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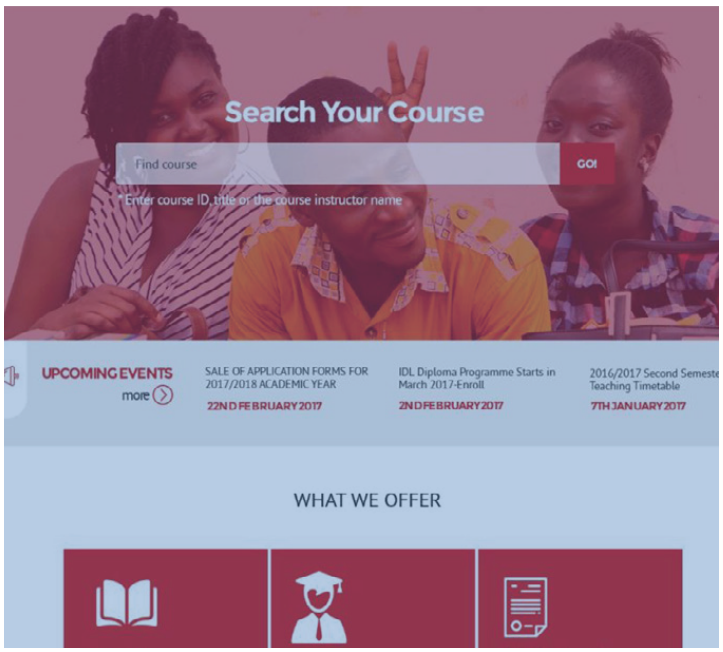

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Art inheritance: Revitalizing traditional material culture motifs through innovative graphic design and artistic expression

ABSTRACT

Orang Ulu's culture and traditions are adapting to modernization and finding new ways to thrive amidst changes that have influenced various aspects of their lives and material culture in Malaysia. This paper highlights the exciting potential for Orang Ulu's material culture to flourish through the development of motif design and presents the first Orang Ulu woven fabric in a 3D graphical view. Motif design is a beautiful way to preserve and promote the rich cultural identity of Orang Ulu through graphical expression. It also has the potential to boost the local economy by providing employment opportunities for skilled artisans. The paper highlights the importance of Orang Ulu motif design in their material culture, emphasizes the value of art as a tool for cultural expression and preservation, and outlines the development of these designs through graphic design and research. This study has adopted mixed-methods research to achieve its goal. The accomplished method for this study is categorized into three phases: research and inspiration in Orang Ulu's material culture market; 2D motif design conceptualization; and 3D artistic creation. This study recommends exploring the potential for incorporating Orang Ulu motifs in apparel products. The findings showcase the exciting potential for small and medium enterprises to preserve and promote the Orang Ulu cultural heritage and sustainability while providing economic benefits for the community.

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Introduction

The Orang Ulu community constitutes an indigenous population residing in the upriver areas of Sarawak, Malaysia. The group is recognized for their multifaceted and varied material culture, which encompasses elaborate beadwork, weaving, wood carving, and other customary handicrafts. The art and design of the Orang Ulu community are distinguished by elaborate patterns and motifs that mirror their spiritual convictions, everyday existence, and environment. The designs of Orang Ulu motifs are distinctive and possess noteworthy cultural and spiritual connotations. By developing these designs into art products, the Orang Ulu people can preserve their cultural heritage and traditions and pass them down to future generations. Moreover, it can provide economic opportunities for the Orang Ulu people. The production and sale of these art products can create jobs and income for the community, particularly for women and young people, who are often marginalized. Orang Ulu's art and design are aesthetically pleasing and can attract tourists to the region. This can create opportunities for the Orang Ulu people to showcase their cultural heritage, promote their art products, and generate income from tourism-related activities. Suhaimy & Abdullah (2019) stated that developing Orang Ulu motif designs into art products can also create opportunities for cultural exchange and dialogue between the Orang

Ulu people and people from other cultures. This can promote greater understanding and appreciation of the Orang Ulu culture and foster greater cross-cultural collaboration and cooperation, such as using Orang Ulu motifs in *songket* weaving.

According to Sahari, Durin & Sangin (2016), the Orang Ulu community comprising Kayan, Kenyah, Badeng, Bhukat, and Penan in the Sungai Asap Resettlement Scheme of Belaga, Sarawak, is experiencing alterations in the physical landscape due to development initiatives in the area. The aforementioned factors exert an impact on conventional craft-making endeavors and have appeared as the primary obstacles for Orang Ulu artisans in preserving their customs and legacies. The support of traditional handicrafts can be achieved through three distinct strategies: conventional product reproduction using alternative raw materials, innovation of traditional products, and the involvement of youth in craft-making. It is thus hoped that this study will help designers and scholars better understand the role art plays in building cultural material, with a focus on the Orang Ulu's art and motif design, which they can then apply to their products.

Furthermore, this project facilitates the expression of varied perspectives through innovative means while promoting an artistic discourse that is enhanced by a multitude of viewpoints, including the viability of traditional crafts in the production of Orang Ulu handmade products. Orang Ulu culture and traditions are at risk of disappearing and are affected by modernization, which has influenced various aspects of their lives and material culture (Sahari et al., 2018). Hence, the exploration of the design and art created by the Orang Ulu community as cultural adornment design should be further highlighted to the public; therefore, the unique art produced by Orang Ulu's society may be known and promoted in the national and international market (Suhaimy & Abdullah, 2019). Moreover, Sahari & Hasan (2016) stated that there is no documented Orang Ulu material culture database to adequately cater to tourism and educational purposes. Indeed, there is limited information on Orang Ulu material culture for scholars and curators to study, making it difficult to understand this ethnic culture and product design. Additionally, the production of Orang Ulu cultural objects shows that there have not been many changes in the design and artistic look development in the last decades. On the other hand, new designs and products with mixed motifs inspired by Orang Ulu culture have been accepted into the market (Sahari & Hasan, 2016).

