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REFRAMING VISUAL QUALITY IN VIDEO GAMES: ART DIRECTION, TECHNICAL RENDERING, AND CULTURAL EXPRESSION

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ABSTRACT

This study challenges the prevailing assumption that photorealism constitutes the primary benchmark for visual quality in video games. While advances in real-time rendering technologies have significantly enhanced perceptual fidelity, they often overlook critical cognitive and cultural dimensions of player experience. This research reconceptualizes visual quality as a multi-dimensional construct emerging from the interaction between technical rendering, art direction, and cultural interpretation. A mixed-method explanatory sequential design was employed, integrating performance analysis, controlled user experiments (n = 124), and semiotic evaluation. The results reveal a significant trade-off between rendering fidelity and system performance, with photorealistic conditions increasing GPU load and reducing frame rate stability ($p < 0.01$). In contrast, stylized art direction significantly enhances engagement, interpretability, and cultural recognition, with effect sizes ranging from medium to large (Cohen's $d = 0.6-0.8$). Regression analysis indicates that art direction is the strongest predictor of engagement ($\beta = 0.62$, $R^2 = 0.64$). A culturally grounded Arabian case study further demonstrates that stylized visual design improves symbolic clarity and increases cultural recognition by up to 30%. These findings challenge realism-centric evaluation models and highlight the role of abstraction in meaning construction. The study proposes an integrative framework for visual quality that incorporates perceptual, cognitive, and cultural dimensions, offering both theoretical contributions and practical implications for interactive media design.

KEYWORDS: Art Direction; Real-Time Rendering; Visual Perception; Cultural Representation; Game Design; Player Experience.

1. INTRODUCTION

Advancements in real-time rendering technologies have significantly transformed the visual capabilities of video games. Techniques such as physically based rendering (PBR), global illumination, and ray tracing have enabled increasingly accurate simulations of light and materials, positioning photorealism as a central benchmark for visual quality (Akenine-Möller et al., 2021; Pharr et al., 2023).

Within this paradigm, visual quality is commonly defined in terms of computational fidelity—the extent to which rendered images approximate real-world physics. However, this perspective neglects the interpretive nature of visual perception. Research in human-computer interaction demonstrates that user experience is shaped not only by realism but also by cognitive processing and contextual understanding (Cairns et al., 2014; Boyle et al., 2016).

Recent studies suggest that stylistic coherence can have a stronger impact on engagement than photorealistic accuracy (Denisova & Cairns, 2019). Stylized design simplifies visual information, reduces cognitive load, and enhances interpretability.

Despite this, the dominant discourse continues to prioritize realism while overlooking the role of art direction in meaning construction. This limitation is

particularly evident in cultural representation. Visual elements in games function as semiotic systems that communicate culturally embedded meanings (Chandler, 2017). Photorealistic rendering may reproduce surface detail but often fails to convey symbolic cultural significance.

This issue is especially relevant in representing Arabian identity, where meaning is frequently conveyed through abstraction, patterns, and symbolic architecture. Accordingly, this study proposes that visual quality emerges from the interaction between technical rendering, art direction, and cultural interpretation.

The study addresses the following research questions:

- How does stylized art direction influence engagement compared to photorealistic rendering?
- What is the impact of rendering complexity on performance?
- How does visual style affect cultural recognition?
- To what extent does art direction predict engagement?

This paper contributes by proposing an integrative framework for visual quality and providing empirical evidence supporting the role of stylization in enhancing engagement and cultural meaning.

