

Optimizing Heritage Design Education in Morocco Using English and AI

Hicham Diouane

Faculty of Letters and Human Sciences Martil, Abdelmalek Essa âdi University, Tetouan, Morocco

Email: h.diouane@uae.ac.ma

ORCID iD: <https://orcid.org/0000-0002-8438-6953>

Abdessamad Binaoui*

Faculty of Letters and Human Sciences Dhar El Mahraz, Sidi Mohamed Ben Abdellah University, USMBA, 30000, Fes, Morocco

E-mail: abdessamad.binaoui@usmba.ac.ma

ORCID iD: <https://orcid.org/0000-0003-2652-8041>

*Corresponding Author

Mohammed Moubtassime

Faculty of Letters and Human Sciences Dhar El Mahraz, Sidi Mohamed Ben Abdellah University, USMBA, 30000, Fes, Morocco

E-mail: Mohamed.moubtassime@usmba.ac.ma

ORCID iD: <https://orcid.org/0000-0002-0211-3442>

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Abstract: The Specialized Institute of Applied Technology (ISTA) in Fes provides a vocational training course focused on heritage design to protect and promote the richness and diversity of Moroccan heritage. Currently, this course is taught in French. However, English-language resources, including CAD software, AI tools and online courses predominantly influence the design and new technologies fields. This study investigates the attitudes and preferences of ISTA trainees regarding the language of instruction for heritage design training, how they perceive integrating AI tools into their work, and the relationship between AI and language preference in this field. The study employed a mixed-methods approach, combining quantitative data from surveys with qualitative insights from in-depth interviews. The institution's trainees revealed that approximately 50% do not perceive the current language of instruction (French) as a significant barrier. Nonetheless, 70% expressed a preference for English-language instruction. The Chi-Square as well as Fisher's Exact tests revealed no significant association between language preference and the use of artificial intelligence in heritage-related work in the context of the current sample. Interestingly, the actual use of AI software among participants is low suggesting that while the theoretical value of AI is acknowledged, practical adoption is limited, possibly due to barriers such as lack of access to AI tools or insufficient training.

Index Terms: Vocational Training and Education (VTE), Moroccan Heritage, Patrimony Design, AI Image Processing, English for Specific Purposes (ESP), English as a Medium of Instruction (EMI)

1. Introduction

Fes, renowned as the historical capital of Morocco, stands as one of the oldest urban Islamic sites in North Africa. It is considered a significant model for examining the space hierarchy from an Islamic perspective [1]. The city retains its historical authenticity, positioning it as an important tourist destination [2]. The ancient medina of Fes, a UNESCO World Heritage site since 1981, houses workshops dedicated to various traditional crafts, such as plasterwork (gebss), tiles (zelij), and wood ceiling design. These cultural elements contribute to the city's allure and have attracted investments to rehabilitate and preserve its status [3]. Given its rich heritage, Fes represents an ideal location for a vocational institution of patrimony design. Under the auspices of the Moroccan Office of Vocational Education and Training (OFPPT), a patrimony design institution was initially established in Dar El Mokri, one of the city's old palaces. However, challenges with modern machinery and transportation in the historic setting led to its relocation to contemporary facilities [4].

Patrimony design instruction is delivered in French, following the model of STEM courses in higher education, and is progressively being adopted in middle and high schools. Additionally, a wealth of documentation on Moroccan history, craftsmanship, and traditional patrimony is authored by French scholars [5,6], who delve into the intricate aesthetic and geometric principles underpinning Moroccan patrimony. These publications have significantly enriched the theoretical knowledge of Islamic architecture by providing techniques and registers formulated in Moroccan Darija. However, the advancement and application of Computer-Aided Design (CAD), and the exploitation of artificial intelligence (AI) in facilitating certain tasks necessitate proficiency in English. This linguistic requirement poses a challenge, as mastery of these technologies is essential for modernizing and preserving Moroccan patrimony while maintaining cultural integrity. Thus, there is a critical need for bilingual education and resources to bridge the gap between theoretical knowledge and practical technological skills in patrimony design.

English is poised to become the dominant language of the global market, potentially challenging the socioeconomic dominance of French. However, despite its progress, English has not yet established a strong foothold within political and economic institutions. Additionally, a major reason for the high dropout rate at the university level, which often leads to low-paying jobs, is the inability to integrate into a market economy that highly values technical and scientific expertise delivered in French [7].