According to Ball (2009), the beliefs that nowadays new generation is not able to use unique motifs due to having some symbolism and spiritualism concepts in the patterns are not entirely true. Omar, Lepun & Alan (2016) found that the gap between generations' styles has resulted in the decline of the development of unique Orang Ulu motif designs. Indeed, there has not been much development in Orang Ulu cultural motif designs, and some Western motifs and simple patterns were mixed with their patterns to meet market demand (Ball, 2009). The present endeavor amalgamates erudition and ingenuity to examine material culture through the lens of art and graphic design to stimulate scholars to scrutinize and artistically represent material culture.

In this paper, the researcher will investigate how the elements of Orang Ulu motifs can be adapted into new productions and developed. The community's involvement in documenting and organizing this material culture is essential to instilling a creative way of thinking that can be extended across generations. Hence, this paper attempts to move beyond merely an introspective activity and aims to create an awareness of art's role in developing adornment design as a part of cultural material that can be applied to the products. Hence, this paper aims to investigate and classify the Orang Ulu motifs in adornment design through art and develop a motif design that reflects the changing status of Orang Ulu handicrafts as an indicator of transformations in society. Thus, it furnishes the means to participate in a creative pursuit and articulate oneself through artistic discourse regarding a particular matter.

Eisner (2008) states that the utilization of art in research is a clever approach that can be likened to a profound dialogue. This method facilitates the emergence of numerous perspectives instead of seeking a solitary solution to a given problem. In contrast to scientific investigation, the realm of art provides researchers with the opportunity to adopt a personal stance on matters and respond in a subjective manner that is comprehensible to themselves and conceivable to others. This study facilitates the emergence of varied perspectives in innovative manners, thereby enhancing artistic discourse through numerous lenses, including the durability of handicrafts.

This research project provides an opportunity for the scholar to gain a comprehensive understanding of the historical context of Orang Ulu products, as well as the associated art and graphic design work. By examining handmade products across various periods, a more inclusive and nuanced portrayal of these items can be developed. The hands-on artistic exercises enable the researcher to engage with the subject creatively, experiment, play, and pick, thus looking for and introducing their narratives. Finally, the researcher developed a motif from critical views and acquired knowledge. The researcher gains insight into the importance of adornment design as a part of material culture, is exposed to the spatial relationships they are involved with and explores their creative abilities to present an artistic statement on a selected subject. The project offers an opportunity to stop and observe the importance of the adornment design of the Orang Ulu community as a signifier of a transforming self and society.

Literature Review

Orang Ulu Material Culture

The Orang Ulu, a group of people residing in Central Borneo, exhibited social stratification through the regulation of ornamentation, limiting the types of adornments that were permissible for individuals to utilize and don.

According to Rosli et al. (2021), the term "Orang Ulu" refers to a collection of 26 distinct ethnic groups, including but not limited to the Kenyah, Kayan, Kelabit, Kajang, Murut, Penan, Saban, Tabun, Ukit, Punan, and others.

Historically, the Orang Ulu people have been known for their hunting and gathering practices as well as their subsistence agriculture. They practiced shifting cultivation and lived in longhouses, which were communal dwellings that housed multiple families. The longhouses were often decorated with intricate carvings and designs that reflected the community's spiritual beliefs and natural surroundings. The Orang Ulu people also had a rich artistic and cultural tradition that included intricate beadwork, weaving, wood carving, and other traditional crafts. Orang Ulu's art and design were characterized by intricate patterns and motifs that reflected the community's spiritual beliefs, daily life, and natural surroundings.

Prown (1982) describes that material culture is studied through artefacts that reflect the beliefs of a particular community or society at a given time. According to Miller et al. (2005), self-knowledge and self-actualization are contingent upon our ability to examine the historical context that has been shaped by our predecessors, as reflected in the material mirror. Indeed, this world confronts us as a material culture and continues to evolve through us.

Due to the wide-ranging cultural diversity of objects, Prown (1982) suggested that the classification of things should be according to functions for cataloging purposes and the convenience of accessing information. He explained that the six classifications are art (paintings, drawings, prints, sculpture, photography), diversions (books, toys, games, meals, theatrical performances), adornment (jewelry, clothing, hairstyles, cosmetics), modifications of the landscape (architecture, agriculture), applied arts (furniture, furnishings, receptacles), and devices (machines, vehicles, musical instruments, implements, scientific instruments), of which the investigation on adornment design of Orang Ulu culture is selected for this study.

Being part of the third-largest island in the world, Borneo, Sarawak has a vast culture that has yet to be explored. Sarawak's Indigenous and unique ethnicities have made their culture colorful and exciting to explore.

Motif Design in Orang Ulu's Material Culture through Art and Graphic Expression

Motif design is a significant aspect of Orang Ulu's material culture because it reflects the community's cultural identity, values, and beliefs. Orang Ulu motif designs are characterized by intricate patterns and symbols that are rich in meaning and often draw inspiration from the natural world. The designs are commonly utilized in diverse forms of conventional art, including but not limited to beadwork, weaving, wood carving, and body embellishment. The motif designs of the Orang Ulu are emblematic of the cultural identity of the community. Cultural artefacts serve as a means of conveying a community's distinctive historical, traditional, and moral characteristics and are a significant medium for articulating and disseminating their cultural identity to external parties.

In addition, the motif designs frequently possess spiritual connotations and are purported to possess safeguarding or therapeutic capabilities. These objects are utilized in diverse rituals and ceremonies and are perceived as a means of establishing a connection with the spiritual realm. The motif designs of the Orang Ulu community possess a significant cultural heritage, characterized by a lengthy and profound historical background. The cultural artefacts have been transmitted across successive generations and are regarded as a means of safeguarding the community's historical and traditional legacy. Art plays a significant role in both expressing and safeguarding culture, as it provides a platform for individuals and communities to convey their experiences, values, and traditions through creative and meaningful mediums. The provision of art materials offers a means for both individuals and communities to creatively articulate their distinct experiences, emotions, and viewpoints potently and distinctively.

