 3 -Evaluation
- 4 -Inference
- 5 -Explanation
- 6 -Self-organization.

2 – Critical thinking and design process

The design process is typically structured into a series of stages through which both thinking and implementation evolve. It begins with the **Discover** stage, where the need or idea requiring design or development is explored. At this point, the designer must identify and engage with the need in a tangible way—either by directly interacting with users who experience it, or by observing it in real-life product scenarios. As user needs evolve in tandem with

advancements in design and technology, new design challenges continue to emerge. These cannot be fully captured in any existing database, which only reflects problems that have already been addressed and resolved.

This is followed by the **Define** stage, during which the designer clearly articulates the problem, conducts thorough analysis, and gathers all relevant information. At this point, access to prior studies, scientific research, and user feedback becomes crucial. These sources help streamline the research phase, and artificial intelligence can play a supportive role by facilitating quick access to such information.

The third stage, **Ideate**, is considered one of the most critical phases. Here, the designer generates a range of ideas aimed at solving or improving the problem to meet user needs. The ideation process often involves brainstorming—either individually, in groups, or with end users—alongside techniques such as mind mapping, morphological analysis, and rapid sketching. Designers may also encounter challenges such as mental blocks, time constraints, or overlapping concepts. Translating brainstorming outcomes into tangible, testable concepts is key, yet remains a human-driven task. Although AI tools can support this phase, they cannot replace the designer's role in critical evaluation, interpretation, and idea selection. The designer must employ higher-order thinking skills—such as assumption testing, induction, and inference—to assess the feasibility and relevance of generated ideas.

Next is the **Prototype** stage, where a tangible model of the design is created using actual materials and construction methods. This phase involves iterative testing and refinement based on feedback until a final version is achieved.

Across all stages, the design process closely aligns with elements of critical thinking, as outlined in Figure 4 - Peter Drucker's model, including analysis, tactical implementation, and strategic planning. These components highlight the indispensable role of human intervention—grounded in practical experience and critical

thought—that artificial intelligence alone cannot replicate.

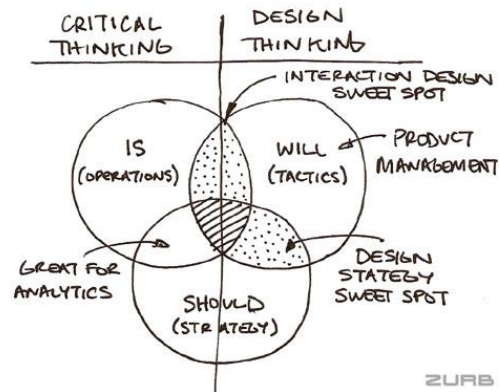


Figure 4- Peter Drucker's Paradigm of Change Model
Drucker, P. (1993). *Managing for the Future*

Brainstorming and its various techniques are among the most important methods designers rely on for idea generation and evaluation. These techniques support creative thinking and effective problem-solving. Therefore, it is essential to analyze brainstorming strategies and their relationship with **Generative AI (GEN-AI)**, as well as the mutual influence between them.

Several brainstorming methods are commonly used in the design process, including:

1. **Mind Mapping:** A non-linear visual technique that helps organize thoughts and create associations between ideas. It allows designers to generate concepts and explore detailed aspects of the product or problem by expanding their perspective.
2. **Reverse Thinking:** Also known as "Wrong Thinking," this creative technique challenges conventional logic by intentionally focusing on how to cause a problem rather than solve it. This reversal often reveals unexpected solutions and encourages out-of-the-box thinking.
3. **Role-Storming:** In this approach, team members adopt different roles (e.g., customers or users) and respond to design

questions from those perspectives.

Incorporating methods such as the Six Thinking Hats enables designers to view the product or concept from multiple angles, facilitating a deeper understanding of user needs and more tailored solutions.

4. **Word Association:** This technique involves using related or random words to spark new ideas. By exploring surprising connections between terms, designers can stimulate creativity and uncover innovative approaches to product development or problem analysis.
5. **Traditional Brainstorming:** A classic group-based method where participants freely share ideas without criticism or judgment. This open environment encourages the generation of diverse ideas from multiple perspectives and cultural backgrounds, leading to richer and more inclusive design outcomes.

Understanding how these methods interact with GEN-AI tools can offer new insights into how AI can support or even enhance the brainstorming process—whether by expanding the range of associative ideas, simulating user roles, or visualizing mind maps in real-time.