The core issue this study addresses is the impact of the current language of instruction on integrating AI tools in heritage design education. While using French in educational settings may not be a perceived barrier to some, it limits the accessibility of English-based resources that dominate the field of AI and design technologies. We hypothesize that transitioning to English-medium instruction will enhance trainees' access to AI-driven design technologies, improve their technical proficiency, and increase their competitiveness in global markets. To test this hypothesis, the study seeks to answer the following questions: How do patrimony design trainees perceive English as a medium of instruction concerning their ability to engage with AI tools? To what extent does the current French-language curriculum limit access to English-dominated AI resources and CAD technologies? What are the potential socioeconomic and cultural implications of adopting English in preserving Moroccan heritage while aligning with global technical standards? Through a mixed-methods approach, the research evaluates trainees' attitudes toward English instruction and assesses their current usage of AI tools in heritage design projects. The findings highlight how linguistic adaptation could align Moroccan patrimony education with global technological advancements while safeguarding cultural authenticity.

The following section reviews existing literature on language instruction in Morocco, focusing on the STEM fields and the potential of CAD software and AI in heritage protection. The third section outlines the methodology, including survey design, data collection from ISTA trainees, and the analytical framework used to assess their attitudes toward the language of instruction. It also discusses the potential impacts of integrating English into the curriculum, focusing on access to English-language design resources and tools. The fourth section presents the findings, including statistical analyses and their implications for patrimony design education. The fifth section summarizes key insights offering recommendations for implementing English as the medium of instruction at ISTA to enhance educational outcomes and the global competitiveness of graduates.

2. Literature Review

English for Specific Purposes (ESP) has become a vital area within English Language Teaching (ELT), focusing on meeting the specific linguistic needs of learners in professional and academic fields. Developed in the 1960s, ESP emerged as a response to the global demand for English in sectors such as business, science, and technology [8]. Unlike general English courses, ESP tailors its content and objectives to the specific requirements of its learners, as identified through needs analysis [9,10]. This targeted approach ensures that learners acquire the specialized language skills necessary for their professions, such as the technical terminology used in fields like design, engineering, and healthcare. Key components of ESP include genre analysis [11] and corpus linguistics [12], which help learners navigate specific genres and language patterns prevalent in their fields. In professional contexts like design, ESP focuses on enabling students to engage with English-language resources which are critical for success in global markets [13] such as AI tools and CAD software.

As technology continues to shape professional communication, ESP must evolve to incorporate real-world tools and authentic materials, preparing learners for the practical demands of their industries. A key subset of ESP is English for Science and Technology (EST), which addresses the linguistic needs of scientists, engineers, and technologists. EST originated alongside ESP, as the global dominance of English in scientific communication grew in the 1960s. EST emphasizes discipline-specific vocabulary [14] and the rhetorical structures found in scientific writing, such as meta-discourse features [15]. EST also adapts to different contexts, including academic and professional settings. In academia, discipline-specific writing practices necessitate tailored EST instruction [16], while in the workplace, the emphasis is on the importance of oral communication alongside written skills [17].

Approaching the issue of the language of instruction in Morocco is multifaceted and historically grounded. The shift from one language to another is not recent; in the 1980s, Morocco transitioned from French to Arabic as the dominant language in the educational system [18]. However, despite this shift, there remains a pronounced inclination towards French, particularly in the instruction of STEM subjects [19]. Some scholars and educators argue that English would be a more suitable alternative given its global dominance and the promising outsourcing opportunities in

Morocco's industrial sectors [20]. Yet, this proposal is often met with resistance from educational policymakers who continue to favor the French language, arguing that there is a strong historical connection between France and Morocco and the lack of sufficient Moroccan English instructors [21].

The political preference for French overlooks the growing interest among young Moroccans in learning English, driven by the increasing impact of globalization and the tendency to identify with American culture [22]. Moreover, English is required as a priority as French in online job offers and become essential in rapidly developing fields such as programming and web development [23]. Despite the noticeable presence of English and its integration in technical higher education institutions, such as engineering schools, students can exhibit negative attitudes towards General English (GE) courses, favoring English for Specific Purposes (ESP) instead [24]. This indicates that the implementation of ESP is insufficient to meet the needs of both students and trainers.

Several countries have transitioned or are transitioning from French to English, driven by political and economic considerations. In Algeria, the growing perception of English as a "decolonial" alternative to French reflects broader sociopolitical shifts and the reconfiguration of linguistic hierarchies in post-colonial contexts [25]. Likewise, Rwanda's transition to English as the primary language of education and business has demonstrated tangible economic benefits, with higher labor market returns for English-proficient individuals [26]. These cases underscore the potential advantages of English-language instruction for Morocco's vocational trainees, particularly in fields influenced by global technological and economic trends.

During the colonial era, France implemented a dual educational system in Morocco, providing an advanced curriculum for the social elites destined for administrative positions and higher jobs, while offering a basic education oriented towards handcrafted work for the general population [27]. However, Technical Vocational Education and Training (TVET) is now seen globally as a vital component of educational systems playing a key role in facilitating school-to-work transitions and supporting lifelong learning [28]. Despite this importance, TVET has consistently faced challenges in being regarded with the same importance as general education or higher education by various social segments including officials, graduates, and their parents. Vocational training is often seen as a fallback option for those who have not shown the ability to pursue general higher education or finish general secondary schooling [29]. In addition, some Moroccan students in public schools often struggle to achieve good marks due to their lack of proficiency in French, despite their excellence in STEM subjects [30]. Hence, some of these students might give up applying to engineering and medical schools and opt instead for vocational institutions where they must deal with French as the language of instruction.

