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## **Improving Visual Style Classification Information in Digital Games Using Intercoder Reliability Assessment**

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### **ABSTRACT**

The digital gaming community appreciates visual style information in digital games as it facilitates information seeking. Nevertheless,

learned scholars have discovered that the digital game visual style classification is inconsistent and easily modified, potentially limiting the information and leading to inaccurate visual terminologies during information discovery. Therefore, this cross-sectional study was performed to assess multiple visual style classification terms and their definitions among Malaysian game developers using the closed card sorting exercise. A total of seven professional game developers participated in an online survey that comprised thirty-five digital game case studies using a card sorting technique. They were asked to classify nineteen visual style classification terms, including *psychedelic*, *text*, *illusionism*, *photorealism*, *televisualism*, *handicraft*, *caricature*, *cel-shaded*, *comic book (anime)*, *watercolour*, *Lego*, *minimalism*, *pixel art*, *silhouette*, *bright*, *dark*, *maplike*, *colourful*, and *black and white*. The Fleiss' kappa intercoder reliability assessment was performed to measure the coders' agreement on visual style classification, followed by the think-aloud protocol descriptive analysis to gather assessment insights into the visual style descriptions. The intercoder reliability test achieved a significantly moderate agreement based on the results. The professional game developers agreed on eighteen visual styles and rejected the *bright* visual style classification due to its overlapping description with the *colourful* visual style. The definition of ten visual style classifications was improved from the existing Video Game Metadata Schema (VGMS) description, contributing to the digital game's coherence and consistency. This improvement will enhance visual style classification information for machine-learning-based recommendation systems for digital game distribution platforms and digital archiving.

**Keywords:** Visual style classification, digital game, Fleiss' kappa model, intercoder reliability, machine-learning.

## INTRODUCTION

The utilisation of digital game information from multiple media platforms is becoming an increasingly essential aspect among the growing digital gaming community, including consumers, developers, curators, and scholars (Cho et al., 2022; Lee et al., 2015b). Despite the advanced development in the gaming industry, the application of descriptive metadata sets restricts the information on digital games (Clarke et al., 2016). To date, searchable metadata in digital game

catalogues and repositories only provide access to basic information, such as title, platform, publisher, and genre (Tennis et al., 2015). According to the standard metadata schema set, the elements for overall video games are inspired by various existing information sources, such as game web and catalogue records (Lee et al., 2013; Lee et al., 2015a). One component of the schema emphasised visual style aesthetics, which is related to the game art visual development. Visual aesthetics is a critical component of visual classification, which has been introduced to describe visual style classification in digital games (Cho et al., 2018).

The visual style is defined as cohesive and unifying visual aesthetics (Lee et al., 2015). A game's visual appearance is recognisable as initially intended by its creator and determined in the context of creation (Lee et al., 2014). Visual styles can be examined and discussed from various facets of the aesthetic look of digital games (Lee et al., 2015). As such, the visual styles structured in classification terminologies are derived from contemporary art domains, such as abstract, watercolour, photorealism, caricature, minimalism, and other domain-related visual cultures. The existing visual styles are uniquely correlated with the digital game visual style classification.

## **RELATED WORKS**

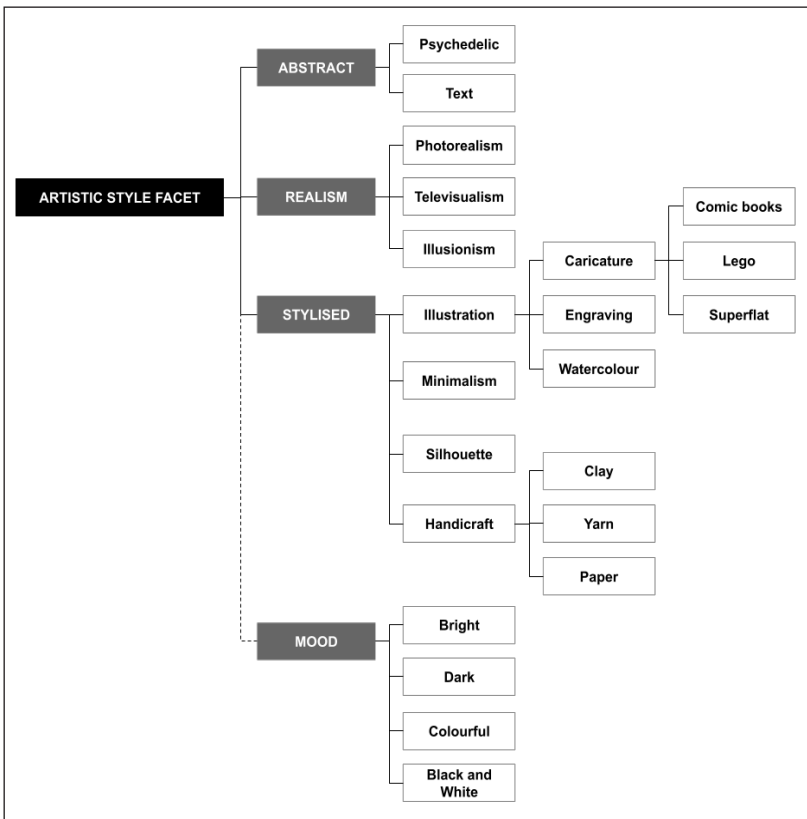
Digital games have evolved in accordance with advanced computer technology and have affected visual styles by making them more diverse and complex (Keating et al., 2017). Discussion on visual styles in academia and online community forums has indicated an increasing interest in exploring artistic elements and aesthetic appeal. Previously, a survey on useful information visual style showed that 53.4 percent out of 671 participants were satisfied users of visual style classification information (Lee et al., 2015b). However, the visual style terms are blatantly modified from existing art movements and intertwined with contemporary technological terms. Occasionally, visual style classifications have been too specialised or too broad to accommodate the terms and descriptions, potentially limiting the information and leading to inaccurate visual terminologies.

