Development of textile pattern design by M. C. Escher's tessellation technique using chaekgeori icons

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Abstract

The purpose of this study is to raise awareness of the uniqueness and excellence of Korea's traditional culture among members of the MZ generation (Millennials and generation Z) and explore the possibility of utilizing archetypes of traditional culture in the contemporary context. To that end, this study develops and proposes unique contemporary textile pattern designs applying M. C. Escher's tessellation technique to the formative characteristics and symbolic meaning of Chaekgeori icons. To develop the designs, this study reviews the previous literature and theoretically considers the concept of Chaekgeori, its formative characteristics, and Escher's tessellation. After extracting iconsrelated to the themes, stylized iconographic motives were applied to geometric shapes to create repeating units. Then, Escher's tessellation was applied to these repeats to develop twelve contemporarily reimagined textile patterns. To verify the usability of the developed textile pattern designs in products targeting the MZ generation, in-depth interviews were conducted with the MZ generation living in Jeju. The developed textile patterns were mapped onto the selected items to prove the applicability of the developed textile patterns to the items preferred by the MZ generation. The contribution of this study lies in the fact that it develops unique and contemporary textile pattern designs based on the formative characteristics and symbolic meaning of Chaekgeori icons and maps the designs of fashion items preferred by the MZ generation, thereby raising awareness of the value and excellence of Chaekgeori as a part of Korea's traditional culture and shedding light on the possibility of using traditional cultural archetypes in contemporary contexts.

Keywords: Chaekgeori, Health wishes, Icons, M. C. Escher, s Tessellation Technique, MZ generation, Textile pattern design, Traditional cultural archetypes, Symbolic meaning

Introduction

In the twenty-first century, cultures are intermixed by active cross-border exchanges. As such, each country tries to shed new light on the value and contemporary applicability of its traditional cultural archetypes in order to ascertain its identity (Choi, 2007). Folk painting (minhwa) is one such cultural archetype. Folk painting is practical painting that symbolically represents the life that ordinary people desire. Folk painting contains people's hopes and desires for happiness, peace, good fortune, and health and serves

educational purposes by encouraging good deeds and warning against immoral conduct. In this sense, folk painting is a cultural archetype with unique values (Encyclopedia of Korean culture, n.d.). As such, this study focuses on Chaekgeori, one of the subgenres of folk painting. Chaekgeori began with paintings encouraging people of letters to engage in academic endeavors or wishing for their success. These paintings not only represent symbolic well-wishing but also contain shamanistic hope for secular success (Lee, 2015a, 2015b; Yoon, 2012). Chaekgeori paintings are characterized by explorative elements of diverse forms and content and modern-looking formative elements in terms of constructive aesthetics and geometrical structures (Lee, 2017). Their formative characteristics set them apart from other traditional paintings from the Joseon period (Im, 2008). These characteristics allow for an expectation that Chaekgeori paintings offer a broad range of possibilities for contemporary reimagination.

Previous studies mostly focused on the formative characteristics of Chaekgeori paintings and their methods of expression (Cho, 2000; Ha, 2018; Han, 1999; Jeong, 2001; Jo, 2008; Kim, 2005; Lee, 2003, 2007, 2010; Pak, 2019; Sin, 2010) while others explored illustrations, ceramics, and costumes utilizing the formative characteristics of Chaekgeori (Kim, 2000, 2015; Kim & Kim, 2014; Lee, 2013; Song, 2008; Wi, 2016). Studies specifically discussing the development of textile pattern designs inspired by Chaekgeori include a study focusing on the formative aesthetics of archetypical Chaekgeori compositions (Lee, 2017) and a study on sock design incorporating reimagined patterns from Chaekgeori icons (Kim, 2012). An example of textile pattern design development relying on the tessellation techniques of M. C. Escher (Maurits Cornelis Escher, 1898–1972) is Son (2005). Son developed modern and practical textile pattern designs based on the Sipjangsaeng (ten symbols of longevity) icons. In particular, research related to the development of modern textile pattern design using Escher's tessellation technique based on the formative characteristics and symbolic meaning of Chaekgeori icons is very insufficient.

Therefore, in order to raise awareness of the unique aesthetics and excellence of the Chaekgeori tradition and explore the possibility of utilizing the traditional cultural archetype in the contemporary context, this study investigates the formative characteristics and symbolic meaning of Chaekgeori icons and design textile patterns with Escher's tessellation technique. This study applies the developed textile patterns to fashion items preferred by the MZ generation (hooded T-shirts, sneakers, and shoulder bags) and presents the results of the design mapping to prove that the textile patterns incorporating the unique and outstanding values of the traditional icons can appeal to the MZ generation.

Literature review

The concept & formative characteristics of Chaekgeori

Chaekgeori (冊巨里) is a Korean term for a painting of books and traditional writing instruments (paper, brush, inkstone, and ink). It is also referred to as chaektak-munbangdo (冊卓文房圖), gimyeonghwa (器皿畵), giyongdo (器用圖), munbangdo (文房圖), chaekgado (冊架圖), and munbangsaudo (文房四友圖) (Yoon, 2012). In 'Chaekgeori,' 'geori (巨里)' can be translated into 'things,' as in things to work on, things to talk about, and things to drink. As such, 'Chaekgeori' means a painting of