The curricula of OFPPT institutions often include complementary modules in Arabic, French, and English. Specific requirements are established for English trainers, who are responsible for enhancing trainees' English proficiency and professional communication skills while employing appropriate pedagogical methods to meet module objectives. Essential competencies include didactic skills in blended learning, cultural awareness, and technological proficiency with Information and Communication Technologies (ICT) [31]. Generally, the office provided guidelines for teaching technical English, but these were predominantly grammar-oriented and did not sufficiently address practical language use in various professional contexts [32]. Additionally, implementing English for specific purposes remains challenging due to the diverse registers required, particularly given the numerous technical programs offered by the institutions. The responsibility for developing these courses often falls on individual instructors, leading to inconsistencies.

In summary, while there is an admitted need for English proficiency in Morocco's evolving job market, particularly in STEM and IT, tertiary education remains largely anchored in French. To address this gap, there is a pressing need for more effective and context-specific English language instruction that aligns with both the professional aspirations of students and the job market requirements.

Handicraft production significantly contributes to poverty reduction in various regions worldwide by creating increased opportunities for women and young people [33]. As one of the aims of the Moroccan Office of Vocational Training is to promote employment, focusing on the artisanal sector is crucial due to its significant economic contribution. In 2022, the artisanal sector employed 1.22 million artisans, making it one of the most active sectors in the country. The primary crafts contributing to the sector's revenue include clothing and accessories (33%), wood crafts (24%), and traditional building crafts (13%) [34]. However, the sector is experiencing a severe decline due to increasing competition [35] and diminishing interest among younger generations [36]. To address these challenges, enhancing the skills of trainees in using Computer-Aided Design (CAD) software and Artificial Intelligence (AI) tools should be taken more seriously.

CAD is a digital tool utilized across various fields to render and communicate artifacts and technological solutions. It has become a significant component of technology education. Integrating CAD in technology education enables teachers to merge design with digital tools, enhancing students' communication and problem-solving skills [37]. In Cultural Heritage, digital technologies like 3D scanning and computational modeling have revolutionized the study of historical structures, helping in analyzing and improving these buildings and pinpointing potential areas for enhancement [38].

The integration of Artificial Intelligence (AI) across various sectors has garnered significant academic attention in recent years. First, AI enhances decision-making by processing large datasets and providing actionable insights, thereby augmenting human choices and improving efficiency [39]. Second, AI is quite beneficial in "smart manufacturing," where it optimizes production, predicts maintenance needs, and minimizes downtime [40]. Third, in the service sector,

AI, through chatbots and automation, can significantly improve response times and customer satisfaction [41]. Further arguments state that AI facilitates lifelong learning and skill adaptation, which may help mitigate the effects of automation on employment [42]. Similarly, implanting AI tools such as image recognition and learning models can help identify structural issues and restore old buildings. Also, by engaging in human-computer dialogues, large language models (LLMs) can comprehend and evaluate sponsors' needs and preferences, creating more thorough and accurate conservation and renewal plans [43].

Recent research highlights the increasing role of advanced technologies in the preservation and restoration of cultural heritage, including ancient murals and museum artifacts. Wang et al. (2025) present an innovative image restoration and enhancement technique that leverages generative adversarial networks (GANs) and style perception to address the limitations of existing methods, offering high-definition restoration outcomes [44]. Similarly, Yan et al. (2025) introduce ArtDiff, a model that integrates the Internet of Things (IoT) and artificial intelligence (AI), particularly image inpainting, to improve the precision of ancient mural restoration. Their approach effectively mitigates degradation phenomena such as peeling and cracking, enhancing the fidelity of restored artworks [45]. Li (2023) provides a comprehensive review of the application of diffusion models in image restoration for cultural heritage, emphasizing their significance and potential in this domain [46]. Further expanding on the need for multifaceted approaches, Wang et al. (2025) explore the limitations of single-technology solutions in digital heritage preservation, advocating for the LiPhoScan 3D reconstruction model, which underscores the necessity of integrating multiple techniques for more robust results [47]. Collectively, these studies reflect a growing interdisciplinary trend, merging expertise from engineering, artificial intelligence, and art conservation to develop sophisticated solutions for the digital preservation of cultural heritage.

Integrating these technologies into handicraft jobs serves a dual purpose: it ensures greater competitiveness with non-traditional machinery and helps preserve Moroccan heritage. Additionally, promoting collaboration among artisans and young designers can facilitate the development of new, innovative products, thereby revitalizing the sector. This strategy aligns with global vocational training trends, which emphasize technology's importance in enhancing traditional skills and promoting sustainable economic growth.

