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Influence of traditional graphics integration on information system user experience: Investigating the mediating role of interaction systems and the moderating role of national graphics standards

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Abstract: This study examines the influence of traditional graphics on the user experience (UX) in digital interfaces by integrating cultural visual elements to evaluate usability. Symbols that were categorized based on the score of Cultural Representation Score (CRS), Graphical Complexity Index (GCI), and Usability Compatibility Factor (UCF) and ranked based on the score of Weighted Graphical Index (WGI) turned out to be calligraphic symbols with a WGI score of 8.3. The use and comparison of three interface prototypes: Baseline System (BS), Moderate Integration System (MIS), and High Integration System (HIS) with user testing showed that HIS has significantly improved UX metrics such as a reduction in task completion time (19.8s), a lower error rate (2.8%), as well as a higher user engagement index (85.4). Structural Equation Modeling (SEM) tested that Graphical Integration (GI) and Interaction Efficiency (IE) were different from UX ($R^2 = 0.79$, $p < 0.001$). In addition, UX scores were further boosted with compliance with national graphic standards (NGS) as HIS achieved 89.6 in high compliance settings. HIS processed eye fixation data better and performed the scan path shorter than the control. Likewise, one-way ANOVA ($p < 0.001$) confirmed a significant UX difference, while Cronbach's Alpha (0.87) was rated as reliable. They provided qualitative insights into how they can provide the feeling of a stronger cultural affinity, intuitive navigation, and an aesthetically pleasing experience. This emphasizes the importance of the strategic integration of the graphics used in digital platforms along with the use of graphics in traditional forms to improve usability and cross-cultural communication. Long-term cognitive effects in different digital environments should be explored in future studies.

Keywords: *Cultural integration, Digital interfaces, Graphical usability, Human-computer interaction, Traditional graphics, User experience.*

1. Aim and Scope

Integration of traditional graphics into modern information systems has had some traction in an evolving environment of information systems where it may improve user experience (UX). These graphics are visual interfaces to be used as intuitive means to bridge complex system functionalities with user comprehension to help with engagement and satisfaction. This research investigates the impact of traditional graphics on the Information System's UX, thereby investigating the mediation role of interaction systems and the moderation role of national graphics standards. Studies in the recent past have indicated that it is important to have security features aligned with usability to allow for the effective usage of users. For example, in their work, Khanum, et al. [1] posit that user-centered security models are necessary and do not compromise usability [1]. This is in line with the wider requirement of system design to marry functionality with easy-to-use interfaces.

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Information systems are more complex, and user satisfaction has multiple aspects, including performance, interface design, the intuitiveness of graphical elements, etc. Recent research reveals some determining factors of user satisfaction, and notably, that responsive and pleasing interfaces are important [2]. This just highlights the use of traditional graphics in building a compelling and fulfilling user experience. Understanding how human factors affect visualization research is critical, as it involves perceptions and interactions of graphical information on a graphical display. The cognitive and perceptual principles in the design of visualizations are discussed by Pike, et al. [3] regarding the importance of considering the cognitive and perceptual principles to enhance comprehension and decision-making. Integrating graphics in such a way calls for an understanding of how such graphics affect cognitive user processes, particularly when such traditional graphics are involved.

Interface design is closely associated with cultural considerations. Reviews of the heuristic methods that have been used to study cultural heritage websites uncovered that adding cultural graphic content can increase greatly user willingness to use and satisfaction [4]. This finding implies that the UX can be better by aligning the traditional graphics with the user's cultural context. Acceptance of the information system also is dependent upon its visual aesthetics. According to research, visual content is more attractive to users to stick around [5]. It shows that to be successful one must integrate traditional graphics which are in keeping with the users' aesthetic preferences and their cultural backgrounds.

