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Integrating an Artificial Intelligence Workshop as a Course into the Undergraduate Industrial Design Curriculum: Importance, Functions, and Prerequisites

***Amirmahdi Seifi*[1*], *Khashayar Hojjati-Emami*[2]**

[1] Design faculty, Tabriz Islamic Arts University, Tabriz, Iran. Email: am.seifi@tabriziau.ac.ir
[2] Department of Industrial Design, Iran University of Art, Tehran, Iran. Email: k.emami@art.ac.ir

[*]**Corresponding author:** Amirmahdi Seifi

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Abstract

Artificial intelligence (AI) has grown rapidly as a result of its extensive application in science and industry. This article emphasizes the essential role of AI in industrial design, which assesses user behavior and preferences, enhances workflows, and facilitates the development of human-centric, high-performance, user-friendly products with increased precision and efficiency. Additionally, it advocates for the incorporation of a specialized AI workshop into the Iranian undergraduate industrial design curriculum. Professional designers in AI technology are essential for its efficient use in design; consequently, educational programs should incorporate an AI workshop to equip future designers effectively. This paper's theoretical basis is obtained from library research. This pilot study used the descriptive survey method, employing a simple random sample of 30 third and higher year industrial design students at Iran University of Art (17 males, 13 female). The field research revealed that although students acknowledge AI and its role in design, they lack comprehensive knowledge and practical familiarity. This preliminary finding highlights the need for an introductory AI workshop to cover theoretical foundations, give training in professional interaction with AI tools, and develop competencies for future practice. The study suggests that faculty expertise, hardware-software infrastructure investment, and industry collaboration are critical to the workshop's success. Such a workshop can bridge the current educational gap and also offer students the opportunity to apply theoretical principles in realistic scenarios. This integration may improve designers' efficiency, enrich design learning, and contribute to preparing a new generation of industrial designers capable of working with emerging technologies.

Keywords

Artificial Intelligence, Industrial Design Education, Workshop-based Learning, Curriculum Development.

Introduction

In the past few decades, undergraduate industrial design education has provided students with practical workshops in wood, plastic, and metal to enhance their comprehension of manufacturing processes. The swift advancement of new technologies, especially artificial intelligence (AI), has underscored the necessity of implementing practical workshops in this field at the undergraduate level. As industrial designers develop a significant percentage of their professional competencies during their undergraduate education, the curriculum must adapt to technological advancements. This paper examines the significance of artificial intelligence in industrial design, the present state of artificial intelligence education in this domain in Iran, and the necessity of including a specific artificial intelligence workshop into the undergraduate curriculum.

In the modern age of knowledge and information technologies, AI is anticipated to drive future human progress and impact many scientific and professional domains. In industrial design, AI facilitates a profound comprehension of user requirements, optimizes processes, and aids in the creation of creative, human-centric products with increased efficiency and accuracy (Seifi & Pourkhorshidi, 2018; Yampolskiy, 2018). Consequently, career prospects for designers skilled in AI are anticipated to increase. Designers who effectively integrate AI into their work while preserving creativity are more likely to secure their professional relevance in the future. Accordingly, this study underscores the importance of introducing undergraduate industrial design students to AI while tackling the challenges and requirements for creating an effective training workshop.

The paper utilizes both library research and a pilot field study. It offers a general explanation of AI prior to addressing the imperative of creating such a workshop. AI definitions are often categorized into four types: systems that reason logically, systems that act logically, systems that simulate human cognition, and systems that mimic human behavior. Artificial Intelligence comprises various fields, such as natural language processing, neural networks, fuzzy logic, computer vision, and machine learning, with its underpinnings rooted in philosophy, psychology, mathematics, linguistics, economics, computer science, engineering, control theory, cybernetics, and neuroscience (Russell & Norvig, 2009).

Although the applications of AI in industrial design are expanding, structured training in this field remains absent from the Iranian undergraduate curriculum. The lack of formal exposure to theoretical and practical dimensions of AI may hinder students' preparedness to address emerging professional demands. Accordingly, this study offers a preliminary exploration of students' awareness and experiences regarding AI, while also highlighting educational needs and perceived barriers to guide the prospective development of a future AI workshop within the curriculum.