While existing literature on English for Specific Purposes (ESP) and the integration of Artificial Intelligence (AI) in heritage design offers valuable insights, important gaps remain in the context of bilingual education in vocational training, particularly in regions like Morocco. Much of the current research focuses on theoretical frameworks for ESP but lacks a critical examination of how these frameworks apply in non-English-dominant environments where French is still prevalent in education. Additionally, although AI has been shown to provide significant benefits across various professional sectors, the practical challenges of implementing these technologies in heritage design education have not been adequately addressed. Research is scarce on how linguistic barriers hinder the adoption of AI tools in vocational training, especially in countries where English is not the main language of instruction. This study seeks to bridge this gap by investigating the interplay between language instruction and AI integration in heritage design, offering insights into how transitioning to English-based instruction could improve the use of advanced technologies and help modernize patrimony education in Morocco.

3. Methodology

This study employed a mixed-methods design, integrating both quantitative and qualitative approaches to comprehensively explore the factors influencing heritage design education among trainees at the Specialized Institute of Applied Technology (ISTA) in Fes. The data collection involved both surveys and in-depth interviews.

3.1. Sample Selection and Size Calculation

Participants were selected using a random sampling method from the pool of trainees who enrolled in ISTA between 2008 and 2022. This period was chosen to ensure a representative sample of trainees who experienced varying degrees of exposure to new technologies and instructional approaches over time. A total of 68 trainees participated in the study, a number deemed appropriate given that ISTA graduates 25 students every two years in the heritage design program. This sample size allows for a reasonable level of confidence in the representativeness of the findings, considering the relatively small overall population of graduates in this specialized program.

3.2. Survey Design and Data Collection

A structured questionnaire was administered to the selected participants. The survey comprised closed-ended and Likert-scale questions designed to capture trainees' perceptions and preferences regarding their language of instruction, the role of AI in their heritage design work, and their access to relevant technology. The survey was designed based on established frameworks for evaluating vocational education outcomes, ensuring that questions were clear, unbiased, and aligned with the study's objectives.

3.3. Interview Process

In addition to the surveys, qualitative data was collected through semi-structured interviews with a subset of participants. These interviews allowed for a deeper exploration of individual perspectives on language barriers, AI

integration, and vocational training experiences. The interviews followed a flexible guide, allowing participants to discuss their challenges and successes in detail. The interviews provided qualitative insights that helped triangulate the findings from the survey data.

3.4. Data Analysis

Quantitative data from the surveys was analyzed using statistical methods, including descriptive statistics and cross-tabulations (as well as Fisher's Exact tests), to identify trends and relationships between variables such as language preferences, AI usage, and perceived barriers. Qualitative data from the interviews was analyzed using thematic analysis, where recurring themes and patterns were identified and coded to provide a deeper understanding of the issues raised. This dual approach ensured a robust analysis, combining the breadth of survey data with the depth of interview insights. This mixed-methods design allowed the study to comprehensively address the research questions, providing both statistical and narrative evidence to explore how language of instruction and AI integration influence vocational training outcomes in heritage design.

4. Results and Discussion

Table 1. Gender Distribution Frequencies

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	28	41.2	41.2	41.2
	Male	40	58.8	58.8	100.0
	Total	68	100.0	100.0	

In the study, there were 28 female participants and 40 male participants according to Table 1, making a total of 68 participants. This distribution indicates a slight predominance of male participants, with males constituting 58.8% of the sample and females 41.2%.

Table 2. Specialty Distribution Frequencies

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Heritage design	60	88.2	88.2	88.2
	Interior design	8	11.8	11.8	100.0
	Total	68	100.0	100.0	

According to Table 2, heritage design is the dominant specialty in the study, accounting for 88.2% of the total sample. This category will be the main focus of the study, exploring how they view the use of AI within heritage contexts.

Table 3. Language Choice Distribution Frequencies

Language	Selected (%)	Not Selected (%)	Total Responses (N)
English	67.6%	32.4%	68
Arabic	52.9%	47.1%	68
Moroccan Arabic	35.3%	64.7%	68
French	29.4%	70.6%	68

As can be inferred from Table 3, data reveals a strong preference for English in heritage-related training, with 67.6% of respondents selecting it. This suggests that English has become a dominant language in the field, likely due to its global relevance in academia, research, and technological advancements, including AI integration in heritage design. Arabic follows with 52.9%, indicating that it remains a significant medium of instruction, particularly for formal and professional communication in Morocco. The choice of Arabic is also ideological, as the language reflects not only the cultural background of the country but also the religious dimension due to the compelling bond of Arabic with Islam [48].