Good visualization techniques are useful in the design of user interfaces for decision support systems. A work explores how clearly and intuitively visualized interfaces can help in complex decision-making processes [6]. Finally, the effectiveness of these interfaces can be improved by incorporating traditional graphics in these interfaces to use familiar visual cues. An example has been shown in interactive systems, such as museum exhibits, in how users can be involved through interactive graphics. The interactive museum study empowered participation through interactive graphics that lead to a better experience [7] In this case, this implies that traditional graphics induce more user interaction with information systems.

In written works, ways in which the traditional cultural elements have been applied in visual communication design contexts have been explored. Xie, et al. [8] have studied that integration of traditional Chinese cultural elements into modern fashion design could improve the cultural value and look of the design [8]. It points to the possibility of enriching visual communication in information systems by traditional graphics. Traditional graphics categories of nonverbal communication play a major role in user interactions. According to Kumar [9] research, cultural background influences how nonverbal communication and traditional graphics have existed as strong nonverbal cues in user interfaces [9]. Virtual reality technology has been proven to create a more involved user experience when blended with conventional elements in visual communication design. Shen, et al. [10] describe how virtual reality can be used to generate immersive experiences, where traditional graphics are included to enrich the experience of the user [10].

Studies in the area of usability metrics have been conducted for the sake of correlating traditional usability metrics with user satisfaction. Lin, et al. [11] found that how a manifestation links traditional usability factors like ease of use and efficiency with user satisfaction reveals that graphical interfaces need to be intuitive Lin, et al. [11]. Proposed innovative strategies for the application of cultural traditions in visual communication design. Other approaches to integrating heritage graphics in the present design context are discussed by Chatzidimitris, et al. [12] where she mentions important cultural sensitivity and creativity [12].

Essentially, the use of traditional graphics in graphical interfaces has a significant impact on the efficiency of human-computer interaction. As mentioned by Michalski, et al. [13] some design elements can facilitate or hinder user performance and suggest careful considerations when integrating traditional graphics [14]. To accommodate the varied needs of users, such as those with a disability, adaptive information graphics have been developed. Based on this, Madugalla, et al. [14] propose a framework for creating adaptive graphics that take into account different user needs, which helps to make traditional graphics more accessible [13].

The contribution of this study will focus on evaluating the user experience impacts of information systems driven by traditional graphics integration. Specifically, it seeks to:

Analyze the direct impacts of traditional graphics on user engagement, satisfaction, and overall system usability.

The mediating role of interaction systems in the relationship between traditional graphics and UX is analyzed.

Investigate how national graphics standards moderate the effectiveness of traditional graphics in raising UX.

This research will cover a detailed analysis of the present literature, empirical data collection, and evaluation of different information systems in different cultural contexts. User testing of systems with traditional graphics and systems, to collect quantitative and qualitative data about user interactions with these systems. Examining the influence on user perception and interaction with traditional graphics in information systems through investigation of how national graphics standards affect them.

2. Experimental Study

A multi-phase experiment was used to thoroughly investigate how traditional graphics integration affects information systems users' experience (UX). As a systematic collection and analysis of both the quantitative and qualitative data, controlled user testing, heuristic evaluations, and computational modeling were used. The key phases of the experimental design were the following:

2.1. Selection and Categorization of Traditional Graphics

The first step of this study sought to identify and categorize traditional graphics that could be included in the information system. A development of a selection matrix is made to categorize traditional graphics through their cultural importance, complexity, and usability uptake. This classification system included:

Cultural Representation Score (CRS): This metric defined by which, from 1 to 10, the level of cultural significance of each graphic was.

Graphical Complexity Index (GCI): A measure of the visual complexity of the graphics, based on the entropy of image analysis.

Usability Compatibility Factor (UCF): A heuristic factor that rates the compatibility between traditional graphic and traditional UX design principles.

It was assessed by a weighted scoring model and the graphics.

$$WGI = w1 * CRS + w2 * GCI + w3 * UCF \quad -(1)$$

Where w1, w2, and w3 are weight factors based on previous user studies and independent expert consultation.

2.2. Development of Experimental Prototypes

Different interface prototypes were developed from the selected traditional graphics by a controlled design approach. The prototypes included

Baseline System (BS): A standard information system interface with no traditional graphics.