Fig. 1 Chaekgeori folding screen. Note. This figure used 'Chaekgeori', which was written by the "National museum of Korea" and opened as the first type of KOGL, and the fugure can be downloaded for free from the 'National museum of Korea, https://www.museum.go.kr'. [Soure: National Museum of Korea collection (2021)]

| a | b | c | d |

Fig. 2 Chaekgeori type. Note. **a** Bookshelf type, **b** Arragement type, **c** Table type, **d** Compact type [Source: National Museum of Korea collection (2021)] This figure (a, b, c, d) used 'Chaekgeori', which was written by the "National museum of Korea" and opened as the first tupe of KOGL, and the figure can be downloaded for free from the 'National museum of Korea, https://www.museum.go.kr'

books (chaek) and other objects (器物) related to them (Jeong, 2016 and 2020). This is exemplified by the Chaekgeori byeongpung (folding screen) in Fig. 1. Early Chaekgeori paintings were mainly used by royalty and nobility as a motivation for academic endeavors and decorations for their studies. However, over time, the genre became popularized among commoners, which led to the birth of folk painting-style Chaekgeori (Kim, 2012; Lee, 2003).

Chaekgeori can be understood in terms of their types, formal structures, colors, and symbolic meanings. As shown in Fig. 2, Jeong (2020) identified four types of Chaekgeori: the bookshelf type, the arrangement type, the table type, and the compact type. Bookshelf-type Chaekgeori were primarily created at the royal palace. They typically depict bookshelves filled with books and do not feature any other objects. They aptly represent dedication to academic endeavors (Fig. 2a). Arrangement-type Chaekgeori depict books and other objects freely arranged in diverse formations (Fig. 2b). Table-type Chaekgeori show books, vases, and other everyday items placed or stacked on tables or desks. They express the formative aesthetics of books and other room decorations arranged on tables or desks (Fig. 2c). Compact-type Chaekgeori, which mostly consist of folk paintings, are characterized by smaller canvas sizes. As such, these paintings demonstrate unique formative aesthetics by compactly arranging the featured objects for better use of the canvas space (Fig. 2d).

The formal structures of Chaekgeori include the following: multiperspective structures, inverse perspective structures, isometric perspective structures, flat structures, complex structures, and repetitive structures. As shown in Fig. 3, in a multiperspective painting, the perspective shifts and moves freely (Fig. 3a), reminiscent of cubist paintings in Western modern art. The painting shifts its perspective to show all sides of the objects (Song, 2008). Inverse perspective paintings depict objects far away
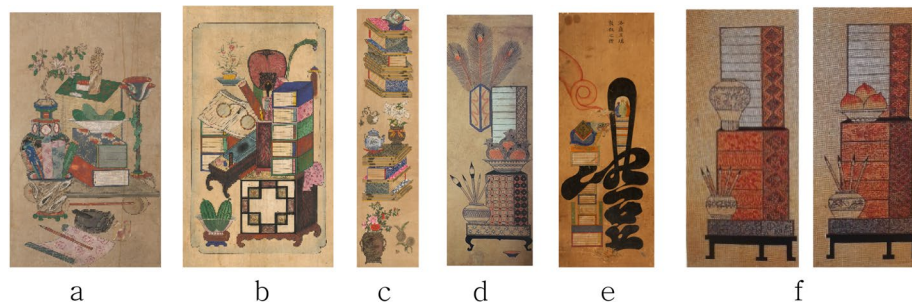
Fig. 3 The formal structure of Chaekgeori. Note. **a** Multiperspective structure, **b** Inverse perspective structure, **c** Isometric perspective structure, **d** Flat structure, **e** Complex structure, **f** Repetitive structure [Source: National museum of Korea collection (2021) (a,b,c); Lee (2015b). The folk painting of Korea 2. koreanology archives (d,f); National Folk Museum of Korea collection (2021)(e)]. This figure (a,b,c) used 'Chaekgeori', which was written by the "National museum of Korea" and opened as the first type of KOGL, and the figure can be downloaded for free the 'National museum of Korea, https://www.museum.go.kr'. This figure (d,f) was included in Lee (2015b)'s book, and permission was obtained from the author (Lee). This figure(e) used 'Chaekgeori', which was written by the "National Folk Museum of Korea" and opened as the first type of KOGL, and the figure can be downloaded for free from the 'National Folk Museum of Korea, https://www.nfm.go.kr'

as if they were up close, or vice versa (Yoon, 2009) (Fig. 3b). The isometric perspective represents how Eastern paintings address spaces. In these paintings, far away objects retain their sizes or even become larger (Kim, 2012) (Fig. 3c). Flat structures are widely used in Chaekgeori (Fig. 3d). The icons on the canvas are depicted on a flat surface without any sense of space between objects (Yoon, 2009). Complex structures combine two or more forms (Fig. 3e). They surrealistically depict concrete objects by deploying the painter's imagination using combinations of multiple forms (Yoon, 2009). Repetitive structures attract attention by providing paintings with repetitive rhythms (Fig. 3f) repeating the same or similar patterns. This form represents simple and abstract truths such as birth, purification, and being one in body and spirit (Jeong, 2001). This form is also related to shamanistic rituals where the same actions are repeated for psychological satisfaction or expression of will to achieve something (Song, 2008). As discussed above, Chaekgeori show unique formal structures that distinguish them from other traditional paintings from the Joseon period.