Moroccan Arabic (Darija) was chosen by 35.3% of participants, highlighting its role as a practical language in craftsmanship and artisan collaboration. Heritage designers often work with artisans who use specialized technical terms rooted in Moroccan Arabic to describe intricate elements of their craft. This linguistic overlap provides an opportunity to enhance collaboration, but it also requires designers to familiarize themselves with these vernacular expressions. Crafts people's language often reflects practical, hands-on experience with tools, and using such terminology can improve the accuracy of communication. However, its lower selection suggests that participants may prioritize standardized or internationally recognized languages for academic and technical training. Meanwhile, French, selected by 29.4%, has a low preference, though it still plays a role in heritage-related projects, especially those involving international partnerships and investors. French is still perceived by some Moroccan students as the language of knowledge and a portrayal of class belonging [51]. Additionally, the presence of French-speaking retirees investing in Moroccan heritage properties has implications for heritage design, as it necessitates bridging the gap between French-speaking clients and local artisans to maintain architectural authenticity while meeting modern needs.

An overview of major e-learning platforms (Udemy, Coursera, LinkedIn Learning...) reveals a pronounced linguistic asymmetry in design education resources, with English predominating as the primary language of instruction even on platforms offering multilingual capabilities. A quantitative examination of Udemy's architectural design course catalog (as of February 2025) illustrates this pattern: of the total 1,603 available courses in this category, 678 (42.3%) are delivered in English, while French-language offerings comprise only 36 courses (2.2%).

These findings suggest that training programs should prioritize English while maintaining strong Arabic support to ensure accessibility. Moroccan Arabic remains valuable in fieldwork, and integrating bilingual resources, technical glossaries, and industry-specific language training can bridge communication gaps. While French is less preferred, offering optional modules in French could cater to students engaging in international collaborations. A multilingual training approach would enhance inclusivity, improve comprehension, and better equip trainees for the diverse linguistic demands of heritage design.

Table 4. Training Language Perception by The Participants

	N	Minimum	Maximum	Mean	Std. Deviation
Is the language used in the training considered a barrier?	68	1	3	1.54	.656
Valid N (listwise)	68				

According to Table 4, the statistical results indicate that most participants do not perceive the language used in training as a significant barrier. With a mean score of 1.54, most respondents feel comfortable with the instructional language. However, the standard deviation of 0.656 suggests some variability, indicating that a subset of participants might occasionally find the language challenging. The issue of language in education, particularly the use of Modern Standard Arabic (MSA) in scientific and technical fields, has long been debated in Arab countries due to the coexistence of MSA with local dialects in a diglossic setting [50]. This linguistic duality can sometimes create barriers in learning environments where technical terminology lacks widely accepted Arabic equivalents. Given the diverse language preferences identified earlier, Arabic, Moroccan Arabic, French, and English, the relatively low mean score suggests that the training is structured in a way that accommodates multiple languages or that participants are generally proficient in the languages used. In practice, trainers may adjust their language depending on the context; for instance, a design trainer might use Moroccan Arabic for explanations while switching to English when introducing software interfaces due to the challenge of finding equivalent Arabic or French terms for technical vocabulary. To further minimize potential language barriers, it may be beneficial to provide training materials in multiple languages and offer additional language support where needed. This approach could help address the concerns of participants who occasionally perceive the language as an obstacle.

Table 5. Artificial Intelligence Use by Participants in Heritage-Related Work

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	26	38.2	38.2	38.2
	Sometimes	22	32.4	32.4	70.6
	Yes	20	29.4	29.4	100.0
	Total	68	100.0	100.0	

Do you use artificial intelligence software in your heritage-related work?

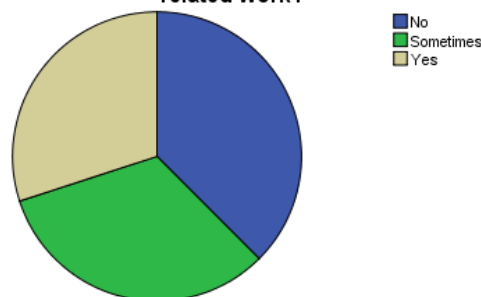


Fig. 1. Artificial Intelligence Use by Participants in Heritage-Related Work

Table 6. Mean Scores of Artificial Intelligence Software in The Participants' Heritage-Related Work

N	Valid	68
	Missing	0
Mean		1.91
Std. Deviation		.824

Based on the mean score of 1.91 (Table 6) for this question, where the scale used was 1 = No, 2 = Sometimes, and 3 = Yes, the results indicate that most students either do not use AI software or use it only occasionally in their heritage-related work. A mean score close to 2 suggests that most respondents fall between "No" and "Sometimes," with a slight lean towards "Sometimes." This finding implies that while some students might experiment with AI tools, regular use is not yet widespread among participants. The limited adoption of AI, as reflected in the mean score of 1.91, could be attributed to several factors, including restricted access to AI software, lack of adequate training on how to utilize AI effectively, or skepticism regarding AI's reliability and practical application in heritage design. According to graphic design trainers, the low AI adoption can be explained by the fact that graphic design sessions are restricted in scope, with a primary focus on CAD software, leaving little room for integrating AI-driven tools. Additionally, the available hardware is insufficient to handle more complex projects that would necessitate AI intervention. These limitations suggest that low AI adoption is not solely due to a lack of interest but is significantly influenced by infrastructural and curricular constraints.