Art serves as a means for individuals to convey their cultural identity and safeguard their heritage for posterity. Art assumes a pivotal function in the conservation of cultural legacy through its documentation and commemoration of the customs, convictions, and rituals of society. Additionally, it serves as a mechanism for intergenerational communication, facilitating the transfer of knowledge, abilities, and traditions from older to younger generations. Artistic expressions such as weaving, pottery, and carving require a significant amount of time, effort, and skill and are often passed down through families or apprenticeships. Art fosters a sense of identity and pride within a community, allowing individuals to connect with their cultural heritage and feel a sense of belonging. Artistic expressions such as clothing, jewelry, and body adornment are often used to symbolize cultural identity and pride. Rosli et al. (2021) assert that motifs constitute the primary focus in the design of adornments and art within ethnic communities, serving to enhance

the aesthetic appeal of the artwork. The production of hand motif art by ethnic groups in Sarawak is characterized by meticulous, delicate, and unique craftsmanship. Hence, it is imperative to emphasize the distinctiveness of the motif art crafted by the community to enhance its comprehensibility among the general populace.

"High-ranking" motifs applied in Orang Ulu culture are the human figure, hornbill, tiger, or leopard. The Orang Ulu were bead connoisseurs who incorporated beadwork into their costumes and belongings; a person could only use beaded items according to their social stratum. Today's bead worker produces not only for their own family but also for the souvenir market, so they feel free to apply any designs that please the buyer (Munan, 1995), which has led to forgetting cultural motif design as a part of cultural heritage (Ball, 2009).

The three subgroups of Orang Ulu, namely Kayan, Kenyah, and Penan, are renowned for their exceptional craftsmanship. According to Fogel & Sellato (2013), the decorative patterns, or kalong, utilized in the handicrafts of these ethnic communities are frequently named after components derived from their local environment. The nomenclature of motifs may be attributed to various sources, such as the inventor of the motif, legendary figures, significant historical occurrences, or neighboring ethnic communities (Fogel & Sellato, 2013). Sahari (2013) posits that the traditional basketry produced by a particular group serves as a means of expressing their wealth, culture, technology, and intellectual prowess. This is achieved using intricate patterns and motifs, as well as the careful selection of materials and manufacturing techniques. The craft makers of traditional basketry are required to possess a comprehensive understanding of the art of basketry, which encompasses knowledge of raw materials, production processes, techniques, and the application of patterns and motifs (Sahari, Durin & Sangin, 2016).

Additionally, it is widely recognized that the Orang Ulu community is characterized by a prevalent decorative pattern, commonly referred to as kalong, as documented by Suhaimy & Abdullah (2019). Various forms and functions of kalongs have been developed in Kalong. Each of these kalongs holds a significant meaning within the Orang Ulu community. According to Suhaimy & Abdullah (2019), certain components serve to safeguard the proprietor of the kalong and embellish their handiwork. Hence, the assertion that contemporary generations are gradually losing touch with the significance of patterns' symbolism is not entirely accurate and warrants further inquiry. The baby carrier is one of the adornment designs of Kenyah and Kayan, as both the motifs decorating it and the small objects attached to it are not only protective devices against spiritual danger (for the child carried in it) but also indicators of social status (for the family owning and using it) (Sahari & Hasan, 2016). However, new designs have been woven in mixed motifs, which are not similar to this concept (Ball, 2009).

Another aspect of Orang Ulu adornment designs is the basketry produced in the longhouses (Munan, 1995). The hats, baskets, and mats show complex patterns, a range of colors, and the use of multiple natural materials (Munan, 1995). Many of the groups among the Orang Ulu were socially stratified, with an upper class or aristocracy, a type of commoner, and one of the enslaved people. The use of some of the Orang Ulu designs, in particular those showing human forms, was restricted to the aristocratic class, while other designs could be used by all (Ball, 2009). Therefore, Ball (2009) stated that the beliefs that nowadays new generation is not able to use unique motifs due to having some symbolism and spiritualism concepts in the patterns are not entirely true. Historically, Orang Ulu individuals have abstained from using symbols that are deemed unsuitable for their particular social class. The tiger was a popular and esteemed emblem, representing dominance, although the inhabitants of Borneo solely possess secondhand knowledge of the sovereignty of the Malayan Forest as tigers are non-existent in their locality (Leibrick, 1989).

The Orang Ulu employ the kelawit motif in their basketry weaving techniques, which is inspired by the blade design of swords utilized for clearing vegetation. The incorporation of patterns in basketry is a common practice among various individuals, particularly weavers within the community. However, the interpretation and significance of these patterns exhibit variability depending on the respondent. The proliferation of names assigned to the motifs by diverse ethnic communities, as well as variations in nomenclature from one village to another and among individuals, was identified as the root cause of this phenomenon (Ball, 2009). Numerous patterns have lost their nomenclature because of this phenomenon. Apart from that, many utility objects utilized by the Orang Ulu community do not pertain to the realm of art.

Rather, these objects were created solely to assist them in carrying out their routine activities. The basket's woven patterns incorporate minimalistic symbols that possess limited interpretive potential. According to Ball (2009), the nature of woven patterns is primarily decorative and lacks traditional spiritual or class-based connotations. Previous researchers have not yet classified the motif designs in question.

The term motif refers to any element in a design. It typically applies to a repeated element, but we'll use the term for non-repeated elements as well. It's hard to believe, but pattern design involves only three broad categories of motifs: geometric, floral, and novelty which can be narrowed down to two: abstract (geometric) and representational (encompassing both floral and novelty). But floral motifs have been

so prevalent throughout eras and cultures that they have been granted a class of their own. Some of the common categories of motif types in the art include:

- Geometrical motif: These motifs are based on geometric shapes and patterns such as squares, circles, triangles, and spirals.
- Floral or scroll motif: These motifs are based on the shapes and patterns of flowers, leaves, and other plant forms.
- Novelty or abstract motif: These motifs are based on shapes and patterns that are not representational of any specific object or image.
- Animal motifs: These motifs are based on the shapes and patterns of animals, such as birds, fish, and insects.
- Mythological and cultural motifs: These motifs are based on the myths and stories of different cultures, often featuring figures such as gods, goddesses, and heroes (Ball, 2009; Leibrick, 1989; Munan, 1995; Omar, Lepun & Alan, 2016; Sahari, 2013; Sahari & Hasan, 2016; Suhaimy & Abdullah, 2019).