According to the Video Game Metadata Schema (VGMS), visual styles include controlled vocabulary and comprise three facets: artistic style, technique, and dimension (Lee et al., 2017). The artistic

style facet (Figure 1) reflects the recognisable visual appearances with intentionally directed artistic features that provide distinctive classifications shared by similarly designed games (Mäyrä et al., 2002). The artistic style is classified into three major categories: abstract, realism, and stylised (Lee et al., 2014). The abstract artistic style recognises non-character-based forms that do not attempt to represent an accurate depiction of visual reality. Abstraction emphasises visual characteristics, such as shapes, patterns, colours, and textures, and consists of *psychedelic* and *text* (Lee et al., 2017).

**Figure 1**

*Artistic Style Facet* (Lee et al., 2014; Rossi et al., 2014)



On the contrary, the realism artistic style depicts an actual simulated environment, referring to real-world originality. Realism is consistent

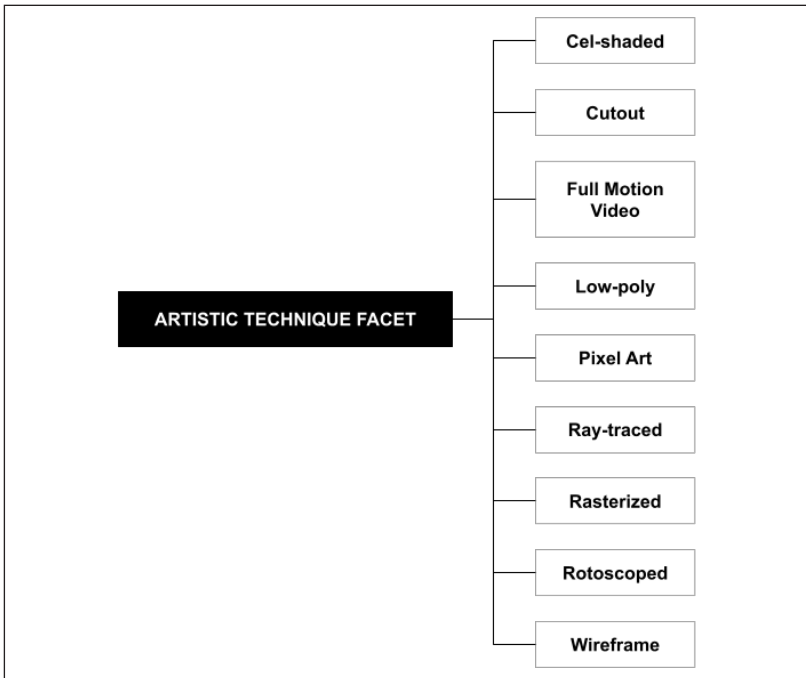
in characters and environments to portray the illusion of an unreal world or imaginary fiction in real-world settings. It is further subdivided into *photorealism*, *illusionism*, and *televisualism*. Meanwhile, the stylised artistic style simplifies reality with non-photographic simulation to depict the image of an object, and its environment is simplified to its most defining features, as intended by specific digital art graphics. The stylised artistic style is categorised into illustration, *minimalism*, *silhouette*, and *handicraft*.

Additionally, Rossi et al. (2014) introduced the mood domain visual aesthetics, such as *brightness*, *darkness*, *colour*, and *black and white*. Keating et al. (2017) broadened the mood domain visual style classification into *achromatic*, *monochromatic*, and *colourful*. Recently, Cho et al. (2018) suggested that *bright*, *dark*, *colourful*, and *black and white* visual style classifications are agreeable amongst game players for the mood domain.

The artistic technique explains the application of computer graphic tools to produce the look and feel of the intended artistic style of the game visual, which is generally created through modelling and rendering according to the technology at that time (Donovan et al., 2013). Examples of artistic techniques that are typically applied in modern digital games include *rotoscoped*, *cel-shaded*, *ray-traced*, and *rasterised*. Figure 2 shows a taxonomy for the artistic technique facet of visual style.

**Figure 2**

*Artistic Technique Facet* (Lee et al., 2017)



The artistic dimension facet is described as two-dimensional (2D) and three-dimensional (3D) space, and sometimes a combination of both. The dimension determining the depth is intended to be seen in the video game. In general, a 2D visualisation presents a flat surface using horizontal and vertical dimensions. Digital games in 2D video elements use flat graphics or sprites that are not associated with 3D geometry (Halpern, 2018). In comparison, 3D visualisation acquires a volumetric approach that includes horizontal, vertical, and depth dimensions, which commonly display an object in multiple perspectives through rotation. Furthermore, 3D games apply materials, textures, and lighting rendered on the surface of the game environments, characters, and objects (Su, 2018). These 3D games also have perspectives and depths that are visible through the camera control lens.

The lack of coherent and consistent terminologies and definitions for digital game visual style classifications used in recognising visual

aesthetics causes difficulties and inconsistencies among practitioners, academicians, cultural experts, and game players as reported by Lee et al. (2012), Donovan et al. (2013), Clarke et al. (2015), and Jett et al. (2016). Due to these problems, it might be difficult for game developers and users to reach a consensus on the classification of visual style descriptions. In realising the knowledge gap explained above, this research aims to assess and improve digital game visual style classifications. It is hoped that the revised classification terms, which best describe the digital game visual style, will be used for effective information discovery and machine learning (ML) vocabulary analysis.

## **METHODOLOGY**

### **Study Design**

A cross-sectional survey involving individual professional game developers was conducted from June to July 2020. The participants were recognised as professional game developers from one of the six personas in video game information research (Lee et al., 2013). Participants from local and international companies were selected based on their prior educational and professional expertise as game programmers, artists, or designers in video game development. The ethical approval for this study was obtained from the institutional research committee, while permission letters were sent to the potential game developers of the respective company.

The purposive sampling method was employed to determine the sample that is best suitable for the present research, which estimated a minimum of two raters using the Fleiss' kappa approach to assess the visual style classification (Enderlein, 1988; Schwabe et al., 2022; Welhouse et al., 2015). The visual style classification terms were determined using the card sorting technique to facilitate the understanding of the visual style identity and comprehension of the user's expectations for the classification (Connor et al., 2017). A closed card sorting session was carried out one-on-one with the participants.

### **Pilot Study**

Four game developers were selected for the pilot study to assess the validity and reliability of the questionnaire and estimate the average

time for a respondent to complete the questionnaire. The respondents took an average of 30 minutes to answer the questionnaire and complete the survey.