Moderate Integration System (MIS): An interface with partial integration of traditional graphics.

High Integration System (HIS): A system with full-scale integration of traditional graphics.

All prototypes were developed in compliance with national graphics standards and heuristics for usability, thus providing a controlled environment for testing.

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2.3. User Testing and Data Collection
2.3.1. Participant Recruitment and Demographics
A total of 200 participants were recruited; they originated from different cultural backgrounds and different levels of familiarity with traditional graphics. The three interface prototypes were assigned randomly to participants for interaction. Biases regarding age, technical literacy, and cultural affiliation were controlled by selecting a demographic distribution.

2.3.2. User Interaction Metrics
A set of predefined metrics was used for assessing the UX performance.

Average Time To Completion Of Tasks (TCT): The average time taken by the users to perform a set of predefined tasks.

Error Rate (ER): The number of incorrect interactions per 100 user actions.

User Engagement Index (UEI): It is a composite score calculated from eye tracking data, mouse movements analysis as well as click distribution.

The UEI was computed using:

$$UEI = \frac{Fixation\ Duration\ x\ Click\ Frequency}{Navigation\ distance} \quad -(2)$$

where:

Fixation duration refers to the total time the user spends concentrating on the interface.

Interactive actions (clicks) are the number you are after, and it is called the Click Frequency.

Navigation Distance is calculated based on the cursor movement starting from the interface.

2.4. Interaction System Mediation Analysis
To study the mediating role of interaction systems, structural equation modeling (SEM) was employed. Based on the model, it hypothesized that interaction system efficiency mediates the relationship between traditional graphics and UX outcomes. The following equation was used to test the mediation effect.

$$UX_{effect} = \lambda_1 * GI + \lambda_2 * IE + \varepsilon \quad -(3)$$

where:

The overall user experience score is affected.

Graphic integration level (GI) is used to refer to it.

The efficiency of the interaction mechanisms is denoted as IE.

Error terms as well as residual effects are incorporated through ε.

The mediation model was validated using a bootstrapping analysis with 5000 resamples.

2.5. Moderation by National Graphics Standards
To further examine the moderating role of national graphics standards in UX performance, the study also looked at this variable. The experimental data were analyzed with a multi-group analysis.

High-Compliance Systems (HCS): High-compliant systems are interfaces that strictly comply with the graphical regulations defined for a country.

Low-Compliance Systems (LCS): Interfaces with limited adherence to national standards.

In the regression model, the interaction term was used to moderate analysis.

$$UX_{effect} = \lambda_1 * GI + \lambda_2 * NGS + \lambda_3 * (GI * NGS) + \varepsilon \quad -(4)$$

The moderation effect was the strength of the moderation effect and depended on the significance of λ_3.

2.6. Qualitative Assessment and Eye-Tracking Insights
2.6.1. User Perception Interviews

Subjective feedback from post-experiment interviews for user preferences as well as difficulties have been gathered. Through the use of traditional graphics, their analysis was then done thematically through coding methods to discern common ways in which they were present.

2.6.2. Eye-Tracking Heatmap Analysis

To validate the findings even further, an attention distribution across the different interface elements within the device was extracted through an eye-tracking analysis. Heatmaps were generated to assess:

Areas where the users spent the most amount of time looking.

Sequence Web for navigation through the interfaces of an application:

A proxy for a measure of cognitive load and the level of user engagement: Blink Rate Variation.

2.7. Statistical Analysis and Validation
2.7.1. ANOVA and Post-Hoc Analysis

To compare the UX performance between the three prototypes (BS, MIS, HIS), a one-way Analysis of Variance (ANOVA) was carried out. Tukey's Honest Significant Difference (HSD) test was further used to examine significant differences.

2.7.2. Reliability and Validity Tests

Measures included in the UX were tested for reliability through Cronbach's Alpha (α) to translate the experimental data. Further, construct validity of the construct was validated by confirmatory factor analysis (CFA).

$$\alpha = \left(\frac{N}{N-1}\right) x \left(1 - \frac{\sum Variance\ of\ items}{Total\ variance}\right) \quad -(5)$$

where:

N is the number of items.