Literature Review

This article theoretically examines the research topic through the collection and discussion of information derived from the literature review. This paper elucidates the significance of acquainting industrial design professionals with AI via a workshop in the curriculum, along with its associated challenges. This workshop can also function as a platform for students to comprehend the application of the proposed intelligence in the electronic components of the designed products. The importance of this acquisition can be noticeable through the applications of AI in industrial design and the potential efficacy of this technology in education.

1. *Artificial Intelligence and Industrial Design*

The extensive applications of artificial intelligence and machine learning in minimizing human errors, enhancing user comprehension and problem analysis, optimizing resource and project management, addressing complex human needs, and fostering increased comfort through the design of diverse digital and intelligent industrial devices underscore the growing necessity for heightened focus on this discipline within industrial design (Seifi & Pourkhorshidi, 2018). This technology has revolutionized the design process, facilitating the development of innovative, customized, and efficient products.

The study *Innovation and Design in the Age of Artificial Intelligence* by Verganti et al. (2020) asserts that artificial intelligence is revolutionizing the economy, heralding a new industrial era, and displacing human labor in numerous operational tasks. Products derived from it are progressively linked to the organizations that developed them and offer ongoing data. This study posits that the transformative potential of artificial intelligence not only bolsters the tenets of design thinking but also compels designers to reevaluate their function in the innovation process.

The interaction between designers and AI capabilities in the design domain requires definition and training. The intrinsic abilities of artificial intelligence, including data processing, analysis, and predictive modeling, augment the design process and facilitate more informed and innovative design choices. AI's capacity to tailor experiences using data allows for an evolution of the term *user-centric*, prompting designers to prioritize problem identification and delegate the resolution process to technology, thereby positioning themselves as leaders in the design methodology. AI offers tools and insights while incorporating the human attributes of creativity and empathy, which guarantee that designs are innovative, meaningful, and optimal (Verganti et al., 2020).

As living standards elevate, contemporary products must satisfy the varied and individualized requirements of consumers. Conventional product design methodologies exhibit constraints, including a reliance on significant subjectivity, restricted survey breadth, and relatively inadequate visual representation. Recent advancements in big data and artificial intelligence have resulted in a product design methodology that leverages these technologies, significantly influencing multiple industries (Quan et al., 2023). The utilization of AI enhances the analysis and application of complex data, streamlines the design process, optimizes product structures, and enables more reliable management and maintenance of projects (Zhang, 2022). AI-driven tools can swiftly and precisely simulate and evaluate diverse design alternatives, thus minimizing the time and resources needed for prototyping and testing, while promoting sustainable and efficient design processes through the provision of accurate material science data (Ghoreishi & Happonen, 2020).

AI-driven algorithms evaluate customer feedback at various stages and furnish designers with critical insights for choosing the most effective design. This technology can expedite the design process by facilitating human decision-making and effectively performing creative tasks, provided that the appropriate infrastructure is in place (Sharma, 2023). The incorporation of AI into 3D printing technology has facilitated the development of innovative advanced devices. The integration of 3D printing technology with artificial intelligence has applications across diverse sectors, including architecture, healthcare, and manufacturing, rendering it a crucial technology for future generations (Chun, 2021). Given these developments, a novel model of personalized product manufacturing can be anticipated and observed in the future. Akyazi et al. (2020) posited in their article that artificial intelligence significantly influences the design process by facilitating process optimization, enhancing efficiency, and minimizing waste, thereby enabling companies to develop products characterized by superior performance, extended longevity, high reliability, and enhanced adherence to environmental standards.

Figure 1: *Midjourney generates various ring designs according to a specified set of text prompts (https://darcoffice.com/what-is-midjourney).*

In the future, artificial intelligence will contribute to design from the conceptual phase and idea generation to the presentation of intricate details (Aphirakmethawong et al., 2022). Utilizing this technology enables designers to guarantee coordination across various design stages and the quality of the final product (Moubachir et al., 2022). Tools like Midjourney leverage artificial intelligence to assist designers in generating a multitude of innovative concepts and a more robust depiction of the final design. Figure 1 illustrates the generation of various ring designs utilizing this expression derived from text commands.