Despite recognizing AI's potential benefits, as indicated by participants' moderate agreement on its contributions and limitations in subsequent statements, its actual integration into their workflow remains low. This gap suggests that while students acknowledge AI's theoretical value, its practical implementation is still lagging. The relatively low mean score presents an opportunity for heritage education programs to enhance AI training by incorporating targeted workshops, hands-on practice with AI tools, and curriculum adaptations that bridge the knowledge-to-application gap. Strengthening AI literacy among students could help them harness its potential in heritage preservation and design, ultimately fostering more innovative and efficient workflows.

Table 7. Artificial Intelligence's Impact on Heritage Design Work

	N		Mean	Median	Mode	Std. Deviation
	Valid	Missing				
Artificial intelligence programs can accurately simulate Moroccan heritage	68	0	2,88	3,00	4	1,264
Artificial intelligence can contribute to the more accurate restoration of artistic and historical works	68	0	3,24	3,50	4	1,121
Artificial intelligence programs limit a designer's creativity	68	0	3,38	4,00	2	1,316
AI software are unreliable in some sensitive works	68	0	4,26	4,50	5	,891
Dependence on artificial intelligence programs limits job opportunities in the field of design and creativity	68	0	3,44	4,00	4	1,297

Note. 1= "Strongly disagree"; 2= "Disagree"; 3= "Neutral"; 4= "Agree"; 5= "Strongly agree"

According to Table 7, participants' attitudes towards the role and impact of artificial intelligence in heritage design reveal a mix of optimism and concern. The statement "Artificial intelligence programs can accurately simulate Moroccan heritage" had a mean score of 2.88, suggesting that participants are slightly skeptical about AI's ability to fully capture the intricacies of Moroccan heritage. This score indicates mild agreement but also highlights potential doubts regarding AI's current capabilities in cultural simulation. The statement "Artificial intelligence can contribute to the more accurate restoration of artistic and historical works" had a mean score of 3.24, showing moderate agreement. Participants generally recognize AI's potential to enhance the precision and detail of restoration efforts. This aligns with previous research by Yan et al. (2025) emphasizing AI's role in reconstructing deteriorated artifacts and improving conservation techniques.

The statement "Artificial intelligence programs limit a designer's creativity" scored 3.38, showing that participants moderately agree with this concern. AI's influence on creativity is often debated, as it can both streamline design processes and impose standardized approaches that might restrict artistic freedom. Similarly, the statement "AI software is unreliable in some sensitive works" had the highest mean score of 4.26, demonstrating strong agreement. This suggests that participants see AI as potentially problematic when applied to sensitive heritage projects, likely due to concerns about ethical implications, historical inaccuracies, or lack of nuanced human judgment. Lastly, the statement "Dependence on artificial intelligence programs limits job opportunities in the field of design and creativity" received a mean score of 3.44, indicating moderate agreement. This reflects apprehensions about AI potentially replacing traditional craftsmanship and design roles, reinforcing broader discussions on automation's impact on employment in creative fields.

Since all means exceed 2.88, it is clear that participants generally acknowledge AI's role in heritage design, particularly in restoration. However, concerns about reliability, job displacement, and creative limitations persist. This balanced perspective suggests that while AI offers substantial benefits, its integration into heritage design requires careful consideration of its constraints and ethical implications.

In terms of broader challenges, heritage design graduates face numerous obstacles beyond AI-related concerns. The most pressing issue remains the scarcity of job opportunities, particularly in positions aligned with their field of study. Many struggle with workforce integration due to the lack of internships, practical training, and relevant industry connections. Technical skill requirements, such as proficiency in software like AutoCAD and 3D Studio Max, also present barriers for graduates seeking employment. Additionally, inadequate infrastructure, including limited access to essential tools and raw materials, further complicates professional development.

During training, students encounter resource-related difficulties such as insufficient equipment and financial constraints, particularly concerning graduation projects. The quality of education remains a challenge, with a strong theoretical focus often outweighing hands-on experience. Language barriers, especially regarding French and the instructional language, also hinder learning. Time constraints, information overload, and difficulties in work environment adaptation further contribute to the challenges faced by trainees. Additionally, students emphasize the need for more heritage site visits to deepen their practical understanding.