All the aforementioned brainstorming techniques rely on the designer as the **primary generator of the core data** that Generative AI (GEN-AI) interacts with. The designer is best equipped to define the essential elements of a mind map or keyword associations, due to their deep understanding of the design problem or the proposed product. In this context, GEN-AI assists by expanding these structures, providing additional associations from diagnostic perspectives based on its vast data sets, which the designer can use to enrich their ideation.

Moreover, GEN-AI can simulate various personas with realistic and practical perspectives based on previously recorded user experiences and feedback stored in its databases. This offers the designer access to a wide range of historical insights, which

can be utilized in **virtual brainstorming sessions** to explore and discuss potential design solutions.

However, the **core creative and interpretative role remains uniquely human**. GEN-AI cannot replace the designer's intuitive vision, problem-framing abilities, and creative decision-making. Rather, it serves as a **self-learning support tool** that reduces the time required to implement complex brainstorming methods—thus increasing the overall **efficiency and productivity** of the design process.

Furthermore, GEN-AI represents a **revolution in non-traditional education**, particularly when properly integrated into design pedagogy. Its positive influence on teaching and learning is significant when applied correctly. As one of the latest tools in alternative learning methods, GEN-AI is reshaping the educational landscape in the following ways:

- **Personalized Learning:** Tailoring educational content to match the individual learning styles and paces of students.
- **Adaptive Learning:** Analyzing student performance to deliver content that aligns with their progress and challenges.
- **Instant Inquiry Support:** Using AI-powered chatbots to respond to student questions in real time.
- **Enhancing Creativity and Problem-Solving:** Supporting the development of innovative thinking skills through diverse stimuli and suggestions.
- **Content Generation:** Creating customized learning materials such as texts, videos, and interactive exercises.
- **Supporting Design Thinking:** Assisting students in exploring alternative solutions by analyzing data and proposing creative scenarios.
- **Redefining the Teacher's Role:** Shifting the teacher's role from a source of information to a mentor and guide.
- **Student Performance Analytics:** Monitoring student progress and identifying

strengths and weaknesses to inform instructional strategies.

- **Improved Assessment:**
 - **Continuous Formative Assessment:** Using AI systems to evaluate student work and provide immediate, tailored feedback.
 - **Adaptive Testing:** Dynamically adjusting the difficulty of questions based on student responses.

To empirically test the validity of the research hypothesis, a survey was conducted among product design practitioners, including students and designers. The survey was designed based on the **Ennis-Weir Critical Thinking Test**, a tool developed in 1985 by Robert Ennis and Eric Weir, aimed at measuring critical thinking skills.

Method :

The survey was developed based on a comprehensive review of the literature on critical thinking and its standards, as well as direct observation of the design practice by students and practitioners. It also took into account the widespread use of various methods and applications of Generative AI (GAI) in the design process. The survey was structured according to the **Ennis-Weir Critical Thinking Test**, and was divided into five main sections:

1. **Section One:** Argument Analysis and Critical Evaluation
2. **Section Two:** Identifying Logical Fallacies and Constructive Criticism
3. **Section Three:** Inference and Logical Justification
4. **Section Four:** Presenting Counterarguments and Explaining Alternatives
5. **Section Five:** Final Evaluation and Future Thinking

The survey was designed with three possible responses: (1) Strongly Agree, (2) Agree to Some Extent, and (3) Disagree. It was administered electronically and received a total of **118 responses**.

The respondents all are Egyptians and divided into three categories:

- **60 students (50.8%)** from various faculties of arts and design in Egypt .
- **12 design educators (10.1%),**
- **46 practicing designers (38.9%)** from the design industry.

Out of the total 118 responses, **70 were male and 48 were female**.

The survey was structured around the sections of the **Ennis-Weir Critical Thinking Test** and was designed to assess the impact of AI usage on critical thinking skills, the design process, analysis, result evaluation, and decision-making. For each question, respondents were asked to provide a written justification for their choice (whether Strongly Agree, Agree to Some Extent, or Disagree), offering an explanation for their selection. The questions were as follows:

- **Section One:** Argument Analysis and Critical Evaluation
-
1. Do you believe that Artificial Intelligence can eliminate human creativity in product design or development?
 2. Can Artificial Intelligence generate innovative ideas that meet design standards and are feasible for implementation?
 3. As the use of Artificial Intelligence in the product design process increases, does it weaken designers' critical thinking skills?
 4. Can Artificial Intelligence completely replace the designer in the stages of the design process?
 5. Can Artificial Intelligence make better realistic design decisions than the designer/human mind?
- **Section Two:** Identifying Logical Fallacies and Constructive Criticism
-
6. Given that many designers are using Artificial Intelligence, do you believe that

designers who have not yet adopted it will have a chance to work in the near future?