As for colors, Chaekgeori feature the same colors primarily used in other Joseon folk paintings that implied connected symbolism and shamanism called obangjeongsaek (五方正色: blue (靑), red (赤), yellow (黃), white (白), and black (黑)) and obanggansaek (五方間色: blue (碧), green (綠), red (紅), purple (紫), and yellow (硫黃)). Chaekgeori painters used these obangsaek (五方色: obangjeongsaek and obanggansaek) schemes in harmonious ways to achieve decorative effects and unique color esthetics (Lee, 2010). Most traditional paintings from the Joseon period were ink-and-wash paintings with limited color variations. However, Chaekgeori used contrast between highly saturated and bright prime colors and painted colors in a way that each color forms a flat, monotonous surface (Lee, 2008). The drawings of books and objects were painted with clear, lively, and diverse colors to express people's hope for happiness, longevity, and success (Jeong, 2020).

As for the practical use of Chaekgeori and the symbolic meanings of icons featured in those paintings, many Chaekgeori were placed in guestrooms (saranbang). The harmonious assortment of books, writing objects and other everyday items represent the lives of scholars and men of letters (seonbi) committed to academic endeavors (Yoon, 2012). The Chaekgeori found in women's rooms are different from saranbang paintings; they were mostly painted on shorter and narrower folding screen panels and depict fully ripe fruit and flowers (Kim, 2000). Chaekgeori were also placed in children's rooms. These paintings feature subject matters tailored to children and imply the family's hope for the children's future (Yoon, 2012). As such, Chaekgeori were not solely created and enjoyed by men; they were pragmatic paintings that serve decorative and shamanistic purposes for people of all genders and ages. Chaekgeori demonstrate shamanistic symbolism associated with various objects (books and everyday items), which represent the people's shamanistic hope for success along with the practicality of decorations for sites of daily activities (Cho, 2000). In the nineteenth century, as the demand for books dwindled and increasingly more everyday objects with symbolism for fertility, longevity, and good fortune were created, the focus of the symbolism found in Chaekgeori shifted from academic aspirations to secular well-wishing (Lee, 2007).

Thus, Chaekgeori embody people's shamanistic longing for secular happiness (Yoon, 2012). Some celebrate the frugality and good deeds of scholars while others represent hope for personal happiness, prosperity, harmony, or shamanistic beliefs in times of crisis (Lee, 2003; Yang et al., 2010.

As shown in Table 1, this study classified the icons found in Chaekgeori into animals, plants, and objects and identified their symbolic meanings. In accordance with previous studies such as Han (1999), Lee (2007), Song (2008), Kim (2011), Kim (2012), and Kim (2015), this study identified four themes found in Chaekgeori and the icons representing each. The first theme is academic achievement (學問 祈願), which includes academic growth and promotion. The icons associated with this symbolic meaning included the following: carps, peacock feathers, dragons, brushes, hollyhocks, peonies, and books. The second theme is health (健康 祈願). The icons symbolizing healthy and long life included the following: turtles, coral, grapes, girin, rabbits, and cranes. The third theme is protection (辟邪 祈願). The icons symbolizing protection against evil spirits include the following: peaches and peach blossoms, cauldrons, incense burners, fans, tigers, and bats. The fourth theme is wealth (富 祈願), or prosperous life, which is symbolized by various icons including the following: peonies, lotus flowers, vases with peony flowers, plantain flowers, and knots. Table 2 lists the icons across the four themes identified in this study.

M. C. Escher's tessellation technique

M. C. Escher was interested in the symmetrical patterns created by the Moor, in which similar geometric patterns are repetitively arranged on floors and tile walls to tightly fill the spaces. Escher called these patterns 'tessellations.' Tessellation means fully covering a space using certain shapes of tiles by dividing planes according to certain rules (Kim, 2008). Escher commented about the regular division of a plane as follows: "A plane assumed to be limitless in all directions can be covered or divided

Table 1 Symbolic meanings of Chaekgeori icons

Chaekgeori icon		Symbolic meaning	Chaekgeori icon	Symbolic meaning
Animals	Turtle	Longevity, protection, power, and endurance	Tiger	Mountain worship, mountain spirit, and protection
	Peacock (Peacock feather)	Best office positions and status	Deer	High officials, longevity, dignity, brotherliness, perennial youth and long life, and majesty
	Butterfly	Happiness, harmony, conjugal harmony, and longevity	Chicken	Wealth, government position, pass the state examination, and protection
	Goldfish	Wealth and honor	Dove	Conjugal harmony and longevity
	Crane	Longevity, happiness, and richness	Rabbit	Longevity and good signs
	Dragon	Life, wealth, richness, and good signs	Phoenix	Wealth and honor, conjugal harmony, sun, and richness
	Carp	Success	Cicada	Immortality and reincarnation
Plants	Chrysanthemum	Elegance, longevity, and happiness	Peony	Wealth, peace, honor, and prosperity
	Pear	Longevity, righteousness, and solidarity	Ganoderma lucidum	Longevity and lucky signs
	Bamboo	Filial piety, immortality, and fecundity	Plum blossom	Spirit, ethos, longevity, and hope
	Hollyhock	Promotion	Pine tree	Longevity and fidelity
	Lotus, lotus leaf	Noble man, richness, fecundity, and creativity	Plantain	Wealth
	Mandarin orange	Wishes for prosperity	Pomegranate	Longevity and fecundity
	Peach blossom	Protection and beautiful woman	Grape	Longevity and fecundity
	Peach	Protection, longevity, fecundity, marriage, and immortality	Nectarine	Longevity, immortality, and fecundity
Object	Roll of paper	Government position	Inkstone	Academic achievement
	Brush	Study, government position, and pass the state examination	Book	Pass the state examination and government position
	Cauldrons	Protection and protection of the people	Coral	Longevity and promotion
	Floor lantern	Academic achievement	Viewing stone	Nature worship and longevity
	Incense burner	Protection	Fan	Protection
	Vase of peony blossom	Wealth and honor	Go and Books	Study