Overall, integrating AI into heritage design is a rapidly growing field with significant potential. AI technologies have already been applied to the simulation, restoration, and preservation of cultural heritage worldwide. For instance, AI-powered tools have been used to digitally reconstruct historical sites and artifacts, enabling enhanced engagement and study of heritage materials [54]. Moreover, AI can support heritage site preservation by analyzing environmental data to predict and prevent potential damage.

In the aftermath of the 2023 earthquake in Morocco, historical landmarks such as the Tinmel Mosque and Koutoubia suffered extensive damage. Restoration efforts are now underway, with UNESCO expressing confidence in the expertise of Moroccan professionals to lead these projects [51]. This presents an opportunity to explore AI's role in cultural heritage restoration, particularly in developing accurate reconstructions and predictive conservation strategies. While AI should not be seen as a replacement for traditional restoration techniques, its potential in heritage preservation should be carefully integrated into educational and professional frameworks to maximize its benefits while addressing existing concerns.

For example, Serbouti et al. (2025) propose a Digital Twin Heritage Building (DTHB) framework aimed at ensuring the sustainable preservation of African heritage sites, with the Bab Al-Mansour gate serving as a case study. This framework integrates Heritage Building Information Modeling (HBIM) with IoT sensors to enable real-time monitoring of both structural integrity and environmental conditions. By centralizing data from these sources alongside historical records and environmental factors, the system creates a dynamic and comprehensive model for heritage management. The incorporation of predictive analytics allows the framework to anticipate potential threats to heritage structures, facilitating proactive conservation strategies and optimizing resource allocation. In doing so, the DTHB approach aligns with the principles of Industry 4.0 and 5.0, emphasizing automation, data-driven decision-making, and human-centered innovation in cultural heritage preservation. The Bab Al-Mansour case study illustrates the framework's scalability and adaptability, suggesting its potential for broader application across various African heritage sites. By leveraging AI for informed and efficient conservation, the DTHB framework contributes to the long-term preservation and cultural significance of these historic landmarks [52].

4.1. Correlation test between language preference and AI use

The Chi-Square, as well as Fisher's Exact Test ($p = .116$) tests, were relied on. Chi-Square enabled assessing the association between categorical variables. It is an appropriate statistical method for analyzing the relationship between AI use and language preference. Given that both variables are nominal, AI use (e.g., use vs. non-use) and language preference (e.g., English), the Chi-Square test helped determine whether the distribution of AI use differs across English users. Additionally, this test is non-parametric, meaning it does not assume a normal distribution, which is the case, making it well-suited for studies with relatively small sample sizes like this one ($n = 68$). The Chi-Square test provided insight into whether language preference plays a meaningful role in AI integration within heritage-related work by evaluating whether observed differences in AI adoption are due to chance.

Table 8. Chi-Square Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	4.332 ^a	2	.115	.116		
Likelihood Ratio	4.426	2	.109	.123		
Fisher's Exact Test	4.211			.116		
Linear-by-Linear Association	1.631 ^b	1	.202	.212	.131	.056
N of Valid Cases	68					

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.47.

b. The standardized statistic is 1.277.

According to Table 8, the Chi-Square test for the crosstabulation of AI use and English language preference indicates that there is no statistically significant association between these variables. The Pearson Chi-Square value is 4.332, with a p-value of 0.115 (greater than 0.05), suggesting that any observed differences in AI use among participants who did or did not prefer English are likely due to chance. Additionally, the Likelihood Ratio test, which provides a similar measure of association, also yielded a non-significant result ($p = 0.109$), further supporting the conclusion that there is no meaningful association. Moreover, the Linear-by-Linear Association test yielded a p-value of 0.202, indicating no significant linear trend in the data. Fisher's Exact Test ($p = 0.116$) further confirms this, making it useful when expected counts are low (though in this case, all expected counts exceed 5). These results suggest that English language preference does not have a significant impact on whether participants use AI in their heritage-related work. Moreover, there are no expected cell counts below 5, ensuring that the Chi-Square test assumptions are met. The minimum expected count in this analysis is 6.47, which supports the reliability of these statistical conclusions. While no

significant relationship was found, other contextual factors, such as access to AI tools, educational background, or familiarity with AI technology, may still influence AI adoption in heritage design. Future research could explore these additional variables to provide a more comprehensive understanding of AI usage in this field.

5. Conclusion

The study, which involved 68 participants specializing in heritage and interior design, provides valuable insights into the use of artificial intelligence (AI) within this domain. Most participants were from the heritage design specialty, significantly influencing the study's findings and making the results particularly reflective of this field. Despite the recognition of AI's potential in accurately simulating Moroccan heritage and contributing to the restoration of artistic and historical works, there are notable concerns. Participants moderately agree that AI limits a designer's creativity and reduces job opportunities in design and creativity. There is a strong agreement that AI can be unreliable in sensitive works. Interestingly, the actual use of AI software among participants is low. This suggests that while the theoretical value of AI is acknowledged, practical adoption is limited, possibly due to barriers such as lack of access to AI tools or insufficient training. On the other hand, language preferences for training varied. Despite this diversity, the language used in training was not generally considered a barrier, as reflected by the mean score, indicating most participants did not view it as a significant issue.