7. Does Artificial Intelligence lead to the loss of authentic artistic identity in design, as it relies on fixed, non-creative algorithms?

- **Section Three:** Inference and Logical Justification

8. Can Artificial Intelligence be a tool to enhance creativity, rather than replace it, if used in a complementary manner by designers?
9. Can Artificial Intelligence reduce the time required for each stage of the design process?

- **Section Four:** Presenting Counterarguments and Explaining Alternatives

10. Will design with the help of Artificial Intelligence lead to the creation of similar products, as it relies on analyzing common patterns rather than offering new solutions?
11. Despite the significant advancements in Artificial Intelligence, is the human designer still necessary to define the problem and develop unique and creative solutions?

- **Section Five:** Final Evaluation and Future Thinking

12. Success in future industrial design will require a blend of human critical thinking and Artificial Intelligence capabilities to achieve effective innovation.

designer, and the future of artistic identity in light of the increasing reliance on smart technologies were extracted. The analysis also explores the participants' conviction regarding the effectiveness of Artificial Intelligence as a supporting tool in improving the efficiency of the design process and enhancing creativity. Below in Figure 5 the presentation of the survey results and their analysis.

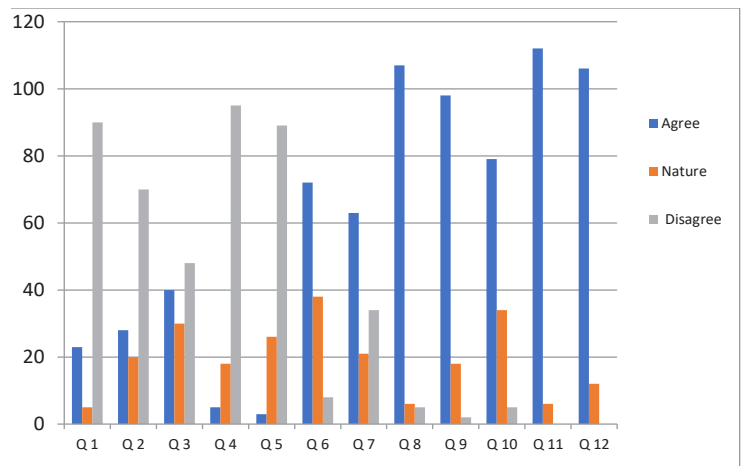


Figure 5 - Survey Results from Design Practitioners on the Impact of Artificial Intelligence on the Design Process -Researcher Own Work

First Section: Analysis of Arguments and Critical Evaluation

- **Impact on Creativity and Critical Thinking:** The results from the analysis of the critical arguments and evaluation reveal that a large portion of respondents disagreed with the idea that AI could replace human creativity or the designer entirely (questions 1, 4, and 5). This suggests that many participants do not believe AI can fully replace the human designer or eliminate human creativity in the design process.
- **AI Generating Complete Ideas:** On the other hand, a significant number of respondents agreed that AI could generate complete, executable ideas (question 2). This agreement increased slightly in question 3, indicating some belief in AI's

Data Analysis:

The results of the survey in were analyzed according to the previously mentioned sections, identifying both positive and negative indicators. The opinions regarding the ability of Artificial Intelligence to generate creative ideas, its impact on critical thinking, the likelihood of replacing the

capability to generate ideas, although with reservations regarding its ability to fully take over the designer's critical thinking role. There is clear acknowledgment of AI's capabilities, but with a preference for human oversight.

Second Section: Future of Designers and Artistic Identity in Design

- **Impact on Future Designers:** In question 6, a large number of participants agreed that designers who do not use AI could face difficulties in the future. This reflects concerns about the growing role of AI and its potential impact on the job market for designers.
- **Impact on Artistic Identity:** Over half of the respondents in question 7 agreed that AI could lead to the loss of the artistic identity of design. This indicates a genuine concern that the increasing use of AI might standardize design and affect the uniqueness of designs that reflect the designer's personal touch or cultural identity.
- **Summary:** These findings highlight a concern about the future of designers' roles and the preservation of artistic identity in the face of AI's growing influence.

Third Section: Positive Impact of AI on Creativity and Efficiency

- **Enhancing Creativity and Efficiency:** In question 8, most respondents agreed that AI could enhance creativity when used in collaboration with human designers. In question 9, most agreed that AI could reduce the time spent on various stages of the design process, reflecting the recognition of AI's efficiency-enhancing capabilities.
- **Summary:** The responses suggest that AI is seen as a tool to improve the creative

process and the efficiency of design workflows, but not as a replacement for human involvement in creative tasks.