by similar geometric shapes placed next to one another without gaps, and these can continue indefinitely as long as there exist certain rules" (H. S. M. Coxeter, 1980; as cited in Kim, 2008, p. 5). He went further to define key principles of pattern design using tess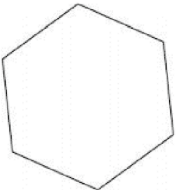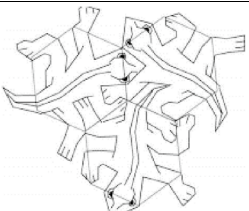ellation motives: translation, axis, and glide reflection (Escher & Vermeulen, 2004). The translation means moving a motive by a certain distance in the left, right, up, or down direction, in accordance with a set of rules. The direction of the motive itself does not change after movement. The axis method can be understood

Table 2 Classification of the themes according to symbolic meaning of Chaekgeori icons

Theme	Symbolic meaning	Icon
Academic achievement wishes	Academic improvement and promotion	Peacock feather, book, brush, hollyhock, deer, chicken, dragon, carp, roll of paper, inkstone, floor lantern, go and books, peacock vase, etc
Health wishes	Good health and long life	Coral, grape, rabbit, crane, cicada, dove, butterfly, chrysanthemum, Ganoderma lucidum, bamboo, plum blossom, pear, pomegranate, nectarine, viewing stone, etc
Protection wishes	Protection against evil spirits	Turtle, fan, tiger, pine tree, peach, peach blossom, cauldrons, incense burner, etc
Wealth wishes	Rich (wealthy) life	Lotus, lotus leaf, goldfish, phoenix, peony, peony blossom vase, plantain, mandarin orange, etc

Table 3 Arrangement methods to patterns

Arrangement methods to form patterns		
Translation		Moving a motive by a certain distance in the left, right, up, or down direction, in accordance with a set of rules
Axis		Moving a motive by a certain angle around the axis
Glide reflection		A motive is translated that is reflected after the parallel direction based on the axis of reflection or reflected before being translated in the parallel direction

Table 4 Escher's tessellation of the patterns

Primary shape	Arrange motive	Tessellation of the patterns

Note. Source: You (2009). p.11.; author reconstitution

as rotation. It moves a motive by a certain angle around the axis. It allows for more diverse image pattern development than direct movement in various directions. In glide reflection, a motive is translated that is reflected after the parallel direction based on the axis of reflection or reflected before being translated in the parallel direction (Shim, 2010). Table 3 summarizes the three principles of tessellation.

As shown in Table 4, You (2009) explained Escher's tessellation technique as combinations of unit elements comprising geometric shapes. Escher's method uses

primary shapes (triangles, squares, rectangles, diamonds, trapezoids, and hexagons) to divide planes according to certain rules to arrange motives and covers spaces with diverse motives for the tessellation of the patterns (You, 2009).

MZ generation

The MZ generation refers to the millennial generation born between the early 1980s and the early 2000s and the Z generation born between the mid-1990s and the early 2000s (Hankyung Dictionary of Terms, 2021). The MZ generation is characterized by their familiarity with the digital environment, primary reliance on mobile services, adaptability to change, and pursuit of new and unique experiences rather than the latest trends and other people (Dictionary of Current Issues, 2021). The MZ generation has a stronger sense of 'me' than 'us,' invests time and money in what they like, and puts value on satisfying themselves (Kim & Chung, 2021). In other words, the MZ generation pursues personal happiness rather than that of the group and practices value-driven consumption where they express their beliefs and values by purchasing products carrying social values or special messages (Dictionary of Current Issues, 2021).

According to Statistics Korea, as of 2019, the MZ generation accounted for approximately 34% of the Korean population at approximately 170 million people. The MZ generation is a consumer group that exerts a great influence on the distribution market through social media services. Many businesses view the MZ generation as one of the key target groups (Dictionary of Current Issues, 2021; Kim, 2020). This study focused on the MZ generation because its members are economically active, use consumption as a means to express their values and preferences, and exert great influence as a consumer group.

Methods

This study reviews previous studies to theoretically consider the concept of Chaekgeori, the formative characteristics and symbolic meaning of Chaekgeori icons, Escher's tessellation technique, and the MZ generation. Based on the results, empirical research is conducted. Then, this study empirically analyzes the findings. To that end, 115 folding screens (649 panels) were selected to identify the formative characteristics and symbolic meaning of the Chaekgeori featured in the folding screens. The folding screens analyzed in this study include the following: 8 folding screens owned by the National Museum of Korea (2021) (66 panels), two Chaekgeori folding screens included in the Gahoe Museum (2015) (71 panels), two Chaekgeori folding screens included in the Busan Museum (2008) (16 panels), eleven Chaekgeori folding screens in 「Paintings in Joseon Royal Palaces」 by Park et al. (2019) (80 panels), 41 folding screens featured in 「Chaekgeori: Joseon's Still Life Paintings That Embrace the World」 written by Jeong (2020) (182 panels), three Chaekgeori folding screens featured in 「Tales of Korean folk painting, Minhwa」 written by Yoon (2012) (8 panels), eight Chaekgeori folding screens featured in 「The folk paintings of Korea 2」 written by Lee (2015b) (45 panels), a Chaekgeori folding screen featured in 「Into the World of Korean Folk Paintings」 written by Kim (2007) (8 panels), and 24 Chaekgeori folding screens featured in 「Chaesaekhwa polychrome painting of Korea」 written by Jeong (2017). The selected