Numerous studies have corroborated that contemporary artificial intelligence serves as a formidable instrument for designers. Nonetheless, an article by Yüksel et al. (2023) asserts that despite advancements in technology, artificial intelligence will never achieve complete self-sufficiency in all creative design tasks. Human designers will perpetually participate in the decision-making process owing to their distinctive knowledge, experience, sensory perception, and intuitive capabilities. The outcomes of artificial intelligence inherently possess a margin of error; however, contemporary advancements in machine learning techniques have led to its application in diverse design domains, including material selection and data analysis, thereby serving as a catalyst for enhancing designers' creativity in the product design process.

Intelligent generative design software, integrated with artificial intelligence, has significantly transformed industrial design. Generative design is a process of design exploration. Designers input design objectives and parameters, including performance or spatial requirements, materials, construction techniques, and budget limitations, into generative design software. The software analyzes all potential solutions and rapidly produces a range of designs. This tool facilitates the testing of designs, allowing the software to learn from each iteration and the design team's ultimate decisions regarding effectiveness. Generative design offers numerous advantages, including a diverse array of design options, swift creation of intricate designs and forms, and optimal material and construction method selection. This sophisticated tool has assisted designers in developing innovative products across diverse design challenges, including everyday appliances, architecture, aerospace, and construction (What Is Generative Design, Autodesk, n.d). Figure 2 illustrates the new Autodesk office in Toronto, the inaugural large-scale instance of design employing generative design software. The office's interior and exterior are customized to meet user preferences and technical specifications.

Figure 2: *Autodesk Canada utilized generative design software to create a distinctive workspace that accommodates employee preferences and work styles, resulting in a space with unique attributes for employees (Image: Ben Rahn/A-Frame Inc.).*

Generative design facilitates an uninterrupted collaboration between humans and computers. The procedure encompasses the subsequent stages:

Input data into the software and generate design options through algorithms and parameters defined by the designer. The designer evaluates the generated designs in relation to their effectiveness in achieving the established objectives. The design options are ranked according to the analysis results.

Evolution employs the outcomes of the ranking to ascertain the direction in which the designs should be advanced. Analysis of designs, wherein the designer contrasts and scrutinizes the designs and assesses the outcomes against essential criteria. Following the selection of the preferred design option, the designer employs or integrates the design into the project or a larger design endeavor (Generative Design for Architecture, Engineering & Construction, Autodesk, n.d). Figure 3 encapsulates the phases of the aforementioned cycle in a general diagram.

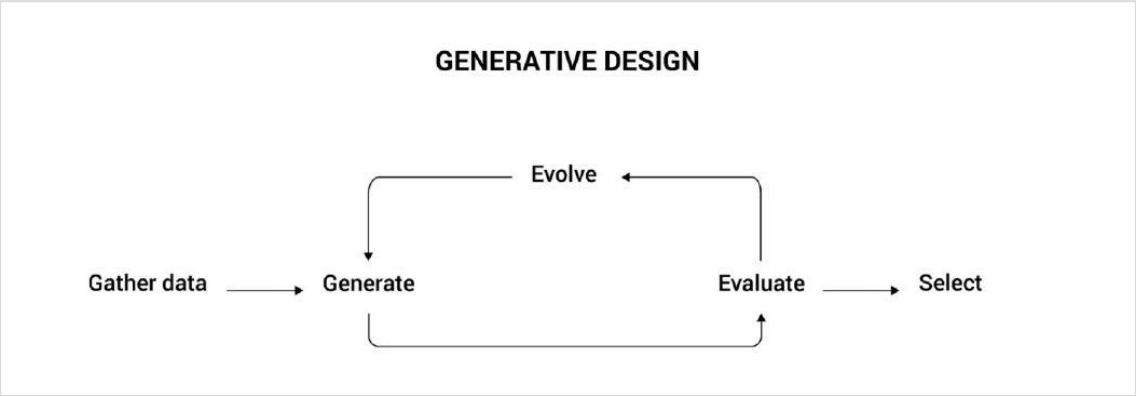

Figure 3: *The generative design workflow (https://www.autodesk.com/autodesk-university/article/Hands-Project-Rediscover-Generatively-Designing-Autodesk-Toronto-Office-2020).*