In conclusion, the study highlights a significant interest and perceived potential for AI in heritage design, tempered by concerns about its limitations and current low adoption rates. The findings underscore the need for better access to AI tools, comprehensive training programs, and further research to explore the unique perspectives of underrepresented specialties and address the concerns regarding AI's impact on creativity and job opportunities. Ensuring inclusive language support and addressing gender and age diversity among participants will also be essential in leveraging AI effectively in heritage design. The study highlights the need for enhanced AI training within heritage design educational programs. Given that most participants recognize the potential benefits of AI but exhibit low practical adoption, educational institutions should incorporate comprehensive AI modules into their curricula. These modules should cover not only the technical aspects of AI but also practical applications tailored to heritage design, including simulations, restoration techniques, and ethical considerations. By providing hands-on experience with AI tools, students can become more proficient and comfortable using these technologies, ultimately bridging the gap between theoretical acknowledgment and practical implementation.

The study also examined the relationship between AI use and language preference among heritage-related trainees, alongside exploring the broader challenges and opportunities in heritage studies. Findings indicate that the use of AI in heritage-related work is not significantly influenced by the language preferences of the participants. The Chi-Square tests showed weak and non-significant associations, suggesting that language preference does not play a critical role in the adoption or use of AI. From a policy perspective, these findings suggest that language of instruction in technical education should prioritize bilingual AI training programs rather than enforcing a single language. By offering AI-related coursework in multiple languages, institutions can ensure accessibility while allowing students to engage with complex technical concepts in their preferred language. This could facilitate broader AI adoption in heritage-related fields while minimizing linguistic barriers.

To enhance the integration of English and AI into the heritage training program, several strategic approaches can be employed. Firstly, incorporating English for Specific Purposes (ESP) courses focused on technical vocabulary relevant to heritage and AI will help students communicate effectively in professional settings. Bilingual resources should also be utilized to support learners in both English and their native languages. Secondly, the curriculum should include practical AI training modules, emphasizing hands-on applications of AI tools in heritage conservation and design through project-based learning. Additionally, practical steps to improve AI integration include providing open-access AI tools for heritage professionals, organizing targeted workshops that address specific heritage applications of AI, and fostering interdisciplinary collaborations between AI experts, designers, and heritage specialists. These initiatives can help bridge the gap between AI's perceived potential and its actual adoption.

Finally, the responsible use of AI in heritage preservation involves ensuring that technology enhances cultural representation without distorting or commodifying it, emphasizing collaboration with local communities to respect their cultural narratives [47]. By addressing these ethical dimensions, stakeholders can promote a more equitable and respectful approach to integrating AI into the preservation of cultural heritage, ensuring that technological advancements align with ethical principles and community values.

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Authors’ Profiles



Hicham Diouane, Ph.D., is a Moroccan researcher and lecturer of English at Abdelmalek Essaâdi University, possesses a PhD in English Studies (2023), a Master's in Gender Studies, and bachelor's degrees in English Literature and General Philosophy from Fes University, Morocco. His academic pursuits reflect a multifaceted engagement with various fields, including education, religiosity, gender issues, and technology. Dr. Diouane has published articles addressing fundamentalism and social changes. In addition to his academic activities, he is interested in graphic design and creative writing.



Abdessamad Binaoui, Ph.D., is a teacher with ten years of experience, a professional translator, and an interpreter. He is also a Ph.D. holder from the Faculty of Letters and Human Sciences, University of Sidi Mohamed Ben Abdellah, Fez, Morocco. He obtained his master's degree in English, Arabic, and French translation at King Fahd Advanced School of Translation, Tangier, Morocco. He holds two Bachelor degrees and many other diplomas. His interests range from ICT integration in education, pedagogy, Moocs, and Tamazight culture, to translation.



Mohammed Moubtassime, MA and Ph.D. in comparative linguistics from the faculty of humanities at Sidi Mohamed Ben Abdellah University- Fes and is currently teaching grammar, theoretical linguistics, morpho-syntax of natural languages, business English, public speaking and debating, gender development, and ICT, leadership and entrepreneurship, critical thinking and analytical skills at the faculty of humanities- fez. He has also acted as the head of the department of English studies at the same faculty since 2011, and the coordinator of the three cohorts of English modular degree programs since 2009. He is a member of the national board for the evaluation and accreditation of the B.A., M.A., and Ph.D. programs at the Moroccan Ministry of Higher Education, scientific research, and professional training. He is an alumnus of the State Department professional

fellowship program on "young entrepreneurs" at the University of Michigan extremism, and project leader of the English teaching internship initiative.

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