paintings were grouped across four themes (academic achievement wishes, health wishes, protection wishes, and wealth wishes). Then, the motives were reconstructed by applying geometrical figures (squares, triangles, hexagons, rectangles, and parallelograms) to create repeated units and then applying the colors extracted from traditional archetypes. The tessellation technique was used to use geometric shapes and their angles, symmetry, shifts, and integration in interesting ways to create textile patterns with diverse visual effects (Jang & Hyun, 2016). Last, the findings of in-depth interviews with MZ generation people living in Jeju conducted to identify the fashion items preferred by the MZ generation and their preference for the textile pattern designs developed herein were presented. Based on the findings, the textile patterns were mapped onto hooded T-shirts, sneakers, and shoulder bags to verify the contemporary relevance of textile pattern designs that contain the uniqueness and value of the traditional culture. This study used Adobe CS5 (Photoshop and Illustrator) for textile pattern design and design mapping. All colors were extracted from the Chaekgeori icons used in this study, and each color is represented by its CMYK numbers.

Results and discussion

Development of textile pattern design using M. C. Escher's tessellation technique using Chaekgeori icons
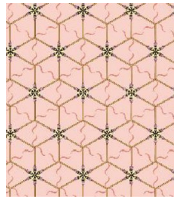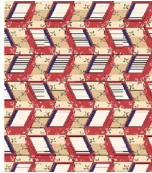
This study developed textile pattern designs using the formative characteristics and symbolic meanings of Chaekgeori icons. To that end, Chaekgeori icons with clearly defined shapes and colors were selected across the four themes identified above (academic achievement wishes, health wishes, protection wishes, and wealth wishes) and were stylized into motives. In this study, stylized iconographic motives were applied to geometric shapes to create repeating units. Then, colors extracted from the archetypes were applied to the repeating units to create repeats. Then, Escher's tessellation techniques (translation, axis, and glid reflection) were applied to these repeats to develop twelve contemporarily reimagined textile patterns. The textile patterns were developed in three stages: be drawn motive, repetition, and textile pattern development.

Table 5 shows the development process of textile patterns inspired by the formative characteristics and symbolic meanings of icons (peacock feathers, brushes, hollyhocks, and books) related to the theme of academic achievement (academic growth and promotion, etc.).

Design 5–1 consists of basic repetitive units in which the stylized icon motives were placed in a repeated arrangement in square shapes, derived from the basis of the peacock feather from icon the Chaekgeori archetypes and its symbolic meaning of higher academic attainment and government official positions. Then, the repeated units form arrangements of following colors: yellow (C9·M15·Y71·K0 and C34·M58·Y80·K24), red (C14·M67·Y65·K0), blue (C86·M76·Y39·K2 and C54·M31·Y6·K0) and black. The textile patterns were developed by parallel displacement to all sides, which belongs to Escher's tessellation techniques.

Design 5–2 is a motive stylized based on the brush and hollyhock icons from the Chaekgeori archetypes and its symbolic meaning of academic success and promotion. The stylized motives were applied to hexagon shapes to create repetitive units. Then, the repeated units were reorganized by matching of the following colors derived from

Table 5 Textile pattern design using academic achievement icons
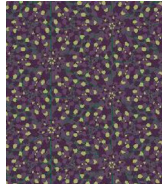
Archetype	Motive arrangement	Colors	Patterns by tessellation
Design 5-1		C9 M15 Y71 K0 C34 M58 Y80 K24 C14 M67 Y65 K0 C54 M31 Y6 K0 C86 M76 Y39 K2 BLACK	Translation
Design 5-2		C4 M8 Y43 K0 C25 M25 Y40 K0 C25 M40 Y65 K0 C50 M74 Y86 K14 C2 M25 Y17 K0 C4 M58 Y47 K0 C9 M35 Y0 K0 C34 M67 Y14 K0 C52 M22 Y58 K0 C100 M100 Y35 K25 BLACK	Axis
Design 5-3		C0 M7 Y11 K0 C2 M14 Y26 K0 C15 M28 Y44 K0 C12 M90 Y15 K0 C28 M87 Y70 K0 C84 M45 Y100 K7 C96 M93 Y33 K1 BLACK WHITE	Glide reflection

Note. This figure(archetype 5-1,5-2,5-3) used 'Charkgeori', which was written by the "National museum of Korea" and opened as the first type of KOGL, and the figure can be downloaded for free from the 'National museum of Korea, https://www.museum.go.kr'. [Source: National Museum of Korea collection (2021)]

the cultural archetypes to create repeats: yellow (C4·M8·Y43·K0, C25·M25·Y40·K0, C50·M74·Y86·K14, and C25·M40·Y65·K0), red (C2M25Y17K0, C4·M58·Y47·K0, C34·M67·Y14·K0, and C9·M35·Y0·K0), blue colors (C100·M100·Y35·K25 and C52·M22·Y58·K0), and black. Then, textile patterns were developed by making the repeats revolve around the six-part rotation axis.