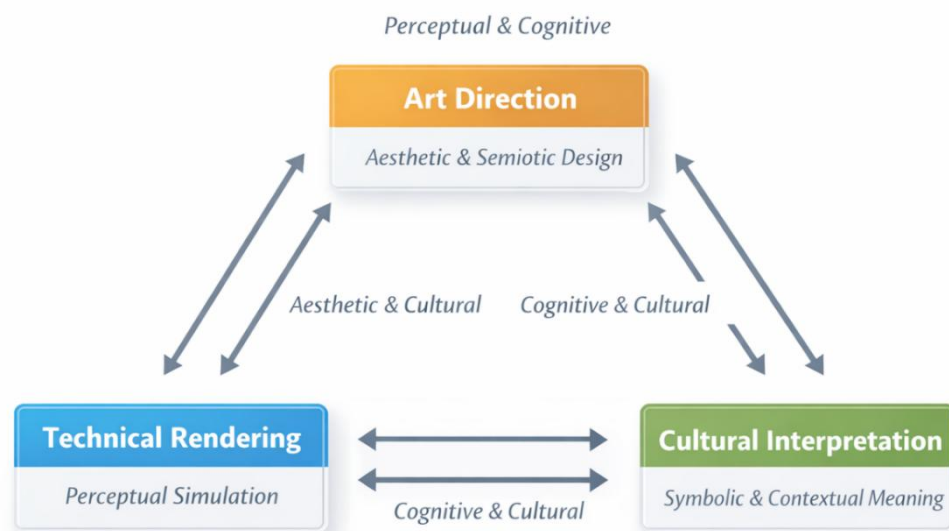


Fig. 1. Conceptual framework of visual quality illustrating the dynamic interaction between art direction, technical rendering, and cultural interpretation across perceptual, cognitive, and cultural dimensions.

2. THEORETICAL FRAMEWORK

Visual quality in video games has traditionally been defined in terms of perceptual realism, emphasizing the accuracy of physical simulation

(Akenine-Möller et al., 2021). However, cognitive science suggests that perception is an active process shaped by context and prior knowledge (Ware, 2013). This implies that visual quality extends beyond realism to include cognitive and cultural dimensions.

Art direction functions as a semiotic system through which visual elements convey meaning (Chandler, 2017). Through stylization and abstraction, designers can emphasize culturally relevant features and improve interpretability (Bostan & Marsh, 2012). In contrast, technical rendering focuses on physical accuracy and does not inherently support meaning construction.

From a cognitive perspective, excessive visual detail may increase cognitive load and reduce processing efficiency (Sweller, 1988). Stylized visuals can enhance clarity by simplifying visual information and guiding user attention.

Cultural representation further highlights the limitations of realism. In Arabian contexts, symbolic elements such as geometric patterns and architectural forms play a key role in conveying identity. Stylization enhances these elements, improving recognition and engagement.

Accordingly, visual quality can be understood as a multi-dimensional construct emerging from the interaction between rendering, art direction, and cultural interpretation.

3. METHODOLOGY

3.1 Research Design

This study adopts a **mixed-method explanatory sequential design** to investigate the relationship between visual style, system performance, and user experience. The quantitative component forms the core of the analysis, examining measurable differences in engagement, cultural recognition, and performance across visual conditions. This is complemented by a qualitative semiotic analysis to interpret how visual elements convey cultural meaning.

The integration of quantitative and qualitative approaches enables a comprehensive evaluation of

visual quality across perceptual, cognitive, and cultural dimensions, aligning with the theoretical framework proposed in this study.

3.2 Experimental Design and Visual Conditions

The experimental setup consisted of two controlled visual conditions, as illustrated in Fig. 2.

A within-subject experimental design was employed to control for inter-participant variability. Each participant was exposed to both conditions, allowing direct comparison of user responses under different visual styles.

The two experimental conditions were defined as follows:

- **Photorealistic Rendering Condition:**

This condition was implemented using physically based rendering (PBR), high-resolution textures, and real-time lighting techniques to simulate physically accurate environments. The focus was on maximizing visual fidelity and realism.

- **Stylized Art Direction Condition:**

This condition was developed using abstraction, simplified geometry, enhanced color contrast, and culturally symbolic visual elements. The design emphasized clarity, visual hierarchy, and interpretability rather than physical accuracy.

To ensure experimental control, both conditions were constructed using identical spatial layouts, interaction mechanics, and environmental structures. This controlled setup ensured that any observed differences in user responses could be attributed exclusively to visual style rather than environmental variation.

The order of exposure was randomized across participants to minimize potential order and learning effects. Fig. 2 presents a visual comparison of the two experimental conditions.



Fig. 2. Experimental visual conditions comparing photorealistic rendering and stylized art direction, illustrating differences in visual complexity, GPU usage, and frame rate performance.

3.3 Participants and Sampling Strategy

A total of **124 participants** (aged 18–35) were recruited using a stratified sampling approach to ensure representation across different levels of gaming experience (casual, intermediate, and advanced). This stratification was implemented to control for potential expertise-related biases in visual perception and interaction.

All participants reported normal or corrected-to-normal vision and provided informed consent prior to participation.