Fourth Section: Limitations of AI in Innovation

- **AI's Limited Innovation Capacity:** In question 10, the majority agreed that AI has limited capacity in terms of innovation compared to human designers. However, question 11 showed a smaller percentage of respondents agreeing on the critical importance of the human designer's presence in the design process, indicating that while AI is acknowledged as a valuable tool, the human designer remains essential for true innovation.
- **Summary:** The results suggest that AI is viewed as a supportive tool rather than a replacement for human creativity, with participants emphasizing the importance of collaboration between AI and human designers.

Fifth Section: Final Evaluation and Future Thinking

- **Importance of Human-AI Collaboration:** In question 12, respondents emphasized the importance of blending human critical thinking with AI's capabilities to achieve comprehensive innovation in design. This reflects a strong belief in the synergy between human expertise and AI to drive future innovation.

Key Observations from the Justifications

1. **Preliminary Nature of AI Results:** Many participants noted that AI-generated results are initial and incomplete, lacking the necessary standards for industrial design and product development. AI does not yet

meet all the design criteria required in professional settings.

2. **Role of the Designer:** Several respondents emphasized that the designer's role is essential in decision-making during each phase of the design process. Designers are seen as the key agents in defining design identity, while AI is viewed as a tool that helps save time, but not as a substitute for human input.

3. **Awareness of Technological**

Advancements: Respondents highlighted the importance of designers being aware of and adapting to the latest technologies, including AI, to remain competitive and relevant in the evolving design landscape.

Result :

From previous studies on the nature of using generative artificial intelligence in the design process, through examining its use in each stage, and also from a survey of design practitioners, whether designers or students, regarding their opinions on the impact of using generative AI on the designer's critical thinking and creative ability, the research concluded the following: Generative artificial intelligence is considered a modern technology that can be used as a tool for an advanced teaching method. It is, in itself, an unconventional approach that can be relied upon in teaching and practicing the design process by those involved in teaching design or practicing it. It is considered a teacher with vast experience that can be analyzed and used to generate new ideas and thoughts, which can support the educational process. Examples of this support include the following:

- 1 - Generated images based on textual descriptions, aiding in visual learning and creativity
- 2 - Created tailored learning materials based on individual student data for improved outcomes
- 4- Enabled automated grading and consistent feedback on student assignments and assessments
- 5 - Developed virtual assistants to answer student queries and provide educational support
- 6 - Enhanced engagement and interactivity in educational content through generative models
- 7 - Created immersive virtual environments for educational simulations and training

9 - Generated diverse and contextually relevant questions for educational

Assessments

13 - Created adaptive learning materials based on individual student data for better outcomes

15 - Enabled automated grading and consistent feedback on student assignments and assessments

16 - Developed virtual assistants to provide educational support and answer student queries

18 - Produced realistic and visually appealing artwork and creative visuals

19 - Enhanced the performance and generalization of machine learning models through data augmentation techniques

20 - Improved learning outcomes by generating tailored educational content based on student data

22 - Automated the generation of educational content such as lesson plans and study materials

23 - Developed intelligent tutoring systems that adapt to individual student needs and progress

24 - Generated feedback on student assignments and assessments to aid in their improvement

26 - Integrated GANs with augmented reality to enhance learning experiences in various subject

"It also does not affect critical thinking, as it cannot enable appropriate, realistic decision-making, critical analysis, or the creation of a final, manufacturable product. It cannot analyze actual materials, experiment with user experiences, test the product, or obtain feedback. All of these steps can only be performed by human designers, with artificial intelligence serving as a guiding and supportive tool. Therefore, generative AI is a self-learning tool that supports innovation, reduces the time required for many research and integration tasks, facilitates faster and more comprehensive brainstorming, and helps test quick insights and viewpoints during discussions by visualizing ideas. It also enhances innovation by creating imaginative, fantastical, and diverse designs from different cultures, which boosts the designer's creativity and ability to imitate."

However, there are some essential recommendations for using generative artificial intelligence, whether as a teaching method or a learning approach. These include:

- Using GEN-AI as a teaching tool to create diverse and suitable content that aligns with the different trends for each group of students.
- Introducing generative AI to beginner design students gradually, accompanied by various skill-based and practical competencies in design practice.
- Recommending that students document the steps in which they relied on generative AI during all stages of the design process.
- Focusing on the use of generative AI as an ideal means to study the integration of sciences in the field of product design.
- Expanding the discussion on the ethical dimension of design using generative AI and encouraging students to comment on ethical issues related to the use of AI and avoid them.
- Emphasizing the reliance on personal capabilities for skill-based tasks in design, ensuring that the final results are manual.
- Focusing on the use of GAI in:
 - **Customization:** Generating educational materials tailored to the students' needs.
 - **Interaction:** Providing support through educational chatbots.
 - **Analysis:** Analyzing educational data to improve curriculum content, teaching methods, and learning strategies.
 - **Innovation:** Creating virtual experiences.
- Continuously developing the knowledge of students, teachers, and practitioners in AI sciences due to their significance in design practice. AI advancements are leading to a reduction of many tasks in the design process, which, if neglected, can cause designers to fall behind technological progress and cling to outdated design methods throughout all stages.