## Data Collection

Independent, self-administered survey questionnaires were conducted via online video communication with the respective professional game developers. The respondents were briefly introduced to the digital game visual style classification (<http://jazmijamal.org/phd>). They were then instructed to complete the survey questionnaire via Google Forms and perform the think-aloud protocol to elaborate visual style interpretations. The session was video recorded using screen recording (OBS Studio) and documented for analysis.

## Instruments

The questionnaire comprised three main sections: background survey, visual style classification card sorting, and summary. The background survey section consisted of demographic and psychographic information, including gender, age category, academic qualification, professional experience in the digital game industry, job position, and experience in searching visual style information.

In the second section, respondents were instructed to perform a closed-card sorting exercise, which consisted of nineteen pre-defined visual style classifications, including *psychedelic*, *text*, *illusionism*, *photorealism*, *televisualism*, *handicraft*, *caricature*, *cel-shaded*, *comic book (anime)*, *watercolour*, *Lego*, *minimalism*, *pixel art*, *silhouette*, *bright*, *dark*, *maplike*, *colourful*, and *black and white* (Cho et al., 2018). Additionally, the term ‘*others*’ enabled the respondents to express new terminologies that were not included in the existing visual style classification terms. The respondents were given thirty-five sets of digital game images that were carefully selected based on video game titles released between 1990 and 2018 (Cho et al., 2018). Each digital game image was derived from published video game products and displayed numerous visual styles. Furthermore, recent game titles from 2019 to 2021 were included to represent the most current visual style trend.

The respondents were urged to adopt the think-aloud protocol while assessing the digital game images to provide better insight into



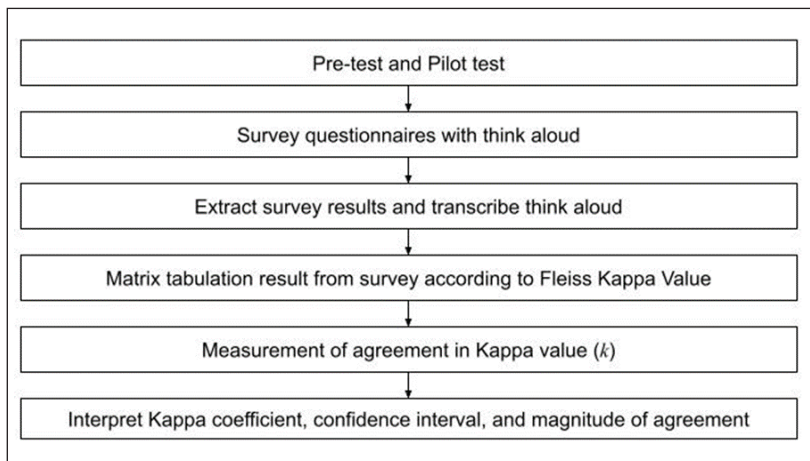
distinguishing visual image identification and its relationship with visual style classification (Vert et al., 2021). Previous studies have shown that the think-aloud method supported the improvement of visual style descriptions from a visual terminology perspective (Krupke et al., 2019). In the summary section, the respondents were asked to provide overall feedback and share opinions on the survey.

## Data Analysis

Data entries were carried out using Google Forms and Google Docs. Descriptive statistics were used to illustrate the demographic information, while categorical data were presented as percentages. In addition, the Fleiss' kappa intercoder reliability assessment was performed to measure the coders' agreement on visual style classification using the Statistical Package for the Social Sciences (SPSS) version 27. The think-aloud protocol descriptive analysis was conducted to gather assessment insights into the visual style descriptions. Figure 3 depicts the data analysis procedure. Finally, the overall intercoder agreement, interpretation magnitude of kappa on visual style classification, and think-aloud transcription were analysed and interpreted.

### Figure 3

*Data Analysis Strategy for Intercoder Reliability Assessment with Think-aloud Protocol*



## RESULTS

This study recruited seven professional male game developers between 31 and 40 years old who were either directors or team leaders in their respective game development disciplines. The game developers consisted of four game artists (from Unity Technologies Inc. Sweden, Ammobox Studios, Bandai Namco Studios, and Alchymy Creative Enterprise), one game designer (Kurechii Studios), and two game programmers (Sony Interactive Entertainment Studios Malaysia and Unity Technologies Inc. SEA). They all had over five years of experience developing games for the international market. They were also aware of and had experienced classifying visual styles used in game development.

Table 1 shows the statistical results of the intercoder reliability analysis based on the overall visual style classification agreement. The intercoder reliability analysis indicated a kappa value of 0.553, corresponding to the moderate agreement level within the 0.41–0.60 kappa range (Viera et al., 2005). The kappa value depended on the marginal distribution, which had an asymptotic 95 percent Confidence Interval (95% CI) of 0.553–0.554. The standard error (0.010) implied that the p-value was less than 0.05, which was statistically significant.

**Table 1**

*Intercoder Reliability Analysis Overall Agreement on Visual Style Classification Results*

|                   | Kappa ( <i>k</i> ) | Asymptotic     |        |         | Asymptotic 95% Confidence Interval |             |
|-------------------|--------------------|----------------|--------|---------|------------------------------------|-------------|
|                   |                    | Standard Error | z      | P-value | Lower Bound                        | Upper Bound |
| Overall Agreement | 0.553              | 0.010          | 57.630 | 0.000   | 0.553                              | 0.554       |

The interpretation of the individual visual style classification terms was organised according to the magnitude of kappa, indicating the degree of agreement, as shown in Table 2. According to the results, *bright* visual style classification had no agreement and was therefore rejected.