When people think of geometrics, the first idea that probably comes to mind is the classics: polka dots, stripes, plaids, checks, and diamonds. Geometric patterns can be simple or complex, regimented, random, straight, curvy, or anywhere in between. Some geometric patterns and motifs have real-world associations, but those associations tend to be loose and mutable. For example, tartan plaids originated in and are still strongly associated with Scotland, but they are used so widely that the association is often lost. As such, geometrics are the most versatile and universal of prints. Florals and scroll motifs from cherry blossoms to cabbage roses to ultra-graphic blooms, floral prints and patterns are an inextricable part of nearly every design tradition—and just about every fabric collection too. Flowers are feminine, beautiful, and classic, and because of their universal appeal, it’s no wonder they get a category all to themselves. And it’s a category with more gravitational pull than geometrics; if you toss daisies over a polka-dot background, it’s considered a floral print, not a geometric print. Novelty, or "conversational," prints encompass virtually everything else that doesn’t fall into the geometric or floral categories. The theme of the motifs (trains, planets, and cities) narrows the potential audience for the fabric, but novelties tend to speak more loudly than the other two types, both visually and as an emblem of identity for the wearer or user of the fabric.

And speaking of gravitational pull, the novelty category has the strongest of all. If you throw a duckling in with those daisies and dots, you’ve got a novelty print. While several classic themes, like the old west, kitchen, nautical, zoo, and holiday motifs, will always enjoy an audience, the popularity of others can fade in and out with fashion. Motifs are a common feature in many forms of art, and they can be categorized into diverse types based on their characteristics and origins.

Methodology

Developing motif designs in Orang Ulu's material culture through graphic design and art for small and medium-sized enterprise products can be a complex process that involves several steps. The accomplished method for this study is categorized into three phases: (1) research and inspiration in Orang Ulu's material culture market; (2) design conceptualization and motif; and (3) artistic creation in Orang Ulu's material culture. This study has adopted mixed-methods research to achieve its goal. The researcher has done observations for phase one in five different places from October 1, 2022, until March 14, 2023, at the Sarawak Cultural Heritage Museum located in Kuching, Sarawak. Handicraft, located in Miri; Miri Handicraft Center, located in Miri; Mujan Handicraft Center, located in Miri; and Sungai Asap, located in Bintulu, Sarawak. For the second and third phases, the researcher used Adobe Illustrator and CLO3D software to develop and simulate the motif and fabric designs.

Findings

Research and Inspiration in Orang Ulu's Material Culture Market

The first step in developing Orang Ulu motif designs is to research the community's history, traditions, and values. The subject matter pertains to the examination of customary designs and themes employed in diverse art forms, including but not limited to weaving, beadwork, and wood carving. Orang Ulu designs frequently incorporate elements from the natural world, including flora, fauna, and topography, as sources of inspiration. During this phase, the researcher identified various motif classifications within the Orang Ulu material culture.

The Orang Ulu people employ a varied range of motifs that are indicative of their relationship with the natural world, spiritual convictions, and cultural customs. The patterns are frequently observed in the textiles, wood carvings, and beadwork of the group in question. Distinct variations can be observed between Orang Ulu motifs and Iban motifs concerning their provenance, connotations, and configurations. The motifs of the Orang Ulu are frequently emblematic of the Orang Ulu community's affiliation with nature, spiritual convictions, and cultural customs. The Orang Ulu community employs figurative motifs in their customary handicrafts and textiles to communicate diverse connotations that hold paramount importance to their cultural legacy and spiritual convictions.

Other popular motifs include the "Kenyalang", or hornbill, which is a sacred bird to the Orang Ulu people and is often depicted in their textiles and carvings. The Orang Ulu people also use a lot of soft geometric patterns in their designs, such as triangles, diamonds, and zigzags, which are believed to symbolize fertility, protection, and good luck.

On the other hand, Iban motifs are very sharp and complicated geometric shapes. These patterns are often used in their textiles and wood carvings and are believed to stand for the balance and harmony of nature. These are some observations and interviews that have been conducted with local people and sellers in the Orang Ulu material culture market.

- Dragon, tiger, and human faces are the most popular in Orang Ulu culture.
- Human figures often represent ancestors, spirits, or mythical creatures that are significant to their spiritual beliefs. The full-figure human motif was reserved for the aristocracy.
- "Higher" animals (hornbills, humans, and leopards) belong to the topmost branches.
- Middle-class families used modified half-figures, masks, and less conspicuous creatures like dogs or dragons.
- The tiger, a symbol of power, was a popular high-class design (despite Borneo having no tigers).
- The hornbill is a sacred bird to the Orang Ulu community, and it is often depicted in their motifs as a symbol of protection, good luck, and fertility.
- There is no sketch, and they memorized the motifs. It is extremely hard to make curvature motifs on baskets.
- There is no special fabric for Orang Ulu clothing. There is no difference between men and women in choosing motifs and colors in Orang Ulu culture.

The description of Orang Ulu products gathered from interviews and observational research in the five places mentioned above is written in the following Table 1.