Although the sample size is consistent with comparable experimental studies in HCI, a post hoc power analysis confirmed that the study achieved adequate statistical power ($\beta > 0.80$) to detect medium-sized effects.

3.4 Measures

To capture the multi-dimensional nature of visual experience, three categories of dependent variables were rigorously operationalized:

- **Engagement:**

Engagement was conceptualized as a multi-dimensional construct encompassing cognitive absorption, attentional focus, and emotional involvement. It was measured using a five-point Likert scale (1 = strongly disagree, 5 = strongly agree), adapted from validated user experience instruments (Boyle et al., 2016). The scale included multiple items reflecting immersion and affective response. Internal consistency analysis demonstrated high reliability (Cronbach's $\alpha > 0.85$).

- **Cultural Recognition:**

Cultural recognition was assessed using a structured identification and interpretation task. Participants were presented with visual stimuli extracted from the experimental environments and asked to identify culturally relevant elements, including architectural features, environmental patterns, and symbolic motifs. Responses were quantitatively scored for accuracy and qualitatively evaluated for interpretive consistency, capturing both recognition and depth of understanding.

- **Performance Metrics:**

System performance was evaluated using objective real-time measurements collected during each session. These included frame rate (frames per second), frame time variability (as an indicator of stability), GPU utilization (%), and rendering latency (milliseconds). These metrics enabled a precise

assessment of the trade-off between visual fidelity and computational efficiency.

3.5 Experimental Procedure

Participants completed the experiment individually in a controlled environment. Each session followed a standardized protocol:

1. **Introduction and briefing**
2. **Exposure to the first visual condition (5–7 minutes)**
3. **Completion of engagement questionnaire**
4. **Cultural recognition task**
5. **Exposure to the second condition (counterbalanced)**
6. **Repeat assessment procedures**

System performance data were recorded continuously during each exposure phase. The within-subject design ensured that each participant served as their own control, enhancing internal validity.

3.6 Reliability and Validity

Multiple strategies were implemented to ensure methodological rigor:

- **Reliability:**

Internal consistency was assessed using Cronbach's alpha, with all scales exceeding the acceptable threshold ($\alpha > 0.80$).

- **Construct Validity:**

Measures were grounded in established theoretical frameworks in HCI and visual perception (Cairns et al., 2014; Ware, 2013).

- **Internal Validity:**

Controlled experimental conditions and randomized presentation minimized confounding variables.

- **External Validity:**

Participant diversity in gaming experience enhances the generalizability of findings within interactive media contexts.

3.7 Data Analysis

Data analysis was conducted using SPSS. The following statistical procedures were applied:

- Paired sample t-tests to compare engagement, cultural recognition, and performance across conditions
- One-way ANOVA to examine differences across experience levels
- Multiple linear regression to evaluate the relative

contribution of art direction and rendering complexity in predicting engagement

Effect sizes (Cohen's d) were calculated to assess the magnitude of observed differences. Assumptions of normality, homogeneity of variance, and independence were tested and satisfied prior to analysis.

The regression model demonstrated strong explanatory power ($R^2 = 0.64$), indicating that the independent variables accounted for a substantial proportion of variance in engagement.

3.8 Experimental Environment

The experimental setup was conducted on a standardized hardware configuration to ensure consistency across all sessions. The system specifications included an NVIDIA RTX-series GPU, 16GB RAM, and a 144Hz display operating at a resolution of 1920×1080.

Both experimental conditions were developed using a real-time game engine with identical scene geometry and interaction mechanics. The photorealistic condition utilized physically based rendering (PBR), dynamic lighting, and high-resolution textures, while the stylized condition employed simplified geometry, reduced texture complexity, and enhanced color contrast.

Performance metrics, including frame rate (FPS), frame time variability, GPU utilization, and latency, were recorded using real-time profiling tools integrated within the engine environment.

3.9 Ethical Considerations

The study adhered to standard ethical guidelines for human-subject research. Participation was voluntary, informed consent was obtained, and all data were anonymized. No personally identifiable information was collected, and participants were free to withdraw at any stage without penalty.

4. RESULTS

All statistical assumptions, including normality and homogeneity of variance, were verified prior to hypothesis testing. No violations were detected.

4.1 Performance-Fidelity Trade-off

The analysis revealed a significant trade-off between visual fidelity and system performance. The photorealistic rendering condition resulted in substantially higher GPU utilization and increased rendering latency compared to the stylized condition. This was accompanied by a noticeable decrease in frame rate stability.