**Table 2**

*Interpretation Magnitude of Kappa on Visual Style Classification*

| Strength of Agreement    | Value of Kappa | Visual Style Classification |
|--------------------------|----------------|-----------------------------|
| Perfect agreement        | 1.00           | 1.00 Text                   |
| Almost perfect agreement | 0.81–0.99      | 0.989 Psychedelic           |
|                          |                | 0.808 Black and White       |
| Substantial agreement    | 0.61–0.80      | 0.791 Lego                  |
|                          |                | 0.783 Maplike               |
|                          |                | 0.722 Pixel Art             |
|                          |                | 0.696 Minimalism            |
| Moderate agreement       | 0.41–0.60      | 0.588 Televisualism         |
|                          |                | 0.562 Handicraft            |
|                          |                | 0.553 Cel-shaded            |
|                          |                | 0.443 Illusionism           |
|                          |                | 0.429 Dark                  |
| Fair agreement           | 0.21–0.40      | 0.417 Photorealism          |
|                          |                | 0.347 Caricature            |
|                          |                | 0.326 Comic Book (anime)    |
|                          |                | 0.317 Watercolour           |
|                          |                | 0.314 Silhouette            |
|                          |                | 0.308 Colourful             |
| Slight agreement         | 0.01–0.20      | -                           |
| No agreement             | < 0.00         | -0.012 Bright               |

This research also included a descriptive transcription of the professional game developers’ think-aloud protocol to bolster the visual style classification interpretations. The following visual style classification terms were used to structure the think-aloud verbatim from the respondents. The analysis emphasised only eleven visual style classifications with moderate and fair agreement levels that provided critical arguments to improve the terms and descriptions.

**i. Lego**

The respondents substantially agreed that the *Lego* visual style classification is related to the game mechanic feature of stacking blocks. The *Lego* style imitates the distinctive features of the original LEGO® products in terms of the minifigures, sets, or environments. As such, the *Lego* visual style is characterised by blocky, yellow heads

and cup hands, and exhibits limited movement, which resembles the existing LEGO® design. However, the respondents noted that the *Lego* visual style was irrelevant because the game’s visual aesthetics adhered to realistic principles in its environment. The *Lego* visual style provides a similar hands-on experience in a digital environment by incorporating photorealistic elements into lights, textures, maps, and colours.

## ii. Maplike

A majority of the respondents agreed that the *maplike* visual style emphasises maps and map-based gameplay. *Maplike* refers to gaming areas often composed of tiny rectangular or hexagonal visual graphics. Nevertheless, the top-down viewing angle is considered a gameplay perspective instead of a visual style. The dominant features of maplike are used to recognise the object creations, such as units, buildings, terrains, and environments that are designed for map-based viewing. Therefore, the respondents felt that the *maplike* visual style should be viewed as an artistic map-making technique through map-viewing lenses rather than a point of viewing angle.

## iii. Pixel Art

The respondents also agreed that *pixel art* is a visual style characterised by pixelated, often sprite-based visuals similar to those found in 8-, 16-, and 32-bit games and modern games that intend to replicate it. Classic retro video games are frequently associated with the *pixel art* style due to the limited rendering technology of early-generation consoles. The “pixelated style” refers to the boxy and pixelated appearance of raster graphics for the late display technology. The respondents perceived that the *pixel art* aesthetics had been addressed by remaking it to replicate retro game nostalgia. The *pixel art* style concerns the artist’s inspiration for craft-making in pixelated images of modern machines for 2D game environments.

## iv. Televisualism

The respondents moderately agreed that *televisualism* is a photorealist visual style that combines realism with the artistic and graphical features of television programming. Examples of *televisualism* include score bars during a sports broadcast or framing stories on a

nightly news show. The *televisualism* style emphasises implementing user interface features from broadcast channels or programmes. The visual experience is accurately depicted from the broadcasting camera position, showing a wide angle to observe action throughout the gameplay. Generally, the *televisualism* visual style appreciates hyper-realistic images that adhere to the laws of physics. Recreating existent humans in a life-like manner requires not only realistic modelling but also considers physics and body mechanics to capture the reality of human action. Thus, according to the respondents, the physics of motion was considered to recreate non-organic living forms, such as vehicles or objects, to achieve realistic action.

#### **v. Cel-shaded**

The respondents agreed that *cel-shaded* is a computer rendering technique that enhances the illusion of a 3D surface by providing the modelled entity with a cartoon-like appearance due to the rounding edges effect and the removal of colour gradation. Additionally, this technique creates the illusion of hand-drawn animations for 3D rendering. Interestingly, cel-shading is based on the perception of 2D animated cartoons, where the characteristics emphasise the outlines of separate blocks of colour. The *cel-shaded* rendering technique is applied to 3D environments in which the rendering characterises the edges of the polygonal model and highlights them through basic silhouette forms, such as specular, ambient, and shadow. The *cel-shaded* visual style characteristics also emphasise stroke features, noticeable colour separation, a limited colour palette, highlights, and basic silhouette forms. This rendering technique is moderately accepted in both 2D and 3D perspectives as the dominant characteristic of its cartoon-like appearance.

#### **vi. Dark**

The respondents also concurred that the *dark* visual style is derived from the mood domain, which has a moderate agreement level. The style portrays desaturated colour values ranging from a shade of grey to darkness. Therefore, objects and scenery with low luminance appear in darker colours. The *dark* visual style was identified as a visual style with characteristics that complemented the existing *realism* or *stylised* visual styles. The respondents acknowledged that unique properties of the *dark* visual style allowed the perception of fewer colour values in the game, whether in 2D or 3D dimensions.

### **vii. Photorealism**

The respondents somewhat agreed that *photorealism* uses a high-end visualisation paradigm to capture the essence of photographic likeness with a reality embodiment that emulates reality. The digital game visually renders emphasised details of a particular subject, possibly observed by the human eyes. The visual aesthetics of photorealism strongly correlates with historical-based concepts or themes in digital games. The historical scenes are reconstructed by utilising accurate historical references. The *photorealism* visual style appreciates the authenticity of facts to express realistic visual imagery. Moreover, the respondents felt that fictional games were considered photorealistic due to their precision in replicating fictional elements that influenced scenes inspired by real-world environments but set in parallel realities. The *photorealistic* visual style was associated with hyper-realistic visual presentation. As a result, the respondents agreed that this style incorporated scientific theories with facts and proof of reality to recreate the visual experience regardless of the themes.

### **viii. Comic Book (Anime)**

The respondents fairly agreed that term *comic book (anime)* refers to a visual style replicating common artistic elements found in mass-market comic books, such as accentuated character features and broad line strokes. The *comic book* visual style presents comic strip elements, such as panels or cut scenes, precisely defining the style. The visual style recorded a fair agreement in terms of comprehending the definition. The results also revealed the accuracy of the terminology in describing the visual style based on generic comic books or anime. The *comic book* visual style may be influenced by American cartoons, Japanese manga, or any other regional graphic influence on the comic book's characteristics. Thus, the respondents felt that it is crucial to recognise the *anime* style through the apparent characteristics of manga drawings. The *anime* visual style is distinguished by its figural form and familiar characteristics of the manga drawing style. It also correlates with the *cel-shaded* style because it implies the cel-shading technique, which dominates the colour rendering technique for 3D objects.