Table 1 (part 1)

Classification of Orang Ulu's Motifs and their Properties (All photos taken by author)

Classification of Orang Ulu's Motifs and their Properties	
Classification	Geometrical
Photo	
Name	Basket with hudok pusung tubak
Description	Inspired by snake

Table 1 (part 2)

Classification of Orang Ulu's Motifs and their Properties (All photos taken by author)

Classification of Orang Ulu's Motifs and their Properties	
Classification	Geometrical
Photo	
Name	Rattan basket
Description	Inspired by snake
Classification	Geometrical and Novelty
Photo	
Name	Kenyah lepo keh hat
Description	/
Classification	Geometrical
Photo	
Name	Belanyat, carrying backets for clothing and traveling
Description	/
Classification	Novelty
Photo	
Name	Aristocratic baby carrier (ba') for high-class family
Description	Inspired by the dragon in straightforward design
Classification	Geometrical
Photo	
Name	Large orang ulu beaded basket
Description	Orang ulu people believe that it uses seldom in design and is named "Weng"

Table 1 (part 3)

Classification of Orang Ulu's Motifs and their Properties (All photos taken by author)

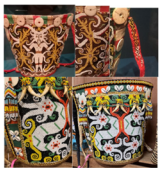
Classification of Orang Ulu's Motifs and their Properties	
Classification	Novelty
Photo	
Name	Beaded box decorated
Description	Inspired by the dragon in straightforward design
Classification	Geometrical and Novelty
Photo	
Name	Beaded orang ulu headdress worn during festive occasions
Description	/
Classification	Geometrical
Photo	
Name	Beaded box decorated
Description	/
Classification	Novelty
Photo	
Name	Baby carrier for a high-class family
Description	Inspired by the human figure and "Kenyalang" or hornbill
Classification	Geometric
Photo	
Name	Baby carrier for a middle-class family
Description	Inspired by a dragon in a plain design

Table 1 (part 4)

Classification of Orang Ulu's Motifs and their Properties (All photos taken by author)

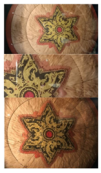
Classification of Orang Ulu's Motifs and their Properties	
Classification	Novelty
Photo	
Name	Orang ulu beaded sunhat decorated with traditional motif
Description	Inspired by a dragon in a straightforward design
Classification	Novelty combines scroll
Photo	
Name	Beaded panel for sunhat
Description	Decorated with spiritual dragons and aso' motifs (dog motifs)
Classification	Novelty
Photo	
Name	Beaded sunhat
Description	Inspired by the dragon in straightforward design
Classification	Geometric
Photo	
Name	Kayan beaded sunhat
Description	Very seldom among Orang ulu people
Classification	Geometric
Photo	
Name	Kenyah 19th century woven hat
Description	/

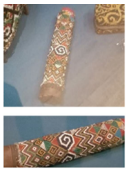
Table 1 (part 5)

Classification of Orang Ulu's Motifs and their Properties (All photos taken by author)

Classification of Orang Ulu's Motifs and their Properties	
Classification	Geometric and Novelty
Photo	
Name	Orang Ulu beadwork
Description	/
Classification	Geometric and Novelty
Photo	
Name	Seat mats of beaten bark or woven rattan attached to the loincloth
Description	/
Classification	Geometric and Novelty
Photo	
Name	Cylindrical container
Description	Inspired by a dragon
Classification	Geometric and Novelty
Photo	
Name	Beadwork panels from Kayan baby carriers with human figures and dragon head
Description	Inspired by the human figure and "Kenyalang" or hornbill
Classification	Geometric and Novelty
Photo	
Name	Beadwork panels from Mahakam Kayan baby carriers
Description	Inspired by tiger head and human (kelunan) means people

Table 1 (part 6)

Classification of Orang Ulu's Motifs and their Properties (All photos taken by author)

Classification of Orang Ulu's Motifs and their Properties	
Classification	Geometric and Novelty
Photo	
Name	Kayan man's beaded cap (above) Women's beaded headdgear panel (below)
Description	Inspired by the human figure and "Kenyalang" or hornbill
Classification	Geometrical
Photo	
Name	Beaded box decorated
Description	/
Classification	Geometric and Novelty
Photo	
Name	Beadwork panels Ramo Sengro
Description	Inspired by Tiger feet

Motif Design Conceptualization

Once the research and inspiration have been gathered, the next step is to conceptualize a design. This involves creating sketches or digital renderings of the motif, experimenting with different shapes, colors, and patterns, and refining the design until it reflects the community's cultural identity and aesthetic values. This study adopted the main character in the Orang Ulu motif design, which is a spiral and curvy shape as shown in Table 2 and inspired by a decorated baby carrier and beaded box wallet and utilized in most material culture Orang Ulu products.

Motif One: Decorative baby carriers serve as the inspiration for this element. The designer has taken the same element, and in the first combination, the element is repeated in a 60-degree rotation based on the designer's vision. One piece of this combination has been cut, as shown in Table 2. Afterwards, the cut element is copied and placed on a vertical axis, and

the process is repeated for the second combination. In this repetition, the design unit is projected in the direction of the vertical axis, and a mirror design is repeated in the vertical direction. Finally, in the third combination, a new element is rotated and repeated ("120-Degree Rotation Repeat) as shown in Table 2.

Motif Two: In the second design, this element is also inspired by decorated baby carriers. The designer has taken the same element, and in the first combination, the element is repeated in a 60-degree rotation, and based on the designer's vision, two pieces of this element are cut separately as shown in Table 2. Afterwards, the cut elements are copied and placed in a vertical axis repeat for the second combination, which is named "Four-Way Mirror Repeat". Finally, in the third combination, a new element is created with placement from both new cut motifs, as shown in Table 2. In this repetition, the design unit is projected and repeated by the vertical axis at first, and then both units are projected under the horizontal axis.

Motif Three: A beaded box wallet serves as the inspiration for the third design's element. The designer has taken the same element, and in the first combination, the element is repeated in "Horizontal Mirror Repeat," and based on the designer's vision, three pieces of the combination element are cut separately as shown in Table 2. In this type of repeating, the design unit is projected under the horizontal axis only once, and it creates a mirror image in the horizontal axis. Afterwards, the cut elements are copied and placed together. Finally, in the third combination, a new element is created with placement from all three new cut motifs and placed in a vertical axis repeat for the third combination. In this repetition, the design unit is projected in the direction of the vertical axis, and a mirror design is repeated in the vertical direction as shown in Table 2.