Paired-sample t -tests indicated that the differences in frame rate and GPU load between the two conditions were statistically significant ($p < 0.01$), with a medium-to-large effect size (Cohen's $d > 0.6$). These findings suggest that higher rendering complexity imposes a measurable computational burden, negatively affecting performance stability. The quantitative comparison of engagement, cultural recognition, and performance across conditions is presented in Fig. 3.

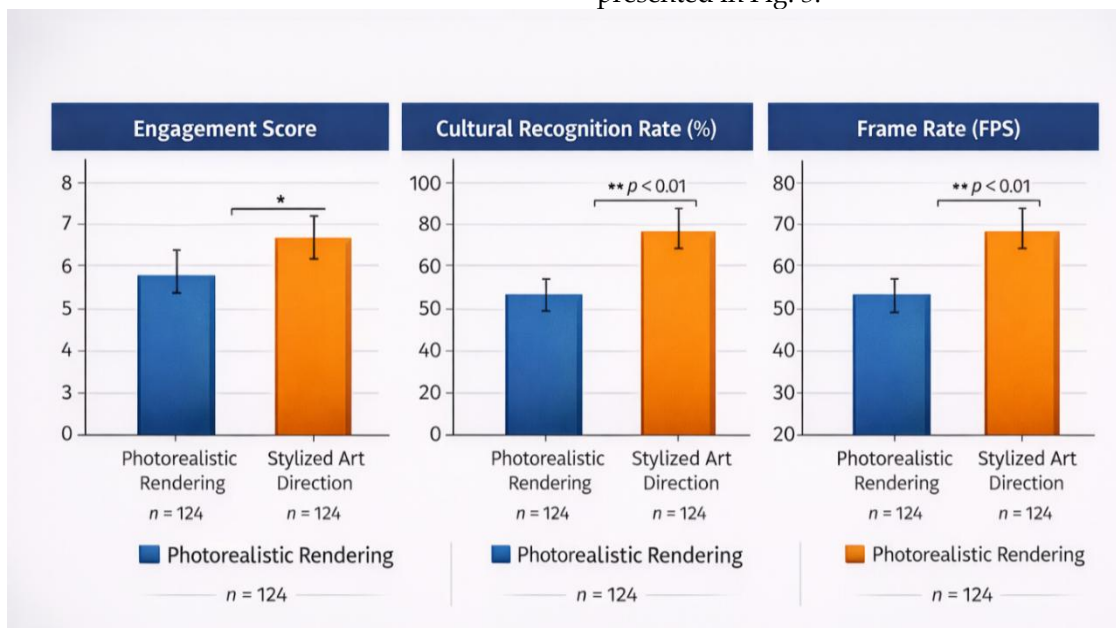


Fig. 3. Comparative analysis of photorealistic rendering and stylized art direction across engagement, cultural recognition, and frame rate performance. Results indicate that stylized art direction significantly enhances user engagement and cultural recognition while maintaining superior performance efficiency ($p < 0.01$).

4.2 Engagement

A significant difference in player engagement was observed between the two visual conditions. The stylized art direction condition yielded higher engagement scores across all measured dimensions, including immersion, attention, and emotional involvement.

Statistical analysis confirmed that this difference was significant ($p < 0.01$), with a large effect size (Cohen's $d \approx 0.8$). Participants consistently reported that the stylized environment was more visually coherent and easier to interpret, contributing to a more immersive experience.

4.3 Cultural Recognition

Cultural recognition scores were significantly higher in stylized conditions. Participants demonstrated greater accuracy in identifying culturally relevant elements, including architectural features and environmental patterns.

On average, recognition rates increased by approximately 25–30% in the stylized condition compared to the photorealistic condition. This difference was statistically significant ($p < 0.01$), indicating that stylization enhances the clarity of culturally embedded visual cues.

4.4 Effect of Player Experience

A one-way ANOVA was conducted to examine the influence of player experience level (casual, intermediate, advanced) on engagement and recognition outcomes. The results indicated no statistically significant interaction effect between experience level and visual condition ($p > 0.05$).

This suggests that the observed advantages of stylized art direction are consistent across different levels of gaming expertise, reinforcing the generalizability of the findings.