2. *Artificial Intelligence and Education*

Articles have examined the topic of education in the era of artificial intelligence; in this context, Içen (2022) notes that the 1960s and 1970s witnessed the advent of computer-assisted education, which was delivered to students in a consistent and standardized manner for decades. Computer-based education acclimates students to the utilization of computers in academic settings. Initial systems lacked artificial intelligence and concentrated on independent programs on local machines. The proliferation of the Internet facilitated the emergence of e-learning and web-based systems. The advancement of artificial intelligence technologies has resulted in the development of intelligent educational systems, thereby transforming the delivery of education.

Intelligent educational systems depend on specialized databases for educational content and methodologies, and by assessing the student's comprehension of a subject, the system dynamically delivers instruction customized to their requirements. The learning path is perpetually modified according to the student's advancement and individual requirements. AI algorithms can predict, diagnose, evaluate, and offer valuable recommendations. The education sector has started to recognize the potential of AI in improving learning experiences across diverse disciplines. Artificial intelligence augments the educational experience, enabling students to concentrate on advanced tasks and engagements. This technology assists educators by delivering optimal classroom insights at any moment, proposing suitable solutions for students, and streamlining administrative tasks, while facilitating improved monitoring of learner behavior for timely interventions (Içen, 2022).

Gašević et al. (2023) assert that, despite extensive research, artificial intelligence in education has recently garnered attention due to the advent of systems like ChatGPT and DALL-E. The growing societal impact of AI renders its role in education crucial for both policymaking and future research. Individuals' initial encounters with AI, especially in the realm of creativity, have generated both prospects and apprehensions regarding bias, ethics, equity, and precision linked to the technology. The education sector faces specific challenges, including the quandary of evaluating student essays and fulfilling assignments in the era of AI. Historically, universities have been sluggish in their adaptation to change. This prudent strategy offers benefits in maintaining long-term stability; however, a sluggish reaction to swift developments in AI may be concerning.

The trust between AI systems and humans is crucial. The growing dependence on AI in industrial design renders the development of reliable AI essential. The emphasis is on explainable AI, which not only renders decisions but also elucidates the rationale behind those decisions (Tsang & Lee, 2022). Numerous AI tools, utilizing generative AI models, generate human-like text responses that may lack accuracy or realism. These models cannot ensure factual accuracy and frequently generate plausible content on trivial subjects. There is a demand for effective pedagogical strategies that leverage the constraints of prevalent AI models to improve students' advanced critical thinking abilities (Gašević et al., 2023).

The literature review indicates that the swift incorporation of artificial intelligence technologies — such as generative design, data analysis, and optimization— is transforming the world of industrial design. This change requires future designers to possess digital and analytical skills to effectively utilize advanced technologies and participate in novel human-computer collaborations while preserving creative judgment. In light of the significant and increasing influence of AI on the field, it is important for university-level industrial design education to proactively respond to this change by formulating specific pedagogical methodologies. Therefore, academic institutions should prioritize addressing students' knowledge, practical experiences, and particular educational requirements related to AI in industrial design to guide curriculum development and ensure graduates are equipped for the profession's increasing expectations.

This study used a descriptive survey as an initial exploratory measure to assess undergraduate industrial design students' familiarity and practical experience with AI technologies at an Iranian university. The research concentrated on third-year and higher undergraduate students for this pilot study, employing simple random sampling and descriptive statistics to summarize the data that emerged.

Methodology

A questionnaire was developed to evaluate the understanding of undergraduate industrial design students about artificial intelligence and their acquaintance with related concepts and tools, comprising three main sections:

1. Fundamental understanding of AI concepts,
2. Experience interacting with AI-based tools,
3. Awareness of AI applications in industrial design, predominantly consisting of multiple-choice questions.