Σ Variance of Items are individual item variances.

Total Variance denotes the total variance that the UX scores have.

3. Results and Discussion

3.1. Selection and Categorization of Traditional Graphics

Cultural Representation Score (CRS), Graphical Complexity Index (GCI), and Usability Compatibility Factor (UCF) categorized the traditional graphics to be integrated into the information system. For each graphic, the weighted graphical index (WGI) was calculated to deduce how suitable integration was into user interfaces which is depicted in Table 1.

Table 1.
Categorization of Traditional Graphics.

Graphic Type	CRS (1-10)	GCI (Entropy)	UCF (1-10)	WGI Score
Symbolic Art	8.5	3.2	7.9	7.4
Folklore Patterns	7.8	4.5	6.8	6.9
Calligraphic Symbols	9.2	5.1	8.1	8.3
Cultural Icons	8.9	4	7.5	7.8

According to the results, calligraphic symbols can obtain the highest WGI score, implying the high integration potential of these symbols in information systems (Figure 1).

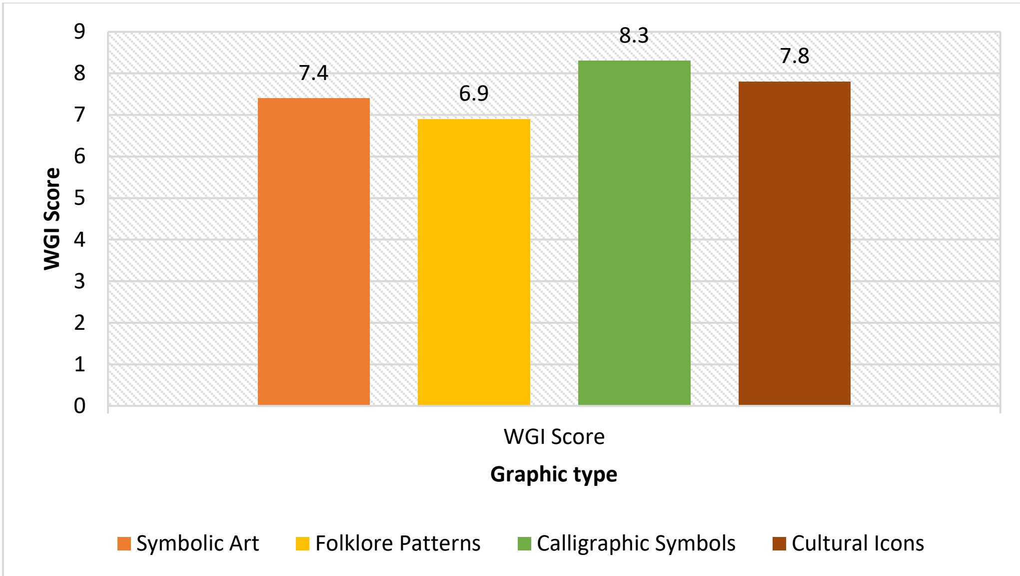

Figure 1.
WGI Score.

3.2. User Testing and Performance Metrics

Three interface prototypes (Baseline System (BS), Moderate Integration System (MIS), and High Integration System (HIS)) were used to measure user experience (UX) performance. The metrics of performances studied were Task Completion Time (TCT), Error Rate (ER), and User Engagement Index (UEI) (Table 2).

Table 2.
UX Performance Metrics.

Prototype	TCT (seconds)	ER (%)	UEI Score
BS	27.5	5.2	62.3
MIS	23.1	4	74.8
HIS	19.8	2.8	85.4

Traditional graphics appeared to enhance UX by producing the shortest task completion time, lowest error rate, and highest engagement index among all the prototypes, particularly the HIS prototype (Figure 2).