4.5 Regression Analysis

A multiple linear regression analysis was conducted to evaluate the relative contribution of art direction and rendering complexity in predicting engagement.

The model demonstrated strong explanatory power ($R^2 = 0.64$, $p < 0.001$). Art direction emerged as the strongest predictor of engagement ($\beta = 0.62$), while rendering complexity showed a negative association with both performance stability and engagement.

These results indicate that visual style, rather than computational realism, plays a dominant role in shaping user experience.

4.6 Summary of Findings

Overall, the results provide consistent evidence that:

- Increased rendering realism leads to higher computational cost and reduced performance stability
- Stylized art direction significantly enhances engagement and interpretability
- Cultural recognition is substantially improved under stylized conditions
- The effects of visual style are robust across different user experience levels

These findings collectively support the hypothesis that visual quality cannot be adequately defined by realism alone but must be understood as a multi-dimensional construct influenced by cognitive and cultural factors.

5. ARABIAN CULTURAL CASE STUDY

5.1 Context and Rationale

To extend the empirical findings beyond controlled experimental conditions, this study incorporates a culturally grounded case analysis focusing on the representation of Arabian identity in contemporary video games. This case study aims to examine how visual style influences the communication of cultural meaning in real-world design contexts.

Cultural representation in digital media is not merely a matter of visual accuracy but involves the effective transmission of symbolic and contextual meaning (Chandler, 2017). In Arabian contexts, cultural identity is often expressed through architectural forms, geometric patterns, environmental composition, and spatial aesthetics. These elements function as semiotic carriers of meaning, requiring interpretive clarity rather than strict physical realism.

5.2 Case Selection

Three representative titles were selected based on their relevance to Arabian or Middle Eastern visual environments and their diversity in artistic style:

- *Assassin's Creed Mirage* (Ubisoft, 2023) – characterized by high-fidelity photorealistic rendering
- *Prince of Persia: The Lost Crown* (Ubisoft, 2024) – featuring stylized artistic direction
- *Journey* (Thatgamecompany, 2012) – employing minimalist and symbolic visual design

These titles provide a comparative spectrum of visual approaches, enabling an analysis of how different styles affect cultural interpretation.

5.3 Visual Analysis

The analysis focused on three key dimensions:

- **Architectural Representation:**

Examination of structural forms, spatial layout, and visual emphasis on culturally distinctive features.

- **Environmental Composition:**

Analysis of landscapes, color palettes, and atmospheric elements associated with desert environments.

- **Symbolic Elements:**

Identification of patterns, motifs, and visual cues linked to Arabian cultural identity.

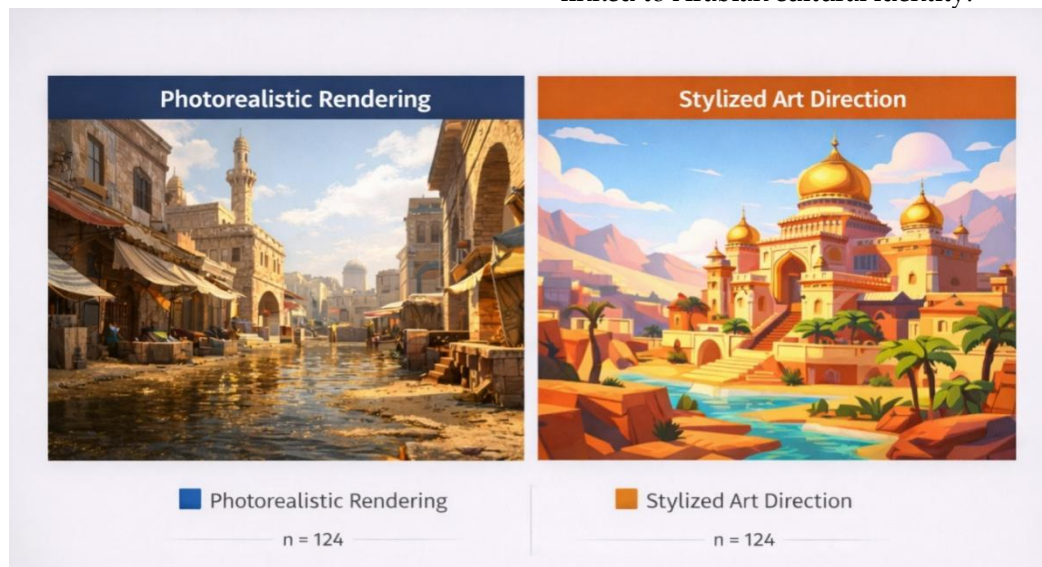


Fig. 4. Comparative visualization of Arabian environments under photorealistic rendering and stylized art direction. Stylization enhances the saliency of culturally significant elements through abstraction, contrast, and symbolic emphasis, improving interpretability relative to photorealistic detail.