The research population comprised third-year and above students enrolled in the bachelor's degree program in industrial design at Iran University of Art, as they had completed numerous courses at the requisite academic level, rendering them suitable for this study.

The questionnaires were distributed to the research students in two formats: paper-based and web-based, resulting in a sample size of 30 respondents for this pilot study. The research employed a descriptive survey methodology, utilizing a questionnaire for data collection. This study's sample was obtained using a simple random sampling (SRS) procedure.

The gathered data were examined using descriptive statistics (e.g., frequencies, proportions), and the results were presented in a comparative and interpretative format based on these indicators. Descriptive computations were conducted using spreadsheet software, resulting in numerical data presented in Figures 4, 5, & 6 within the findings section.

A descriptive method is a research approach wherein the investigator objectively delineates the characteristics of a phenomenon and employs various information-gathering techniques to accurately portray the phenomenon in question and elucidate its essence. This method's survey model analyzes the characteristics and current status of a phenomenon, deriving information from individual knowledge and societal realities.

Findings

This section presents the results from a questionnaire conducted with 30 undergraduate industrial design students (17 males, 13 female). The results are categorized based on the survey's three thematic domains:
1. Acquaintance with essential AI principles,
2. Proficiency in engaging with AI-driven technologies (e.g., chatbots),
3. Knowledge of AI applications in industrial design.

The subsequent figures provide descriptive statistics (frequencies, proportions) to elucidate the patterns that have been observed. Preliminary patterns suggest a cohabitation of inadequate theoretical knowledge with frequent, albeit predominantly non-professional, usage of AI tools; these findings are investigated in conjunction with the pertinent literature in the subsequent sections of the study.

- Concerning the comprehension of fundamental AI principles, as seen in Figure 4, over 73% of respondents had minimal or no knowledge.

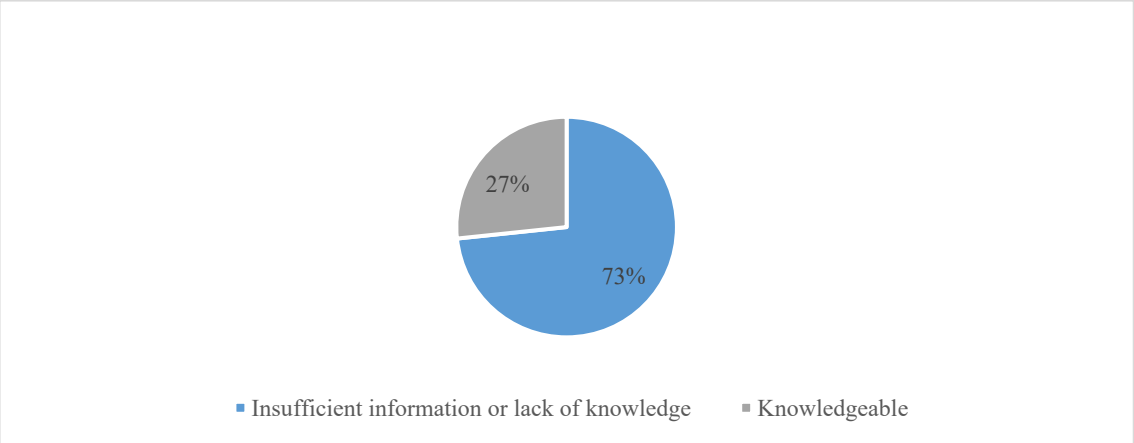

Figure 4: *Distribution of respondents' foundational knowledge level of the basic concepts of AI; n=30 (Compiled and organized by the authors).*

The investigation of these data indicates a pronounced deficiency in formal theoretical training in artificial intelligence at the undergraduate level within the industrial design curriculum at a university in Iran that provides instruction in this discipline.

- In regard to the proportion of respondents with experience utilizing AI-based tools, as seen in Figure 5, approximately 60% indicated such experience; additional research reveals that most of these experiences were personal rather than professional.