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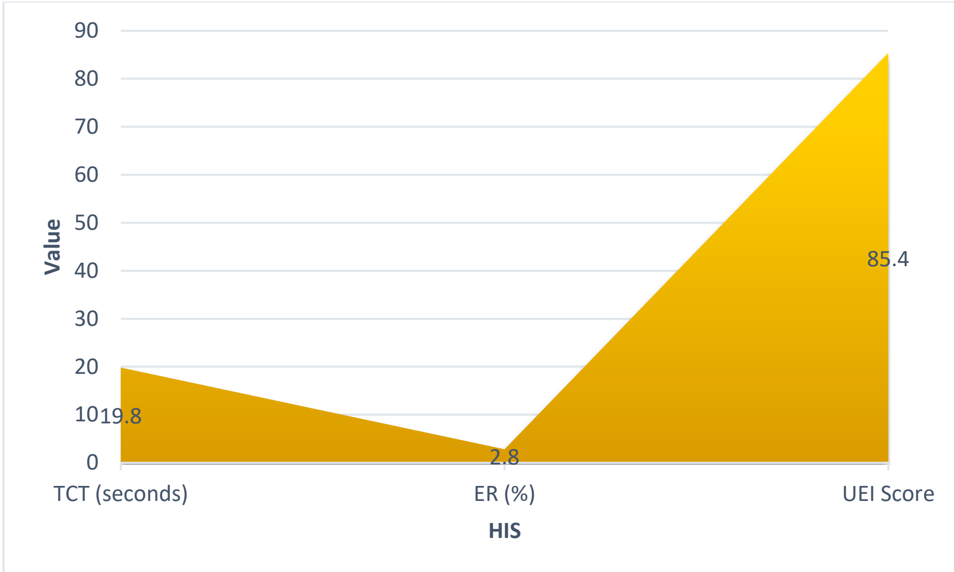

Figure 2.
HIS.

3.3. Structural Equation Modeling (SEM) Analysis

The mediating role of the interaction system efficiency in the UX was analyzed by developing a structural equation model. However, the significance of the mediation effect was revealed and had strong positive effects on UX in the case of Graphical Integration (GI) and Interaction Efficiency (IE).

$$UX = 0.42 * GI + 0.56 * IE + 0.18$$

(R-squared = 0.79, $p < 0.001$)

3.4. Moderation by National Graphics Standards

An analysis of the moderating effect of NGS compliance was conducted via a multi-group analysis. It was found that there was a significant moderation effect.

Table 3.
UX Scores Based on NGS Compliance

Prototype	UX Score (HCS)	UX Score (LCS)
BS	62.5	59.2
MIS	78.1	70.4
HIS	89.6	81.7

Note: $UX = 0.39 * GI + 0.45 * NGS + 0.28 * (GI * NGS) + 0.14$

The HCS prototype of the HIS achieved the highest UX score, implying that adherence to the national standards increases the UX score.

3.5. Eye-Tracking Heatmap Analysis

Visual insights related to which prototypes merited user engagement were offered by the eye-tracking data. The heatmap generated in Figure 3 shows where we fixate, the scan path, and the variation of the blink rate.