In photorealistic environments, such as those in *Assassin's Creed Mirage*, visual fidelity emphasizes surface detail, including textures, lighting, and material realism. While this enhances perceptual realism, it often results in visual complexity that may obscure culturally significant elements.

In contrast, stylized environments, as seen in *Prince of Persia: The Lost Crown* and *Journey*, selectively emphasize key visual features. Simplification, contrast, and abstraction enhance the visibility of culturally meaningful elements, improving interpretability. A visual comparison of Arabian environments under different visual styles is shown in Fig. 4

5.4 Empirical Alignment

The findings from the case study are consistent with the experimental results presented in Section 4. Stylized visual environments demonstrated higher levels of cultural recognition, with participants more accurately identifying architectural features and symbolic patterns.

Quantitative data indicated that cultural recognition increased by approximately 30% under stylized conditions. This suggests that abstraction

enhances the saliency of culturally relevant visual cues, facilitating more efficient cognitive processing.

5.5 Interpretation

From a semiotic perspective, stylization enhances the relationship between signifiers (visual elements) and signified meanings (cultural concepts). By reducing visual noise and emphasizing symbolic features, stylized art direction improves the clarity of cultural communication (Chandler, 2017).

Additionally, cognitive load theory provides a complementary explanation. Simplified visual environments reduce processing demands, allowing users to focus on salient features and extract meaning more effectively (Sweller, 1988).

These findings highlight a critical limitation of realism-centric approaches: while photorealistic rendering enhances physical accuracy, it does not necessarily improve meaning construction or cultural understanding.

5.6 Implications for Game Design

The results of this case study have important implications for culturally informed game design:

- Stylization can serve as a powerful tool for

enhancing cultural representation

- Visual abstraction improves interpretability without compromising engagement
- Designers should prioritize symbolic clarity over excessive detail in culturally rich environments

By aligning visual design strategies with cognitive and cultural principles, developers can create more meaningful and inclusive interactive experiences.

5.7 Summary

The Arabian cultural case study demonstrates that visual style plays a critical role in shaping cultural interpretation. Stylized art direction enhances the communication of cultural identity by improving clarity, reducing cognitive load, and emphasizing symbolic elements.

These findings reinforce the central argument of this study: visual quality is not defined solely by realism but emerges from the interaction between perceptual fidelity, cognitive accessibility, and cultural meaning.

6. DISCUSSION

The findings of this study provide strong empirical and theoretical support for rethinking visual quality in video games beyond the dominant paradigm of photorealism. While advances in rendering technologies have significantly improved perceptual fidelity, the results demonstrate that realism alone is insufficient to explain user engagement and cultural interpretation.

6.1 Re-evaluating the Role of Realism

A central contribution of this study lies in challenging the assumption that higher visual fidelity necessarily leads to improved user experience. The results indicate that photorealistic rendering, despite enhancing surface-level realism, introduces performance instability and does not significantly improve engagement or cultural recognition.

This finding aligns with previous research suggesting that immersion is not solely dependent on realism but is instead shaped by coherence, clarity, and interpretability (Denisova & Cairns, 2019). In this context, realism may be better understood as a supporting factor rather than a primary determinant of visual quality.

6.2 Art Direction as the Primary Driver of Engagement

The regression analysis revealed that art direction is the strongest predictor of engagement ($\beta = 0.62$), outperforming rendering complexity. This highlights the critical role of visual design in structuring user

experience.

From a cognitive perspective, stylized art direction enhances engagement by reducing visual complexity and directing attention toward salient features. This supports theories of visual cognition, which emphasize the importance of clarity and saliency in information processing (Ware, 2013).

Moreover, stylistic coherence contributes to a unified visual language, reinforcing immersion even in the absence of photorealistic detail. This suggests that engagement emerges not from visual accuracy alone but from the meaningful organization of visual elements.