Artistic Creation in Orang Ulu's Material Culture

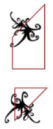
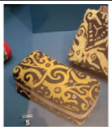
With the motif design completed, the next step is to create the artwork using the medium, such as weaving, beadwork, wood carving, or painting. For this step, the designer decided to use handloom weaving to show a piece of artwork that can present the look of *songket* fabric weaving with the developed motifs due to the lack of any specific Orang Ulu fabric. *Songket* weaving is a traditional handwoven fabric technique that is popular in Southeast Asia. The fabric is known for its intricate patterns and metallic threads, which are often made of gold or silver. The first step in the process is to design the pattern. This involves creating a detailed drawing of the pattern on paper, which will serve as a guide for the weaver. After the loom is prepared, the weaver ties the developed pattern onto the warp threads using a technique called "ikat". Ikat involves tying sections of the warp threads with string or other materials to create a resist. When the threads are dyed, the areas that are tied will resist the dye, creating the pattern. Hence, designers use the laser machine to create the paper or plastic stencil on a different scale to enhance the actual size.

After that, the designer installed the cotton threads in the traditional loom and dyed the threads based on the developed motifs.

Therefore, after removing the blocks, the patterns were placed on the loom, and designers started to weave the fabric using gold weft thread. Once the warp threads are tied to the pattern, the weaver begins weaving the fabric; however, it can be woven on a digital weaving loom. This involves passing the weft threads, which run horizontally across the loom, over and under the warp threads to create the fabric. However, the designer has not added weft threads for experimental study.

Table 2

Process of creation of the developed Orang Ulu Motif using graphic design expression

No.	Inspiration	Character/ Element	Process Development			
			First Combination	Cut-Out	Second Combination	Third Combination
1						
2						
3						

As the fabric is woven, the weaver adds metallic threads, which are often made of gold or silver. After the fabric is woven, it is removed from the loom. The process for creating the piece of artwork is shown in Figure 1. As mentioned before, in the apparel and clothing sector, there are no small and medium enterprises that have successfully incorporated Orang Ulu motif designs into their apparel products. For example, *Pua Kumbu* is a weaving cooperative in Sarawak that produces handwoven textiles featuring traditional motifs and patterns of the Iban people.

Hence, in this study, the songket weaving patterns with developed Orang Ulu motifs were established primarily, and thereafter they were simulated in a 3D version via CLO3D software. A simulated and fabricated fabric in CLO3D software with different properties is shown in Figure 2. As shown in Figure 3, the developed 3D Orang Ulu fabric was simulated based on pattern weaving. Hence, the designer developed patternmaking for each motif separately. Then, a pattern was developed from the combination of these three new motifs, and the designer created a new pattern for the woven fabric.

» **Figure 1:** *Process of Artistic Creation of Developed Orang Ulu Motif*

» **Figure 2:** *Simulated 3D Orang Ulu songket weaving fabric*

» **Figure 3:** *3D simulation of Orang Ulu fabric designs and weaving patterns*

Finally, pattern weaving was applied in ClO3D software to simulate a constructed fabric with gold threads to show how the *songket* weaving looks.

As shown in Figure 3, a fabric can be created based on the developed Orang Ulu's motifs and using *songket* weaving techniques in the Malaysian fabric and textile market. On the plus side, preserving the Orang Ulu motif by using a weaving technique to create a new pattern can be a challenging task. This is because the weaving process may alter the motif's shape, size, or orientation, leading to a loss of its identity. The best technique used to preserve motif identity is called double weaving. In this technique, two layers of fabric are woven at the same time, allowing for the creation of two separate layers of design. By carefully manipulating the warp threads and selecting the right color combinations, it is possible to create a new pattern while preserving the identity of the original motif. Hence this study will propose using the double-weave *songket* technique to create the first orang ulu fabric.

Discussion and Conclusion

The generation and dissemination of knowledge are fundamental drivers of innovation and play a crucial role in fostering the growth of regional cultural heritage. The competencies of a designer have the potential to enhance their social efficacy and aid in addressing contemporary challenges. Developing motif design in Orang Ulu's material culture through art and graphic design can help preserve the rich cultural heritage of the Orang Ulu people. Designers have the potential to act as agents of change and facilitate the growth of local craft industries by utilizing their expertise to develop novel and inventive business models.

As shown in the results, by incorporating traditional motifs and designs into products, these enterprises can ensure that these designs and patterns are passed down to future generations. Developing these products can also contribute to the local economy by creating employment opportunities for artisans and craftsmen. This can help alleviate poverty and support the economic development of the region. Moreover, through the development of small and medium enterprise products that incorporate Orang Ulu motifs and designs, these enterprises can introduce Orang Ulu culture to consumers outside of the community, especially as a fabric that can be made into a garment and spread in the community.

Moreover, by creating products that are attractive to both local and international markets, these enterprises can contribute to the development of creative industries and the promotion of local entrepreneurship. This can foster a greater understanding and appreciation of cultural diversity and contribute to the broader discourse on cultural preservation and heritage in society. Gaining entry into markets for such commodities can be difficult, especially when the business is operating in a geographically isolated location.

The restricted availability of transportation and infrastructure may impede the capacity of businesses to access broader markets and contend with alternative products. Furthermore, the process of creating and promoting these commodities may necessitate a substantial allocation of resources, including financial capital, machinery, and education. Small and medium-sized enterprises may encounter difficulties in accessing these resources, particularly when operating within a resource-constrained environment. Indeed, the idea of the designer using cultural motifs in innovative ways not only holds the potential for artistic and creative exploration but also serves as a strategic means for the Orang Ulu community to gain new rewards from their cultural heritage while maintaining control over the use of these motifs and to preserve them. Designers can produce products, art, or designs that appeal to a wider audience by reinventing these motifs, resulting in commercial benefits and cultural acclaim.

This strategy helps the Orang Ulu to recover ownership and preserve a sense of power over where and how their cultural motifs are used, thus preserving their cultural integrity. In doing so, they find a balance between preserving their legacy and adjusting to the ever-changing global creative landscape.

The integration of customary Orang Ulu patterns into the merchandise of small and medium enterprises can serve to preserve these motifs from potential extinction as younger generations increasingly distance themselves from traditional handicrafts. Furthermore, the success of these enterprises can inspire and motivate younger generations to appreciate and take part in traditional arts and crafts through graphic design, thus ensuring the continuation of Orang Ulu culture and traditions. In terms of the wider society, the development of Orang Ulu motif designs through art as small and medium enterprise products can supply a means for cultural exchange and appreciation. By incorporating these motifs into their products, small and medium enterprises can introduce Orang Ulu culture to consumers outside of the community and provide a window into the unique cultural heritage of the Orang Ulu people. This can foster a greater understanding and appreciation of cultural diversity and contribute to the broader discourse on cultural preservation and heritage in society.