### **ix. Watercolour**

The respondents also concurred that the *watercolour* visual style describes environments and characters that appear to have been painted

with watercolours, ink washes, or Sumi-e. Watercolour is associated with 2D visual art because of the peculiarities of paint pigments with colours that adhere to the paper's surface. The *watercolour* visual style is viewed as a medium to express the visual concepts of illustrative games. Watercolour stroke techniques combine edge-darkening wet paint and wet brush strokes of different colours. In 3D games, the watercolour blocks are bound by thick black line effects. Nevertheless, the drawback of this visual style was observed when the watercolour visual effects were applied in real-time rendering while retaining the sense of painting by hand on paper. Therefore, watercolour presentation in 3D games is less pronounced than in 2D watercolour environments. In short, the respondents fairly agreed that the primary essence of the *watercolour* visual style is appreciating the visual style on flat surfaces, as similarly observed in reality.

#### **x. Silhouette**

The respondents quite agreed that in the *silhouette* visual style, characters or environments are portrayed as solid shapes in a single or limited colour palette, commonly black. The research discovered that silhouette had a slight correlation with the *minimalism* style. Being recognised as a supporting explanation, *silhouette* adheres to the *minimalism* visual style by utilising sparse background and minimising the single use of the colour hue. In 2D games, the *silhouette* visual style characteristics recognise forms and shapes of characters, foreground, and background in chromatic colour. Character forms frequently appear in dark shadows with unseen details, while the backgrounds are overexposed. On the contrary, in 3D games, the respondents perceived that the *silhouette* visual style corresponded to low light and a restricted number of light sources. The silhouette interpretation correlated with the *dark* visual style characteristics by having desaturated, darker colours. In addition, the 3D games' *silhouette* visual style is based on the light source and rendering technique to minimise features and solidify the character's single-colour shape.

#### **xi. Colourful**

The respondents agreed that the *colourful* visual style incorporates numerous colours and visual likenesses. The *colourful* visual style

correlated with other visual styles due to the characteristics of its vibrant colour combinations. The result showed that the *colourful* visual style supported *caricature*, *minimalism*, *psychedelic*, and *comic book (anime)* visual styles. The *anime* visual style applied a cel-shading technique that combines basic and subtype colours and is therefore considered colourful. In addition, the respondents stated that those vibrant mixed colours portrayed in the gameplay were associated with bright descriptions and highly saturated colours.

## DISCUSSION

The visual style classifications in the digital game reflect the philosophies and techniques of the artists' intentions to preserve artistic values. In view of this, the current study applied the Fleiss' kappa intercoder reliability statistical test to analyse the respondents' data and determine the most agreed visual style classifications among professional game developers (Fleiss et al., 2004). In general, the intercoder reliability test measures the degree to which separate coders assess the properties of the same object and achieve similar results (Konstantinidis et al., 2022). A kappa statistic for categorical data estimates the relative level of agreement amongst raters (Fleiss et al., 1979). Accordingly, a value of 1 represents a complete agreement, a value of 0 indicates anticipation by chance, and a negative value implies possible disagreement (Khoo et al., 2017; Warrens, 2010). The Fleiss' kappa coefficient generates a parametric asymptotic CI (Fleiss et al., 1979), where the reliability of the CI should be greater than 95 percent (Fleiss et al., 2003).

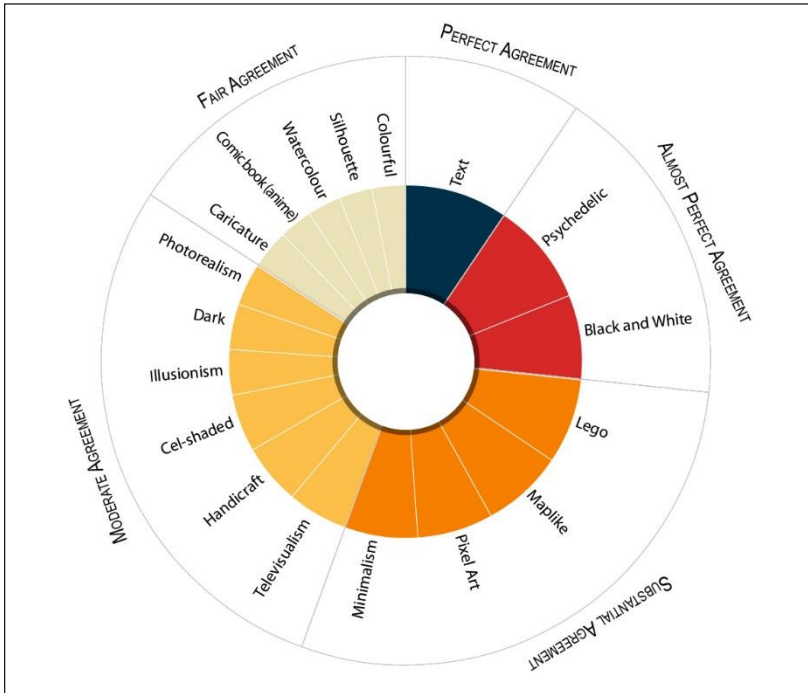
As mentioned earlier, visual style classification consists of three major facets: artistic style, technique, and dimension, which have been refined into nineteen distinct classifications. The findings from this study revealed that the professional game developers agreed on eighteen visual style classification terms based on the significance of their descriptions (Figure 4). The *bright* visual style classification was the only term that the game developers disagreed with due to the overlapping description with the *colourful* visual style. According to the intercoder reliability analysis, the digital game visual style interpretation terms and meanings were associated with the descriptions. Thus, familiarity with visual representation was correlated with the



classification of distinctive visual styles. Occasionally, the visual style characteristics were distinctly recognised by the professional game developers.