6.3 Cognitive Load and Interpretability

The observed differences in engagement and cultural recognition can be partially explained through cognitive load theory (Sweller, 1988). Photorealistic environments often contain high levels of visual detail, which may increase cognitive demand and hinder efficient processing.

In contrast, stylized environments simplify visual information, allowing users to focus on relevant elements and extract meaning more effectively. This reduction in cognitive load enhances both interpretability and user experience.

These findings reinforce the argument that visual quality should be evaluated not only in terms of fidelity but also in terms of cognitive accessibility.

6.4 Cultural Meaning and Semiotic Clarity

One of the most significant contributions of this study is its emphasis on the cultural dimension of visual quality. The results demonstrate that stylized art direction significantly improves cultural recognition, particularly in the context of Arabian visual identity.

From a semiotic perspective, visual elements function as signs that convey culturally embedded meanings (Chandler, 2017). Stylization enhances the relationship between signifiers and signified meanings by emphasizing symbolic features and reducing visual noise.

This finding highlights a critical limitation of photorealistic rendering: while it reproduces physical detail, it does not inherently support meaning construction. Cultural understanding requires selective emphasis and abstraction, which are more effectively achieved through stylized design.

6.5 Toward a Multi-Dimensional Model of Visual Quality

The results support the proposed integrative model in which visual quality emerges from the

interaction between perceptual, cognitive, and cultural dimensions. Rather than treating realism as the ultimate goal, this model positions it as one component within a broader system.

Art direction operates as the primary mechanism for meaning construction, while rendering technologies provide perceptual support. Cultural context mediates interpretation, shaping how visual elements are understood by users.

This perspective offers a more comprehensive framework for evaluating visual design in interactive media and addresses the limitations of realism-centric approaches.

6.6 Implications for Design and Research

The findings of this study have important implications for both game design and academic research:

- Designers should prioritize stylistic coherence and symbolic clarity over excessive realism
- Rendering technologies should be optimized for performance and usability rather than maximum fidelity
- Cultural representation should be approached through abstraction and semiotic design strategies
- Future research should explore the interaction between visual style and other experiential factors, such as narrative and gameplay mechanics

These implications highlight the need for a shift in both design practice and research paradigms toward a more holistic understanding of visual quality. From an industry perspective, these findings suggest a paradigm shift in visual production pipelines. Rather than allocating excessive resources toward maximizing graphical fidelity, developers may achieve superior user experience outcomes by optimizing stylistic coherence and symbolic clarity. This has direct implications for performance optimization, accessibility, and cross-cultural design.

6.7 Limitations and Future Directions

Despite its contributions, this study has several limitations. The controlled experimental environment may not fully capture the complexity of real-world gameplay scenarios, where narrative and interaction dynamics play a significant role.

Additionally, the cultural analysis focuses primarily on Arabian contexts, which may limit generalizability across other cultural settings.

Future research should explore cross-cultural comparisons, longitudinal engagement patterns, and the interaction between visual style and gameplay mechanics. Incorporating larger and more diverse samples would further enhance external validity.

7. CONCLUSION

This study set out to critically examine the prevailing assumption that visual quality in video games is primarily determined by photorealistic rendering. Through a mixed-method approach integrating performance analysis, user perception, and cultural interpretation, the findings demonstrate that realism alone is insufficient to account for user engagement and meaning construction.

The results show that while photorealistic rendering enhances perceptual fidelity, it introduces performance constraints and does not significantly improve cultural recognition. In contrast, stylized art direction consistently enhances engagement, interpretability, and cultural clarity. Regression analysis further confirms that art direction is the strongest predictor of engagement, highlighting its central role in shaping user experience.

By proposing a multi-dimensional framework of visual quality—encompassing perceptual, cognitive, and cultural dimensions—this study contributes to a more comprehensive understanding of visual design in interactive media. The findings challenge realism-centric paradigms and emphasize the importance of abstraction, symbolic representation, and stylistic coherence in effective visual communication.

Beyond its theoretical contribution, this research offers practical implications for game design, suggesting that prioritizing clarity, performance, and cultural meaning may lead to more engaging and inclusive player experiences.

Future research should expand on these findings by exploring diverse cultural contexts, integrating gameplay variables, and examining long-term engagement patterns. Such efforts will further advance the development of culturally informed and cognitively effective visual design strategies in digital media.

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