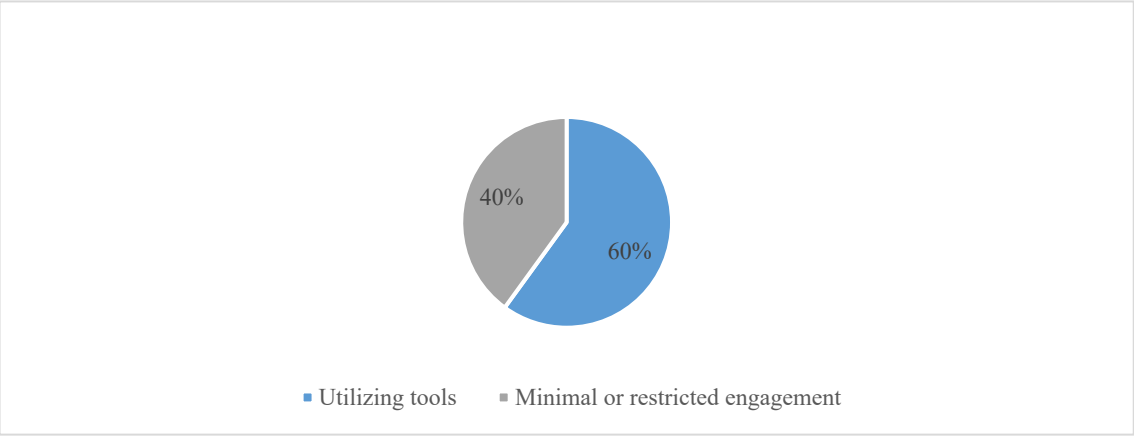

Figure 5: *Utilization of AI-based tools; n=30 (Compiled and organized by the authors).*

Upon further investigation of this observation, approximately 83% of students utilized the aforementioned tools for recreational or personal purposes, while the remainder had experience using these tools for professional or educational purposes, indicating that students are markedly distant from the professional applications of these tools in industrial design projects and works. This may provide challenges for a considerable number of them in their future jobs, considering the growing impact of artificial intelligence technologies across numerous domains.

- Concerning the participants' understanding of AI applications in industrial design, the graph shown in Figure 6 indicates that around 53% of respondents possessed a general awareness of its uses in this domain.