Student Application:

Generative Artificial Intelligence (GAI) was applied as a teaching and learning approach in several courses within the Product Design Department, Faculty of Applied Arts, October 6 University. Among the course outcomes were the following projects:

Project 1

The aim of this project was to design a waste bin for children in schools that promote the culture of waste separation. It utilizes solar energy to generate electricity, providing children with a visual indicator (via lights) to signal whether the waste has been disposed of correctly. The design was intended to be fun, interactive, colorful, suitable for children of different heights in primary school, and easy to assemble, disassemble, and maintain. Students used Generative AI during the brainstorming phase of the project.



Figure 6 – Student project (waste bin to school children that promote the culture of waste separation)

Project 2

This project was carried out through a workshop during lectures, targeting the replacement of electrical energy with solar energy in outdoor loudspeakers. The students worked on redesigning and actually producing a fully functional final prototype. Generative AI was utilized in calculating the required solar energy, reviewing previous studies, and supporting the practical execution of the project.



Figure 7 – Student project (Outdoor Speakers working with solar energy)

as follow a sample of the printed and electronic questionnaire a that was distributed to various target groups. That printed questionnaire was specifically prepared for the Executive Director

of Art & Craft Company for the design and production of wooden works and lighting units.

Survey on the Impact of Generative Artificial Intelligence on the Teaching and Learning Process

This survey has been prepared as part of a research study to explore the positive potential of using Generative Artificial Intelligence (GAI) as a teaching and learning method for design students in faculties of art and design, and to investigate whether it has a positive or negative impact on the critical thinking abilities of designers.

Name: Gehad Abdullah Mousa

Students: _____

Design educator: _____

Practicing designer: CEO at Art & Craft Company

Section One: Argument Analysis and Critical Evaluation

1. Do you believe that Artificial Intelligence can eliminate human creativity in product design or development?

Agree ☐ I agree to some extent ☐ Disagree ☒
2. Can Artificial Intelligence generate innovative ideas that meet design standards and are feasible for implementation?

Agree ☐ I agree to some extent ☐ Disagree ☒
3. As the use of Artificial Intelligence in the product design process increases, does it weaken designers' critical thinking skills?

Agree ☐ I agree to some extent ☒ Disagree ☐
4. Can Artificial Intelligence completely replace the designer in the stages of the design process?

Agree ☐ I agree to some extent ☐ Disagree ☒

1

Figure 8 – Page 1 – Questionnaire Sample

5. Can Artificial Intelligence make better realistic design decisions than the designer/human mind?

Agree ☐ I agree to some extent ☐ Disagree ☒

Section Two: Identifying Logical Fallacies and Constructive Criticism

6. Given that many designers are using Artificial Intelligence, do you believe that designers who have not yet adopted it will have a chance to work in the near future?

Agree ☒ I agree to some extent ☐ Disagree ☐
7. Does Artificial Intelligence lead to the loss of authentic artistic identity in design, as it relies on fixed, non-creative algorithms?

Agree ☐ I agree to some extent ☒ Disagree ☐

Section Three: Inference and Logical Justification

8. Can Artificial Intelligence be a tool to enhance creativity, rather than replace it, if used in a complementary manner by designers?

Agree ☒ I agree to some extent ☐ Disagree ☐
9. Can Artificial Intelligence reduce the time required for each stage of the design process?

Agree ☒ I agree to some extent ☐ Disagree ☐

Section Four: Presenting Counterarguments and Explaining Alternatives

10. Will design with the help of Artificial Intelligence lead to the creation of similar products, as it relies on analyzing common patterns rather than offering new solutions?

Agree ☒ I agree to some extent ☐ Disagree ☐

2

Figure 8 – Page 2 – Questionnaire Sample

Figure 8 – Page 3 – Questionnaire Sample

And as follow the link and home screen for electronic questionnaire.

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تبدیل الحساب adhamkhatab843@gmail.com

<https://docs.google.com/forms/d/e/1FAIpQLSeZtjj9Nd8YY86qRVEXSUqPUiUfQj4S2tcnXH0c6WlUgArw/viewform?usp=header>

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