**Figure 4**

*Digital Game Visual Style Classification Terms Agreement.*



Based on the game developers' feedback, they suggested modifying specific terms to emphasise the recognition of the visual characteristics that described the visual styles. Therefore, this study improved ten visual style classification descriptions following the think-aloud protocol and existing descriptions from the VGMS, as shown in Table 3. Improved descriptions (suggestions in *italic*) contributed to the coherence and consistency of digital game products by increasing their descriptive visual identification.

**Table 3**

*Visual Style Classification Modified Descriptions* (Lee et al., 2017)

| Terms        | Descriptions from VGMS   | Modified Descriptions   |
|--------------|--|---|
| Maplike      | A visual style emphasises maps and map-based gameplay. Game spaces usually consist of small rectangular or hexagonal graphic images like tiles, and players typically have a top-down or isometric view throughout gameplay.                         | A visual style <i>that emphasises map-based gameplay through the lens of map viewing</i> . Game spaces usually consist of <i>grids</i> ; small rectangular or hexagonal graphic images, <i>such as</i> tiles, and players typically have a top-down or isometric view throughout <i>the</i> gameplay, <i>which is commonly associated with strategy games</i> . |
| Pixel Art    | A visual style characterised by the use of pixelated, typically sprite-based visuals found in early 8-, 16-, and 32-bit games, and in modern games intending to replicate it.  | A visual style characterised by the use of pixelated <i>appearance</i> , typically sprite-based visuals found in early 8-, 16-, and 32-bit games, and in modern games <i>that intend to replicate the retro style</i> .   |
| Televsualism | A photorealist style that combines realism with the artistic and graphical features found in television programming. Examples of these graphical features include scores during a sports broadcast or the framing of stories in a nightly news show. | A photorealist style that combines <i>realistic simulations</i> with the artistic and graphical features found in television programming. Examples of these graphical features include the <i>score bars</i> during a sports broadcast or the framing of stories on a nightly news show.  |
| Cel-shaded   | A style that enhances the illusion of a 3D surface, giving the modelled entity a cartoon-like appearance due to the effect of rounding the edges and eliminating gradations of colour.   | A style that enhances the illusion of a 3D surface, giving the modelled entity a cartoon-like appearance due to the effect of <i>shades and lighting that appear as blocks of colour</i> .  |
| Dark         | A visual style characterised by having highly desaturated colours.   | A visual style characterised by having highly desaturated colour <i>values between the shade of grey to darkness</i> .  |

(continued)

| Terms        | Descriptions from VGMS   | Modified Descriptions  |
|--------------|--|--|
| Photorealism | This visual style refers to “photographic likeness with reality”.  | This visual style refers to <i>photorealistic photography and hyper-realistic realism inspired by reality or fictitious reality.</i>   |
| Comic Book   | A visual style replicates common artistic elements found in mass-market comic books, such as accentuated character features and broad line strokes.  | A visual style that replicates common <i>comic strip elements and its universal symbolic icons for expression while maintaining comic stroke features.</i>   |
| Watercolour  | A visual style where characters and environments appear as though painted by water colours, ink washes, or sumi-e.   | A visual style where the characters and environments appear as though painted using watercolours, ink washes, or sumi-e on a <i>flat surface.</i>  |
| Silhouette   | A style in which characters or environments are represented as a solid shape of a single colour, or only a couple of colours, usually black. The interior of a silhouette is often featureless, and the whole is typically presented with a sparse background. | A style in which the characters or environments are represented as a solid shape of a single colour, or a <i>single hue of colour palettes.</i> Silhouette is often featureless <i>unseen details,</i> and the whole <i>image</i> is typically presented with a sparse background. |
| Colourful    | A visual style using many and varied colours.  | A visual style <i>applied to a variety of colour combinations that include basic and subtype colours.</i>  |

Additionally, the think-aloud descriptive analysis by the professional game developers discovered three new visual style classifications comprising *toys*, *anime*, and *stylised realism*, as listed in Table 4. The distinct characteristics of each term served as solid foundations for modern-day visual arts appreciation. For instance, the term *toys* can be appreciated through toy photography and toy-based animation films that feature toy-playing figures. Meanwhile, *anime* is classified separately from comic books due to the apparent distinctions between anime and the *comic book* visual style. On the other hand, *stylised realism* refers to slightly exaggerated characters while maintaining realistic environments. These new terms may complement the gaps left by prior visual style classifications presented in the literature.

**Table 4**

*New Visual Style Classification Terms*

| New Terms        | Descriptions   |
|------------------|--|
| Toys             | The distinctive look of dolls, action figures, and sets of particular toy products or brands resemble playing with the toys in a hands-on experience (Heljakka, 2018).   |
| Anime            | A manga, manhwa, or manhwa-inspired style that emphasises the illustrative exaggeration of the character's facial features for expression while maintaining the character's figure proportions to fit the environment (Mumcu et al., 2018) |
| Stylised Realism | A style that exaggerates distinctive features, especially proportions of a character or object, while retaining a realistic environment consistent with reality (Skulmowski et al., 2022)  |

The assessment reflected the techniques used by artists to create digital games, which had a particular visual appearance that enabled others to classify them easily. These findings verified the speculation that visual style classification described the most prevalent and recognisable visual appearances in digital game aesthetics. Thus, the subsequent research stage is to satisfy the immediate need to extend the knowledge continuum by classifying visual style as an effective information-seeking tool.

### RECOMMENDATIONS

This study suggested the need for additional empirical research on the meaning and classification of visual style classifications. Based on the results, the most agreed visual styles among the professional game developers were *text*, *psychedelic*, and *black and white*. The research also validated that realism and stylised visual classifications correlated with moderate agreement levels. Both terms had interrelated definitions due to the realistic rendering from technological advancement in the field of computer graphic aesthetics.

Furthermore, the *anime* visual style classification was correlated with the cel-shading technique and applied watercolour as part of the background. Cel-shaded characteristics require an in-depth examination of the rendering technique to represent 3D visual style

artistic intentions. Moreover, the characteristics of watercolour paint effects on a 3D platform should be investigated for the cel-shaded rendering technique to determine the dominant characteristics of watercolour effects in a pseudo-watercolour technique.