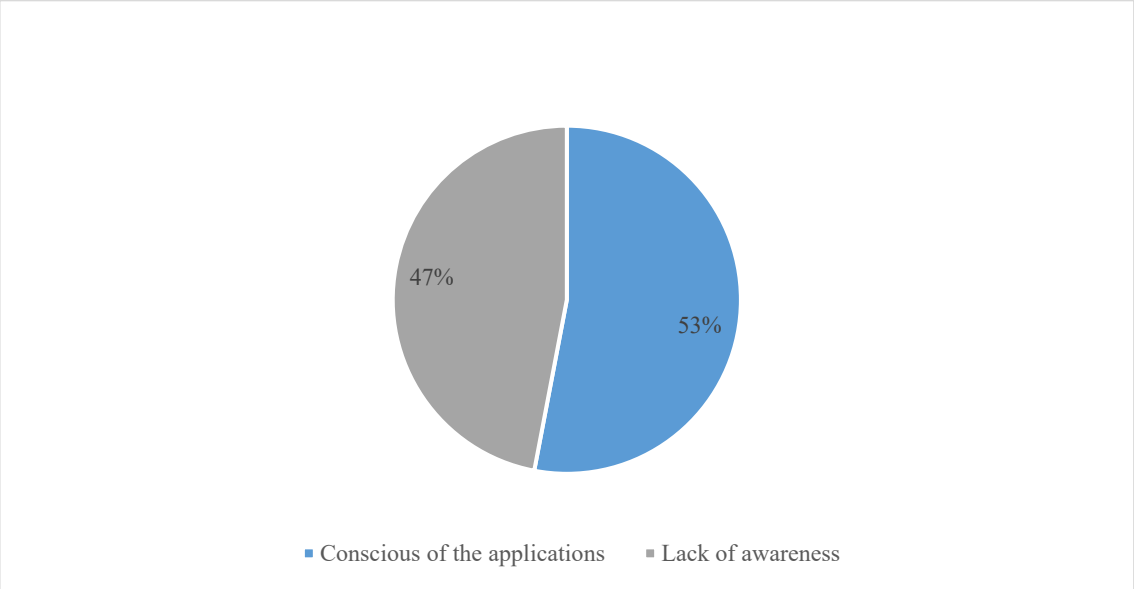

Figure 6: *The awareness of AI applications in industrial design; n=30 (Compiled and organized by the authors).*

Almost half of the respondents were familiar with some applications of AI in industrial design. This finding highlights the gap between students' initial information and their ability to implement AI in the design domain professionally. The investigation of the data reveals that, although a significant percentage of students report initial interactions with AI-based technologies, these experiences are primarily unprofessional, informal, and lacking theoretical comprehension. The findings indicate that the majority of respondents are unfamiliar with fundamental AI principles and possess minimal expertise in professional utilization of AI technology in design, with their understanding of AI applications in industrial design seeming inadequate. This mixed pattern — dispersed practical experience coupled with insufficient theoretical understanding— indicates a distinct educational deficiency in the existing curriculum.

The identified deficiency highlights the necessity to enhance these students' AI-related knowledge and skills through focused educational initiatives, since many of them will constitute the future professional workforce in industrial design in Iran. This pilot study highlights the necessity of enhancing students' abilities through organized educational initiatives. The discussion section offers recommendations for developing a successful workshop on artificial intelligence inside the undergraduate industrial design curriculum.

Discussion

The findings of this pilot study reveal that while around 60% of students reported exposure to AI-based tools, these experiences were primarily non-professional and lacked sufficient theoretical comprehension.

In the sample (n = 30), over 73% acknowledged inadequate foundational knowledge of AI principles, while about 53% indicated merely a rudimentary grasp of AI applications in industrial design. This combined pattern — fragmented practice alongside incomplete awareness indicates a distinct educational deficiency within the existing undergraduate program.

The incorporation of artificial intelligence into undergraduate industrial design programs is becoming increasingly essential due to AI's extensive industrial uses. In product design, AI facilitates generative design, data analysis, predictive modeling, and user experience enhancement, allowing for swift creation and assessment of design alternatives, forecasting consumer preferences, and recognizing market demands and design deficiencies. AI facilitates project management, resource allocation, quick prototyping, insights into material science, and waste reduction, therefore enhancing the efficiency, durability, and sustainability of design solutions. AI streamlines processes by automating repetitive operations, allowing designers to concentrate on complex problem-solving and administrative responsibilities. The successful integration of AI in products necessitates designers possessing pertinent technical expertise; thus, the research highlights a gap between conventional curricula and future job market requirements, advocating for the inclusion of theoretical, hands-on AI training through a workshop in the undergraduate industrial design curriculum.

Despite the revision of the industrial design curriculum in 2018 to incorporate new courses and update content, a specialized workshop on AI basics and its design applications is still lacking. Although certain instructors have intermittently incorporated pertinent digital subjects into traditional courses, a structured, project-based workshop would more effectively facilitate experiential learning — enabling students to experiment, fail, and learn— and should integrate succinct theoretical components with supervised practical activities. Creating such a workshop necessitates interdisciplinary collaboration, particularly in computer science, adequate hardware and software infrastructure, and faculty proficient in AI; in the absence of such specialists, provisional instruction by related-discipline staff may be contemplated.

Significant implementation barriers include institutional financial limitations, uneven quality of instruction across instructors, and the necessity for explicit evaluation standards. To alleviate these concerns, the program must delineate a clear curriculum (including things to be taught, learning outcomes, project specifications, and evaluation methodologies), prioritize project-based assessment (augmented by focused written theoretical reviews if necessary), and seek industry partnerships to obtain resources.