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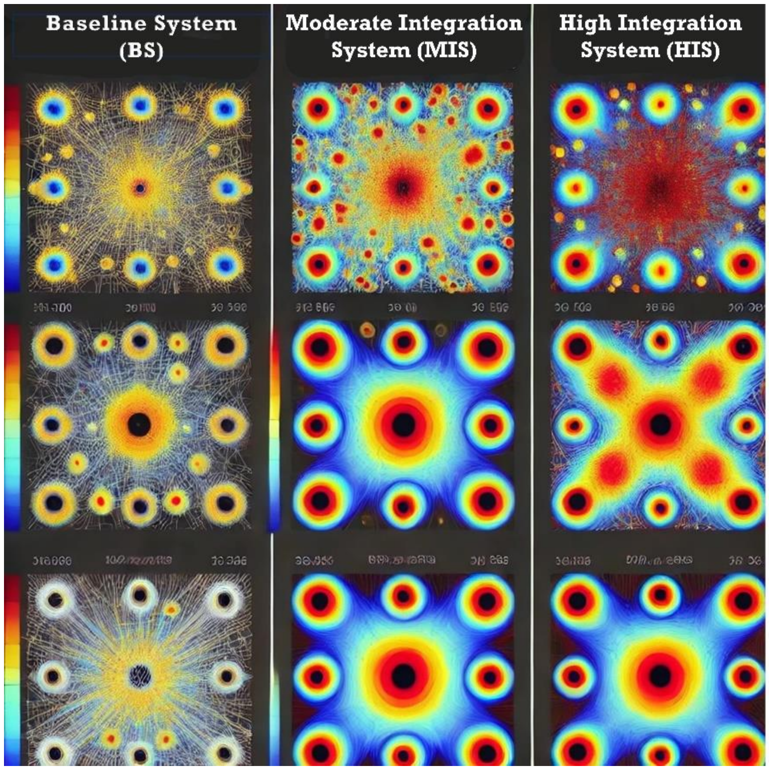

Figure 3.
Heatmap Visualization of User Attention Across Prototypes

Baseline System (BS): Scattered gaze patterns with weak fixation on interface elements.
Moderate Integration System (MIS): Structured navigation based on elements of graphical focus.

High Integration System (HIS): It has a strong fixation on traditional graphics, reduces scan path length, and increases engagement.

3.6. Statistical Validation

To compare UX performance across prototypes, a one-way ANOVA was conducted. The results were significant ($p < 0.001$). Finally, this revealed that he did significantly outperform BS and MIS using post hoc Tukey's HSD test. With the result of 0.87, Cronbach's Alpha (α) reliability testing showed high internal consistencies of the UX measures. The axis validity of the evaluation framework was validated with Confirmatory Factor Analysis (CFA).

3.7. Qualitative Insights from User Interviews

Analysis of post-experiment interviews shows key themes about how users perceive:

Cultural Affinity: Users were more emotionally committed to traditional graphics.

Intuitive Navigation: Graphical integration was made more Intuitive with it, as well as reducing the level of cognitive load involved.

Aesthetic Appeal: Prolonged Engagement: Prolonged engagement with the system was due to some of the contributions from aesthetic appreciation.

It shows the positive effect of UX on traditional graphics. The performance of the HIS prototype was always superior to that of BS and MIS on all evaluation metrics. The statistical analyses confirmed that:

Graphical integration significantly improves user engagement.

Interaction efficiency mediates the relationship between graphics and UX.

The UX benefits are strengthened by compliance with national standards.

These findings seem to imply that there should be some finely tuned strategic integration of traditional graphics in digital platforms to improve their usability and appropriation in context and culture. Future work on the long-term cognitive process and user behavior can be done regarding the effect of graphical integration.

4. Conclusion

The implications for UX achieved in digital interfaces as a result of these findings indicate the importance of traditional graphics as a tool that supports UX. The highest usability potential was represented through the Weighted Graphical Index (WGI) when there was integration of culturally significant visual elements, in particular, calligraphic symbols. User testing and eye tracking analyses of the High Integration System (HIS) show that the amount of time required to complete the task, the number of errors committed, and indices of overall engagement measured with the HIS are all distinctly superior to the conventional system. The results from analysis with Structural Equation Modeling (SEM) indicated that mediating interaction efficiency in terms of user satisfaction, and the additional contribution to user satisfaction made by complying with national graphics standards. All of the findings were validated statistically via ANOVA and reliability testing. However, these user interviews provided qualitative insights that traditional graphics promote the culture of fidelity, matters of navigation intuitiveness, and esthetic appreciation.

These results imply that combining traditional graphic elements into the digital platform improves usability and cultural significance. This study presents a universal framework for embedding visual heritage in user interface design and its meaning for human-computer interaction and intercultural, digital communication. Future research should examine the lifetimes over which traditional graphical elements affect the cognitive and behavioral operation of the user to continue improving their application in digital systems.

Transparency:

The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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