This research is in line with the mission of the government to promote and conserve material cultural communities. According to the policies of creative industries, there is a shift in how art, design and culture play a significant role in the new economy in Malaysia.

In this way, the scope of cultural policy study and practice has been broadened. It is a sign of the democratization of material culture and its importance to society and the economy that there is a broader understanding of culture that includes the creative arts and preserves them.

Moreover, Sahari, Durin, and Sangin (2016) stated that the changing physical landscape due to development projects in the region has affected traditional craft-making activities and has become the main challenge for the Orang Ulu craft makers to sustain their material culture.

Thus, there are three strategies to support material culture: conventional product reproduction (using alternative raw materials), traditional product innovation, and youth participation in craft-making. Hence, the association of this study with the preservation of Orang Ulu culture is to help better understand the role art and design play in building cultural material, with a focus on Orang Ulu's art and motif design.

So, the development of motif designs in the Orang Ulu community would apply to small and medium enterprises to promote them in the market and sustain them, especially textile and fabric products. Therefore, the scarcity of knowledge about Orang Ulu material culture development is addressed by developing pattern and motif designs for small and medium enterprise products.

Moreover, this project highly recommends using either a digital or traditional weaving loom for the younger generation to enable diverse points of view in creative ways. This research shows that developing motif design in Orang Ulu's material culture through art and graphic design is significant as it can contribute to the preservation of the Orang Ulu cultural heritage, promote economic development, and foster cultural exchange.

However, it also presents challenges such as quality control, limited market access, a lack of resources, and the need for intellectual property protection. The resolution of these obstacles is imperative to guarantee the triumph and endurance of said enterprises. In general, the advancement of the Orang Ulu motif design possesses the capacity to yield a favorable influence on both the Orang Ulu populace and the broader society.

Through the provision of mechanisms for cultural preservation, economic advancement, and cultural interchange, these enterprises have the potential to safeguard the endurance and value of the Orang Ulu cultural legacy for future generations.

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A study to Chinese domestic luxury visual brand logo: From domestic to global

ABSTRACT

The present study examines the logotypes of successful Chinese domestic luxury brands (CDLBs), Shanghai Tang and Shang Xia, in order to reveal the underlying resonance between Chinese values and aesthetics. Based on signaling theory, the research underscores the importance of incorporating Chinese cultural elements into the branding strategies of CDLBs to attract Chinese consumers and distinguish themselves within the luxury fashion industry. The study employs a mixed-methods approach, comprising literature review, case analysis, and in-depth interviews, to analyze data from three distinct perspectives: contemporary trends, Chinese name selection, and the incorporation of local cultural elements in design. The findings suggest that CDLBs must strike a balance between conforming to current trends, particularly simplicity, and preserving authenticity, when selecting a Chinese name that holds cultural significance, and integrating traditional design elements in the details. This research provides practical guidance for professionals in the field and paves the way for future studies to explore related topics.

KEY WORDS
Chinese domestic luxury brands, logotype, signaling theory, Chinese culture, branding, Chinese consumers, luxury fashion industry

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Introduction

The mainland of China has emerged as a leading market for luxury goods in recent years, driven by economic growth and increased demand for such items.

According to a report by Bain & Company, while the global luxury market saw a decline of 23% in 2020 due to the COVID-19 pandemic, the Chinese market experienced a 48% increase in luxury consumption.

Furthermore, the report predicts that the Chinese luxury market will continue to expand significantly in the coming years as travel restrictions are lifted and the "Zero-Case" policy is eliminated (Lannes & Zhang, 2020).

This research specifically focuses on two Chinese domestic luxury brands, Shanghai Tang and Shang Xia, rather than the more well-known international luxury brands such as Cartier, Louis Vuitton, and Chanel.

These two brands are notable for their success as luxury brands that are "Made in China" and have been the subject of extensive research in the past decade (Heine & Phan, 2013; Schroeder, 2017; Schroeder, Borgerson & Wu, 2014; Zhiyan, Borgerson & Schroeder, 2013). However, this study goes a step further by specifically examining their brand logo design, which is a crucial element in the brand identity design (van Grinsven & Das, 2016).

A brand logo serves as a visual representation of a brand and is an important tool for differentiating a brand from its competitors. In the rapidly changing luxury market, the brand logo also serves as a cultural signifier and is the first element that consumers encounter, influencing their perception of the brand (Shi & Jiang, 2022). Furthermore, a brand logo design incorporates elements of culture, marketing, aesthetics, and design language (Bossel, Geyskens & Goukens, 2019; Zheng, Shanat & Kanyan, 2022).

Marketing values and aesthetic preferences vary across cultures, which can be explained by Hofstede's (1984; 1994) model. For instance, angularity is often linked to conflict, masculinity, and dynamism, while roundness is associated with harmony, softness, and femininity. In collectivist societies, symmetry is highly valued, while individualistic societies tend to prefer more unconventional forms of creativity.

The individuals make inferences about the quality of a product based on signals given by the seller, even if they cannot directly observe the quality of the product itself. For instance, Song & Kim (2022) expands the scope of signaling theory by examining how brand heritage affects the dining experience of restaurant customers. Therefore, based on signaling theory to examine the influence of local elements in CDLBs' logo design on Chinese consumers' reaction.

This study aims to investigate how these two Chinese domestic luxury brands express and resonate with Chinese values and aesthetics through their visual design elements, specifically their brand logo design. Previous research has primarily focused on the marketing, product design, and catwalk fashion events of these brands, with relatively little attention given to their branding and visual design elements. Both brands have utilized traditional elements in their logo design, such as the use of Chinese characters, traditional motifs, and specific reading order, to communicate their cultural heritage and identity to domestic and overseas consumers.