Core theoretical technical topics recommended for the workshop could include machine learning, neural networks, natural language processing, and computer vision. The training program could also encompass professional engagement with artificial intelligence-based textual and audiovisual content production tools, including data entry, command input, code implementation, and utilization of libraries within pertinent software. The proposed workshop program may concentrate on the elements outlined in Table 1.

Table 1: *Key topics necessitating consideration in the formulation of the learning program for the AI workshop (Compiled and organized by: the authors).*

Subjects	Clarifications Regarding the Subjects Requiring Focus in Program Development
Algorithms of Artificial Intelligence	Instructing on the essential theoretical underpinnings of artificial intelligence, particularly the principles of machine learning techniques and data analysis, to enable students to integrate intelligent features into their designs and equip them for collaboration with other specialists in the field to amalgamate pertinent skills and knowledge.
Establishing an Implementation Platform within Product Components	Comprehending the implementation of artificial intelligence in electronic components to develop functional and unique goods, while gaining familiarity with electronic components, circuits, and microcontrollers suitable for integration into smart products.
Three-Dimensional (3D) Printing and Artificial Intelligence	Examining the interplay between 3D printing technology and artificial intelligence to develop sophisticated prototypes, while also assessing the potential for consumers to design and produce products utilizing these technologies.
Optimization of Products through Artificial Intelligence	Exploring the Feasibility of Creating Eco-Friendly and Sustainable Products through the Optimization of Design via Artificial Intelligence.
Professional Engagement with Tools	Acquire proficiency in the professional engagement with textual and audiovisual content production tools utilizing artificial intelligence technology, including chatbots.

The reviewed literature also indicates that AI can enhance industrial design education by offering adaptive, personalized learning environments that supplement in-person instruction, allowing students to revisit material at their own pace, obtain corrective feedback on tasks, and repeatedly ask questions from the system to experience deeper learning. AI should enhance, not replace, the human-centered methodology fundamental to design thinking: designers serve as interpreters of machine-generated outputs, integrating computational recommendations with human creativity and discernment.

In summary, three practical insights arise from the information presented in this article: first, it is imperative to deliver foundational theoretical content on essential AI concepts in undergraduate courses to mitigate the conceptual gap; second, it is crucial to implement guided, project-based exercises utilizing practical tools (emphasizing design scenarios) to transform non-professional experience into purposeful experience; third, structural support (including faculty training, software/hardware infrastructure, and industry collaboration) could be vital for the success of a useful workshop.

Conclusion

As a preliminary study, this research revealed that the surveyed undergraduate industrial design students possess inadequate theoretical understanding and professional experience pertaining to artificial intelligence, with their current experiences frequently being non-professional. This issue highlights an educational deficiency that may hinder the proper implementation of this technology in industrial design.

The study's limitations are notable: small sample size, single-institution scope, the preliminary nature of the questionnaire, and the absence of comprehensive qualitative methodologies that might yield more profound insights. Consequently, the interpretations articulated in this paper are regarded as preliminary evidence, necessitating intervention studies and a more comprehensive study for generalization and the definitive design of the workshop.

According to the current evidence, pragmatic and immediate recommendations include:

1. Develop a comprehensive introductory workshop that integrates theoretical foundations with practical exercises, concentrating on the applications of artificial intelligence in industrial design.

2. Augment the scientific expertise of faculty members via short-term specialized training or collaboration with AI technology experts.

3. Establish engagement with industry to obtain software and hardware infrastructure and delineate authentic student projects. The proposed strategies, derived from a pilot study, attempt to mitigate the educational gap; nevertheless, their complete implementation and efficacy necessitate more intervention studies and empirical evaluations.

This article emphasizes the workshop format, as the experiential learning method it offers will effectively bridge the divide between theoretical comprehension of artificial intelligence and its practical applications, equipping students to confront the challenges and opportunities presented by advancements in this technology. Finally, this study establishes a preliminary framework for the creation of AI-focused educational programs in industrial design; subsequent research may incorporate larger sample sizes, more comprehensive qualitative methodologies, and the evaluation of proposed workshops to cultivate more effective and broadly applicable educational solutions.

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