The inclusion of the visual aesthetics mood domain in visual styles had a moderate correlation with other classifications, such as *minimalism*, *psychedelic*, *illusionism*, and *silhouette*. The agreement level for mood domain terms was within an acceptable range, with each term being recognised as a supporting explanation for commonly accepted terms. The *colourful* visual style description was vague and had layers of meaning to describe the classification. The style was also associated with overall colour-based visual games. Meanwhile, the findings showed that the descriptive meanings of both *colourful* and *bright* visual style classification descriptions overlapped. Thus, the definition of the *bright* visual style should be revised by synthesising perspectives on visual art theory and computer graphic simulation theory.

It has been argued that the visual style associated with brand names should not be used within the classification terms. It was agreed in the interview that the *Lego* visual style term is more related to a specific toy brand and exhibits biasness towards aesthetics in distinct blocks' mechanics of visual appeal, as described in the *Lego* visual style. Therefore, the findings suggested disassociating the *Lego* visual style into a generic perspective by considering toys or blocks in visual style rather than specific terms associated with a toy brand. For this reason, the term *toys* is proposed as a new visual style classification.

Overall, this study established the groundwork for ML to train specific visual style classification information. The terminologies assist decision-makers in classifying the digital game visual styles appropriately, resulting in high accuracy across a more comprehensive sample size. Therefore, the visual style classification for ML would be meaningful in recognising the digital game's stylistic and semantic attributes that can reveal explicit knowledge associated with the artistic intention.

Future research should explore the relationship between visual style classification and the genre of digital games as a recommendation model. Numerous angles can be applied in terms of research

directions in ML for recognising visual style characteristics. The ability of artificial intelligence to formulate visual style classes within its respective domain also allows it to verify recommendations that correspond to the user's preferred genre. The outcome of such progress would be beneficial in expanding the application of this study for practical ML systems in digital distribution platform services.

## CONCLUSIONS

This study assessed multiple visual style classification terms for information discovery based on the perspective of professional game developers via a cross-sectional survey. The professional game developers agreed on eighteen visual style classification terms based on the significance of their descriptions and rejected the *bright* visual style due to overlapping descriptions. In addition, the think-aloud protocol suggested the modification of ten visual style classification descriptions that reflected an improved visual identity. Besides, three new visual style classification terms were proposed: *toys*, *anime*, and *stylised realism*, which suit modern-day visual arts appreciation. In conclusion, this study proposed revising the visual style description to improve the descriptive characteristics. The amended descriptions provide a more precise explanation of the visual qualities that have been identified in visual research. Overall, this assessment addressed the research's visual style classification terms by providing more accurate descriptions, which would be helpful for future research and the development of a more precise ML classification system.

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## REFERENCES

Cho, H., Donovan, A., & Lee, J. H. (2018). Art in an algorithm: A taxonomy for describing video game visual styles. *Journal of*

- the Association for Information Science and Technology*, 69(5), 633–646. <https://doi.org/10.1002/asi.23988>
- Cho, H., Pham, M. T. N., Leonard, K. N., & Urban, A. C. (2022). A systematic literature review on image information needs and behaviors. *Journal of Documentation*, 78(2), 207–227. <https://doi.org/10.1108/JD-10-2020-0172>
- Clarke, R. I., Jett, J., Sacchi, S., & Lee, J. H. (2016). A conceptual model for video games and interactive media recommended citation. *School of Information Studies: Faculty Scholarship*, 171. <https://surface.syr.edu/istpub>
- Clarke, R. I., Lee, J. H., & Rossi, S. (2015). A qualitative investigation of users' video game information. *School of Information Studies - Faculty Scholarship*, 166. <https://surface.syr.edu/istpub/166>
- Connor, M., & Lawrence, A. B. (2017). Understanding adolescents' categorisation of animal species. *Animals*, 7(9), 65. <https://doi.org/10.3390/ani7090065>
- Donovan, A., Cho, H., Magnifico, C., & Lee, J. H. (2013, July). Pretty as a pixel: Issues and challenges in developing a controlled vocabulary for video game visual styles. In *Proceedings of the ACM/IEEE Joint Conference on Digital Libraries* (pp. 413–414). IEEE. <https://doi.org/10.1145/2467696.2467747>
- Enderlein, G. (1988). Fleiss, J. L.: The Design and Analysis of Clinical Experiments. Wiley, New York – Chichester – Brisbane – Toronto – Singapore 1986, 432 S., £38.35. *Biometrical Journal*, 30(3), 304. <https://doi.org/https://doi.org/10.1002/bimj.4710300308>
- Fleiss, J. L., Levin, B., & Paik, M. C. (2003). *Statistical methods for rates and proportions*. Wiley & Sons.
- Fleiss, J. L., Levin, B., & Paik, M. C. (2004). The measurement of interrater agreement. In *Statistical Methods for Rates and Proportions* (pp. 598–626). <https://doi.org/10.1002/0471445428.ch18>
- Fleiss, J. L., Nee, J. C. M., & Landis, J. R. (1979). Large sample variance of kappa in the case of different sets of raters. *Psychological Bulletin*, 86(5), 974–977. <https://psycnet.apa.org/buy/1979-32706-001>
- Halpern, J. (2018). *Developing 2D games with unity*. New York City: Apress.
- Heljakka, K. (2018). Bel far niente photography as productive play in creative cultures of the 21st century. In *Fotografia e culture visuali del XXI secolo* (pp. 473–478).