Design 5–3 is a motives stylized based on the book icon from the Chaekgeori archetypes and its symbolic meaning of higher academic attainment and government official positions. The icon motives created repeated units through the insertion into parallelograms. The repeated units form the color repeats colored with yellow (C0·M7·Y11·K0,

Table 6 Textile pattern design using health icons

Archetype	Motive arrangement	Colors	Patterns by tessellation
design 6-1		C6 M32 Y24 K0 / C14 M67 Y65 K0 / BLACK / WHITE	Translation
design 6-2		C76 M90 Y55 K27 / C70 M78 Y49 K9 / C44 M22 Y71 K0 / C90 M30 Y90 K35 / BLACK	Axis
design 6-3		C52 M7 Y98 K0 / C87 M50 Y67 K8 / C55 M29 Y10 K0 / C94 M77 Y33 K1 / BLACK	Glide reflection

Note. This figure(aechetype 6-1,6-2) used 'Chaekgeori(책 거리)', which was written by the "National museum of Korea" and opened as the first type of KOGL, and the figure can be downloaded for free from the 'National museum of Korea, https://www.museum.go.kr'. This figure(archetype 6-3) is in the collection of the Gahoe Museum and a license was obtained from the museum to use it. [Soure: National Museum of Korea collection(2021)(archetype 6-1,6-2); Gahoe Museum collection(2022)(archetype 6-3)]

C2·M14·Y26·K0, and C15·M28·Y44·K0), red (C12·M90·Y15·K0 and C28·M87·Y70·K0), blue (C84·M45·Y100·K7 and C96·M93·Y33·K1), black, and white. Then, textile patterns were developed by displacing the repeats in parallel with the method of glide reflection and moving them in reflection.
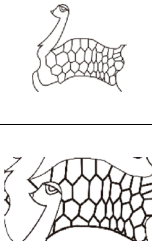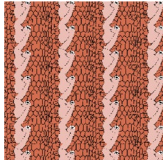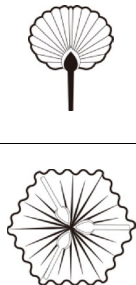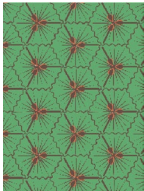
Table 6 shows the development process of textile patterns inspired by the formative characteristics and symbolic meanings of icons (coral, grapes, and bamboo trees) related to the theme of health (longevity and good health).

Design 6–1 consists of basic repetitive units in which the stylized icon motives are placed in repeated arrangement of rectangle shapes, with the basis of the coral

icon derived from the Chaekgeori archetypes and its symbolic meaning of longevity. Then, the repeated units consist of color repeats resulted from following colors: red (C6·M32·Y24·K0 and C14·M67·Y65·K0), black and white. Escher's translation method was applied to the repeats to create textile patterns by moving the motives up, down, left, and right.

Design 6–2 is a motives stylized based on the grape icon from the Chaekgeori archetypes and its symbolic meaning of longevity. The repeats were made by inserting the stylized motives into triangle shapes to create repeated units. The color repeats form the repeated unit of coloration with red (C76·M90·Y55·K27 and C70·M78·Y49·K9), blue

Table 7 Textile pattern design using protection icons

Archetype		Motive arrangement	Colors	Patterns by tessellation
Design 7-1			C6 M32 Y23 K0 / C14 M67 Y65 K0 / BLACK / WHITE	Translation
Design 7-2			C7 M66 Y65 K0 / C63 M68 Y69 K20 / C64 M17 Y68 K0 / WHITE	Axis
Design 7-3			C38 M49 Y54 K0 / C61 M66 Y74 K18 / C76 M43 Y58 K1 / BLACK	Glide reflection

Note. This figure(archetype 7-1) was included in Lee(2015b)'s book, and permission was obtained from the author. This figure(archetype 7-2) used 'Chaekgeori', which was written by the "National museum of Korea" and opened as the first type KOGL, and the figure can be downloaded for free from the 'National museum of Korea, https://www.museum.go.kr'. This figure(archetype 7-3) is in the collection of the Gahoe Museum and a license was obtained from the museum to use it. [Source: Lee, Y. S.(2015). The folk paintings of Korea 2. Koreanology archives(archetype 7-1); National Museum of Korea collection(2021)(archetype 7-2); Gahoe Museum collection(2022)(archetype 7-3)]

(C44·M22·Y71·K0 and C90·M30·Y90·K35), and black. Then, textile patterns were developed by applying the method of the axis of rotation to the repeats and making them revolve around the six-part rotation axis and the three-part rotation axis.

Design 6–3 is a motives stylized based on the bamboo icon from the Chaekgeori archetypes and its symbolic meaning of eternal life and immortality. The color repeats are created through the insertion of parallelograms and the repetitive arrangement of repeated units which are colored with following colors: blue (C52·M7·Y98·K0, C87·M50·Y67·K8, C55·M29·Y10·K0, and C94·M77·Y33·K1) and black. The textile patterns were developed by application of the method of parallel displacement to the repeats and their reflective translation.

Table 7 shows the development process of textile patterns inspired by the formative characteristics and symbolic meanings of icons (turtles, fans, and pine trees) related to the theme of warding off evil (protection from evil spirits).

Design 7–1 is a motive stylized based on the turtle icon from the Chaekgeori archetypes and its symbolic meaning of protection. The color repeats are made by application of stylized motives to rectangles and the coloration on repeated units of following colors: red (C14·M67·Y65·K0 and C6·M32·Y23·K0), white, and black. The textile patterns were developed by applying the method of parallel displacement to the repeats and moving them in four directions.

Design 7–2 consists of basic repetitive units in which the stylized icon motives were placed in a repetitive arrangement in triangles, with the basis of the fan icon derived from the Chaekgeori archetypes and its symbolic meaning of protection from evil spirits and illness. Then, the repeated units create color repeats with the coloration of following colors: Yellow (C7·M66·Y65·K0 and C63·M68·Y69·K20), blue (C64·M17·Y68·K0), and white. Then, textile patterns were developed by making the repeats revolve around the six-part rotation axis and then the three-part rotation axis.
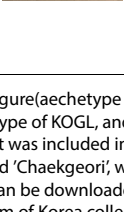
Design 7–3 is a motive stylized based on the pine tree icon from the Chaekgeori archetypes and its symbolic meaning of protection from misfortune. The icon motives were arranged to parallelogram shapes to create repeating units. Then, the repeating units arrange the color to create repeats: yellow (C38·M49·Y54·K0 and C61·M66·Y74·K18), blue (C76·M43·Y58·K1), and black. Then, textile patterns were developed by applying to the repeats and translating and then reflecting them.

Table 8 shows the development process of textile patterns inspired by the formative characteristics and symbolic meanings of icons (peony blossom vase, lotus flower, and plantain) related to the theme of wealth (abundance).

Design 8–1 is a motive stylized based on the peony blossom vase icon from the Chaekgeori archetypes and its symbolic meaning of wealth and prosperity. The stylized motives form repeated units which are arranged with the application of the motifs to rectangles. Then, the repeated created color repeats with following colors: red (C10·M18·Y16·K0 and C51·M63·Y63·K4), black and white. The textile patterns were developed by moving the motifs in four directions with the application of the parallel displacement.

Design 8–2 is a motif with its style based on the lotus flower icon derived from the Chaekgeori archetypes and its symbolic meaning of abundance. The stylized motives were applied to triangles to create repeated units. Then, the repeated units were painted with the following colors derived from the cultural archetypes to create repeats:

Table 8 Textile pattern design using wealth icons

Archetype	Motive arrangement	Colors	Patterns by tessellation
Design 8-1		C10 M18 Y16 K0 C51 M63 Y63 K4 BLACK WHITE	Translation
Design 8-2		C8 M22 Y2 K0 C22 M96 Y25 K0 C48 M18 Y44 K0 C63 M35 Y59 K0	Axis
Design 8-3		C85 M42 Y65 K1 C89 M65 Y28 K0 BLACK WHITE	Glide reflection

Note. This figure(aechetype 8-1) used 'Chaelgeori', which was written by the "National Folk Museum od Korea" and opened as the first type of KOGL, and the figure can be downloaded for free from the 'National Folk Museum of Korea, https://nfm.go.kr'. And it was included in Lee(2015b)'s book, and permission was obtained from the author(Lee). This figure(archetype 8-2,8-3) used 'Chaekgeori', which was written by the "National museum of Korea" and opened as the first type of KOGL, and the figure can be downloaded for free from the 'Nation museum of Korea, https://www.museum.go.kr'. [Source: National Fork Museum of Korea collection (2021) & Lee(2015b). The folk paintings of Korea 2. Koreanology archives(archetype 8-1); National Museum of Korea collection (2021)(archetype 8-2, 8-3)]

red (C8·M22·Y2·K0 and C22·M96·Y25·K0) and blue colors (C48·M18·Y44·K0 and C63·M35·Y59·K0). Then, textile patterns were developed by applying Escher's axis technique to the repeats and making them revolve around the sexpartite rotation axis and then around the tripartite rotation axis.

Design 8–3 consists of basic repetitive units in which the stylized icon motives were placed in a repeated arrangement in parallelograms with the basis of the plantain icon derived from the Chaekgeori archetypes and its symbolic meaning of protection from

misfortune. Then, the repeated units create repeats colored with following colors: blue (C85·M42·Y65·K1 and C89·M65·Y28·K0), black, and white. Then, textile patterns were developed by applying the repeats to the glide reflection technique, which belongs to Escher's tessellation techniques, and displacing the repeats in parallel and in reflection.

To verify the usability of the developed textile pattern designs in productstargeting the MZ generation, in-depth interviews were conducted with theMZ generation living in Jeju. The interviews focused on identifying the items preferred by the MZ generation and identifying their preferences for the developed textile pattern designs. The interview questions asked about the participants' gender, age, preferred items, frequently purchased items, and preference for the textile pattern designs developed herein. As for preferred and frequently purchased items, the participants were asked to choose among the following items listed as popular among the MZ generation by preceding research (Shin, 2020): sneakers, tops, and bags. Specifically, the options included sneakers, hooded T-shirts, man-to-man T-shirts, backpacks, shoulder bags, cross bags, and headwear.

Table 9 Design mapping with a textile pattern design applied

Textile pattern		Design mapping		
		Hooded t-shirt	Sneakers	Shoulder bag
Design 8-3				
Design 5-3				
Design 5-2				
Design 6-3				

The participants consisted of 17 men (34%) and 33 women (66%). Their ages ranged from 20 to 28. Twenty-one percent of the participants chose hooded T-shirts as their favorite items, followed by sneakers (19%), man-to-man T-shirts (16%), and shoulder bags (14%). A total of 22.1% of the participants reported that they frequently purchase hooded T-shirts (22.1%), followed by man-to-man T-shirts (19.75%), sneakers (16.3%), and shoulder bags (9.3%). Based on the findings, this study shortlisted the following items preferred by the MZ generation: hooded T-shorts, sneakers, and shoulder bags. As for the developed textile pattern designs, Design 8–3 was preferred by 28% of the participants, followed by Design 5–3 (18%), Design 5–2 and Design 6–3 (16%, respectively). The reasons reported for selecting a textile pattern designs included the following: it is pretty, it has fresh-looking patterns, it has unique patterns, it looks three-dimensional, it looks like it will look good on actual products, I am willing to buy clothes designed with the pattern, it fits the product, and it is not too simple and is appealing.