- Jett, J., Sacchi, S., Lee, J. H., & Clarke, R. I. (2016). A conceptual model for video games and interactive media. *Journal of the Association for Information Science and Technology*, 67(3), 505–517. <https://doi.org/10.1002/asi.23409>
- Keating, S., Lee, W.-C., Windleharth, T., & Lee, J. H. (2017, January). The style of Tetris is... possibly Tetris: Creative professionals description of video game visual styles. In *Proceedings of the 50th Hawaii International Conference on System Sciences (2017)* (pp. 2046–2055). <https://doi.org/10.24251/hicss.2017.248>
- Khoo, F. S., Teh, P. L., & Ooi, P. B. (2017). Consistency of online consumers' perceptions of posted comments: An analysis of tripadvisor reviews. *Journal of Information and Communication Technology*, 16(2), 374–393. <http://www.jict.uum.edu.my/images/pdf4/vol16no22017/374-393.pdf>
- Konstantinidis, M., Le, L. W., & Gao, X. (2022). An empirical comparative assessment of inter-rater agreement of binary outcomes and multiple raters. *Symmetry*, 14(2), 262. <https://doi.org/10.3390/sym14020262>
- Krupke, D., Zhang, J., & Steinicke, F. (2019). IMPAct: A holistic framework for mixed reality robotic user interface classification and design. *Multimodal Technologies and Interaction*, 3(2), 25. <https://doi.org/10.3390/mti3020025>
- Lee, J. H., Cho, H., Fox, V., & Perti, A. (2013, July). User-centered approach in creating a metadata schema for video games and interactive media. In *Proceedings of the ACM/IEEE Joint Conference on Digital Libraries* (pp. 229–238). IEEE. <https://doi.org/10.1145/2467696.2467702>
- Lee, J. H., Clarke, R. I., & Kim, Y.-S. (2015a). Video game information needs and game organization: Differences by sex and age. *Information Research*, 20(3). [http://informationr.net/ir/20-3/paper683.html#\\_YPeCxugzbcQ](http://informationr.net/ir/20-3/paper683.html#_YPeCxugzbcQ)
- Lee, J. H., Clarke, R. I., & Perti, A. (2015b). Empirical evaluation of metadata for video games and interactive media. *Journal of the Association for Information Science and Technology*, 66(12), 2609–2625. <https://doi.org/10.1002/asi.23357>
- Lee, J. H., Hong, S., Cho, H., & Kim, Y. S. (2015, April). VIZMO game browser: Accessing video games by visual style and mood. In *Conference on Human Factors in Computing Systems - Proceedings, 2015* (pp. 149–152). <https://doi.org/10.1145/2702123.2702264>



- Lee, J. H., Perti, A., Cho, H., Donovan, A., Magnifico, C., & Pittman, K. (2014). *University of Washington / Seattle Interactive Media Museum video game metadata schema: Controlled vocabulary for visual style. Version 1.5*. University of Washington. [http://gamer.ischool.uw.edu/wp-content/uploads/2018/04/VGMSVersion4.0\\_20180824.pdf](http://gamer.ischool.uw.edu/wp-content/uploads/2018/04/VGMSVersion4.0_20180824.pdf)
- Lee, J. H., Perti, A., Cho, H., Donovan, A., Magnifico, C., & Pittman, K. (2015). *Video game metadata schema : Controlled vocabulary for visual style*. [http://gamer.ischool.uw.edu/official\\_release/](http://gamer.ischool.uw.edu/official_release/)
- Lee, J. H., Perti, A., Clarke, R. I., Windleharth, T. W., & Schmalz, M. (2017). *University of Washington / Seattle Interactive Media Museum video game metadata schema version 4.0*. University of Washington. [http://gamer.ischool.uw.edu/wp-content/uploads/2018/04/VGMSVersion4.0\\_20180824.pdf](http://gamer.ischool.uw.edu/wp-content/uploads/2018/04/VGMSVersion4.0_20180824.pdf)
- Lee, J. H., Tennis, J. T., & Clarke, R. I. (2012). Domain analysis for a video game metadata schema: Issues and challenges. In *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 7489 LNCS (pp. 280–285). [https://doi.org/10.1007/978-3-642-33290-6\\_30](https://doi.org/10.1007/978-3-642-33290-6_30)
- Mäyrä, F., & Järvinen, A. (2002, June). Gran Stylistimo: The audiovisual elements and styles in computer and video games. In *Proceedings of Computer Games and Digital Cultures* (pp. 113–128). <http://www.digra.org/wp-content/uploads/digital-library/05164.35393.pdf>
- Mumcu, S., & Yılmaz, S. (2018). Anime landscapes as a tool for analyzing the human–environment relationship: Hayao Miyazaki Films. *Arts*, 7(2), 16. <https://doi.org/10.3390/arts7020016>
- Rossi, S., Lee, J. H., & Clarke, R. I. (2014, September). Mood metadata for video games and interactive media. In *Proceedings of the ACM/IEEE Joint Conference on Digital Libraries* (pp. 475–476). IEEE. <https://doi.org/10.1109/JCDL.2014.6970232>
- Schwabe, S. A., & Caldwell, S. (2022). Can anteroposterior skeletal pattern be determined from a silhouetted profile photograph? A cross-sectional study. *Journal of Orthodontics*, 49(1), 48–55. <https://doi.org/10.1177/14653125211028862>
- Skulmowski, A., Nebel, S., Remmele, M., & Rey, G. D. (2022). Is a preference for realism really naive after all? A cognitive model of learning with realistic visualizations. *Educational Psychology Review*, 34(2), 649–675. <https://doi.org/10.1007/s10648-021-09638-1>

- Su, Y. (2018). The application of 3D technology in video games. *Journal of Physics: Conference Series*, 1087(6), 62024. <https://doi.org/10.1088/1742-6596/1087/6/062024>
- Tennis, J. T., Lee, J. H., Clarke, R. I., & Carpenter, M. (2015). *Developing a video game metadata schema for the Seattle Interactive Media Museum*. University of Washington. <https://digital.lib.washington.edu:443/researchworks/handle/1773/33392>
- Vert, S., Andone, D., Ternauciuc, A., Mihaescu, V., Rotaru, O., Mocofan, M., Orhei, C., & Vasii, R. (2021). User evaluation of a multi-platform digital storytelling concept for cultural heritage. *Mathematics*, 9(21), 2678. <https://doi.org/10.3390/math9212678>
- Viera, A. J., & Garret, J. M. (2005). Understanding interobserver agreement: The kappa statistic. *Family Medicine*, 37(5), 360–363. [http://www1.cs.columbia.edu/~julia/courses/CS6998/Interrater\\_agreement.Kappa\\_statistic.pdf](http://www1.cs.columbia.edu/~julia/courses/CS6998/Interrater_agreement.Kappa_statistic.pdf)
- Warrens, M. J. (2010). Inequalities between multi-rater kappas. *Advances in Data Analysis and Classification*, 4(4), 271–286. <https://doi.org/10.1007/s11634-010-0073-4>
- Welhouse, Z., Lee, J. H., & Bancroft, J. (2015). “What am I fighting for?”: Creating a controlled vocabulary for video game plot metadata. *Cataloging and Classification Quarterly*, 53(2), 157–189. <https://doi.org/10.1080/01639374.2014.963776>