As shown in Table 9, the textile pattern designs preferred by the interviewees were mapped on to the fashion items chosen by them (hooded T-shirts, sneakers, and shoulder bags), thereby applying textile pattern designs inspired by the uniqueness and values of Korean traditional culture to fashion items preferred by the MZ generation.

Conclusions

In this study, a textile pattern for the MZ generation was developed using M. C. Escher's tessellation technique and the Chaekgeori icons. The following paragraphs summarize the process of this study.

First, the images representing 115 Chaekgeori folding screens (649 panels) were analyzed to identify their types (bookshelf, arrangement, table, and compact), formal structures (multiperspective, reverse perspective, isometric perspective, flat, complex, and repetitive), colors (highly saturated and bright prime colors: ojeongsaek and ogansaek), and the symbolic meanings of icons featured in the paintings (academic achievement, health, protection, and wealth). Furthermore, based on the findings on their formative characteristics and symbolic meanings, Chaekgeori icons were categorized under four themes (academic achievement wishes, health wishes, protection wishes, and wealth wishes).

Second, this study utilized M. C. Effect's tessellation technique to develop contemporary textile patterns with diverse visual effects incorporating the formative characteristics and symbolic meanings of the Chaekgeori icons. Escher's tessellation technique forms patterns for tightly filling the space by using geometric shapes (triangles, rectangles, squares, diamonds, etc.) to develop motives and move them using translation (moving in different directions according to a set of rules), axis (rotating around the axis), and glide reflection (translating around the reflection axis and then reflecting, or vice versa) techniques.

Third, textile patterns were developed using motives stylized based on the icons from the Chaekgeori archetypes and their symbolic meanings. Stylized iconographic motives were applied to geometric shapes (squares, triangles, rectangles, and parallelograms) to create repeating units. Then, colors extracted from the archetypes were applied to the repeating units to create repeats. Then, Escher's tessellation techniques (translation, axis, and glid reflection) were applied to these repeats to develop textile patterns. This

study used Adobe CS5 (Photoshop and Illustrator) for textile pattern design and design mapping. All colors were extracted from the Chaekgeori icons used in this study, and each color is represented by its CMYK numbers.

Fourth, the findings of this study can be summarized as follows. With regard to icons symbolizing academic achievement (academic improvement and promotion), this study developed motives stylized based on the following icons: peacock feathers (high government official positions), brushes and hollyhocks (academic achievement and promotion), and books (passing government official examinations and high government official positions). The icons were applied to geometric shapes (squares, hexagon, and parallelograms) to create repeating units. Then, the colors extracted from the archetypes were applied to the repeating units to create repeats, and Escher's tessellation techniques (translation, axis, and glid reflection) were applied to these repeats to develop textile patterns. Regarding icons symbolizing health (long and healthy life), this study developed motives stylized based on the following icons: coral (longevity), grapes (longevity), and bamboos (eternal life and immortality). The icons were applied to geometric shapes (rectangles, triangles and parallelograms) to create repeating units. Then, the colors extracted from the archetypes were applied to the repeating units to create repeats, and Escher's tessellation techniques (translation, axis, and glid reflection) were applied to these repeats to develop textile patterns. Regarding icons symbolizing protection (protection from evil spirits), this study developed motives stylized based on the following icons: turtles (strength and protection), fans (protection from illness and evil spirits), and pine trees (prevention of misfortune). The icons were applied to geometric shapes (rectangles, hexagons, and parallelograms) to create repeating units. Then, the colors extracted from the archetypes were applied to the repeating units to create repeats, and Escher's tessellation techniques (translation, axis, and glid reflection) were applied to these repeats to develop textile patterns. Regarding icons symbolizing wealth (abundance), this study developed motives stylized based on the following icons: peony blossom vases (prosperity and wealth), lotus flowers (abundance), and plantains (wealthiness). The icons were applied to geometric shapes (rectangles, triangles, and parallelograms) to create repeating units. Then, the colors extracted from the archetypes were applied to the repeating units to create repeats, and Escher's tessellation techniques (translation, axis, and glid reflection) were applied to these repeats to develop twelve contemporarily reimagined textile patterns. Based on the findings on the items and textile pattern designs preferred by the MZ generation, textile patterns preferred by the MZ generation were mapped onto the items preferred by the MZ generation (hooded T-shirts, sneakers, and shoulder bags) to verify the applicability of the textile pattern designs embodying the uniqueness and values of Korean traditional culture to items preferred by the MZ generation.

In conclusion, this study developed an creative and modern textile pattern designs based on the formative characteristics and symbolic meaning of the Chaekgeori icons. The developed textile patter designs were mapped and presented to fashion items for the MZ generation. Through this, an opportunity was provided to recognize the value and excellence of the Chaekgeori as a part of Korea's traditional culture to the MZ generation, and the possibility of modern utilization as a traditional cultural archetype was identified. The author plans to use the findings of this study as a basis for follow-up

studies utilizing various traditional culture archetypes aimed at exploring their possibilities for contemporary use that highlights their unique excellence.

Declarations

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