Given the significance of visual image design in the realm of luxury brand design, this study represents an important contribution to the gap in consumer and marketing research knowledge. It highlights the multidimensional aspects of Chinese domestic luxury brand logo design and represents a step towards a more cohesive framework for understanding local luxury brand design.

Methodology

Methodology Overview

The methodology employed in this study includes several chosen approaches: literature research, case study, and summary and in-depth interviews with target consumers.

Firstly, literature reviews and research were conducted literature studies to gain an understanding of consumption trends in Chinese Designer Labels (CDL), the incorporation of Chinese traditional elements in modern graphic design practices, and the expansion of Chinese culture in overseas markets through CDL brand logo design. Literature research was conducted through various sources such as journals and books.

This step is critical for forming an understanding of CDL and their consumers, as well as for collecting secondary data.

The case study, specifically based on the brands Shanghai Tang and Shang Xia, was conducted according to the methodologies outlined by American social scientist Robert Yin, who stated that "Case studies can be done using either qualitative or quantitative evidence. The evidence may come from fieldwork, archival records, verbal reports, observations, or any combination of these" (Yin, 1981).

The case studies of these two brands were used to further enhance understanding and make the findings more applicable and holistic for future practice.

The Interview

Finally, in-depth interviews were conducted to gather additional findings, specifically to understand why and how CDL consumers engage with the brand logos. The interviewees were selected based on the knowledge, understanding and interest of general luxury fashion. The subjects in this study possess prior purchasing experience, a crucial factor to consider in luxury research. They also demonstrate a willingness to allocate a significant portion of their income to luxury items.

Additionally, interviews were conducted with designers who offered valuable insights based on their extensive industry experience, having worked with clients in the luxury brand sector. The interviews were conduct online via LinkedIn and Questionnaire Star, conducting by both text and video interview. These three steps were used to form a conclusion, namely: What elements in these CDLB logos resonate with the audience? What different design strategies do the two CDLBs take?

Result

Appling Signaling Theory in CDLBs' logo design

Asymmetry of information is a key concept in signalling theory, which suggests that signallers and recipients do not have equal access to the same information. For instance, when it comes to evaluating product quality, consumers often lack sufficient information until they make a purchase and own the product. To mitigate this uncertainty about unobservable product quality, businesses use different cues to assist customers.

Cultural heritage or brand heritage has been established as an effective signal among others, to enhance consumers' perceived brand quality (Song & Kim, 2022).

For CDLBs, various existing findings suggest that they should consider and incorporate the rich Chinese heritage in their brand value (Southworth, 2019; Wu, 2022). In this case, the cultural authenticity in the brands serve as signaller. In some situations, customers may not have had direct experience with the original products or services (Song & Kim, 2022). They might not experience Chinese ancient culture or sprite before, therefore, a brand with authentical cultural heritage can convey the sense of credibility and authenticity.

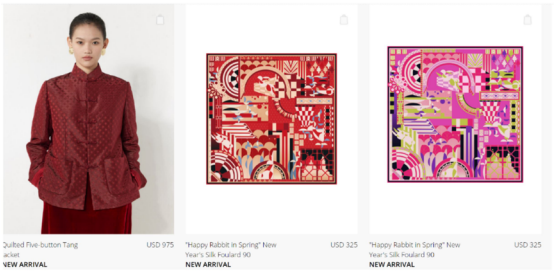
The Change in CDLB Markets

The Chinese luxury market is characterized by two key features: a young and large consumer base, coupled with positive economic growth (Kumar, Sunder & Sharma, 2015). Previous research has identified brand consciousness and attitudes towards certain brands as significant factors that influence Chinese consumers' purchasing decisions in the luxury market.

The concept of "Mainzi," meaning "face value" in Chinese, refers to the desire to gain higher social status through the possession of identifiable prestige items, such as luxury fashion bags and clothing.

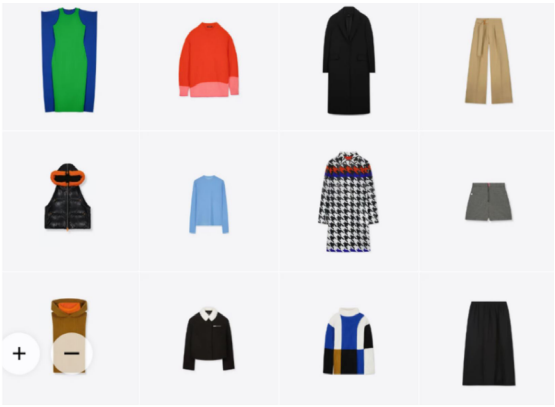
However, inconspicuous luxury consumption has been on the rise, becoming a trend both globally and in the Chinese market (Eckhardt, Belk & Wilson, 2015). Inconspicuous luxury consumers prefer to express their true personalities and tastes through unique designs on inconspicuous luxury items, rather than through loud logos. Shanghai Tang and Shang Xia are two Chinese domestic luxury brands that have embraced inconspicuousness since their establishment (Schroeder, Borgerson & Wu, 2014). Additionally, the increasing preference for domestic brands suggests that Chinese young consumers are more likely to choose local brands for more expensive products.

Shanghai Tang was founded in 1998 by Sir David Tang in Hong Kong. The brand positioned itself as the first and only luxury brand to have emerged from China. Shanghai Tang is unique for its fusion of Chinese traditional culture and design language, such as calligraphy and Qipao, with Western luxury fashion (Fig. 1). With the founder's ambition to become an internationally recognizable luxury brand, and to break the negative perception of "Made in China". In 2008, Swiss luxury giant Richemont fully acquired the brand, and it was sold to Italian entrepreneur Alessandro Bastagli in 2017. In 2000, after Frenchman Raphael le Masne de Chermont, the CEO of Shanghai Tang, and Joanne Ooi, the creative director joined, they repositioned the brand image and marketing strategy. After several years, the brand has been competing with world-class luxury brands such as Prada and Gucci. Shanghai Tang's primary market is mainland China, followed by the United States.



» **Figure 1:** *Shanghai Tang AW22 collection*

Shang Xia, a Chinese luxury lifestyle brand that has been acquired by Hermès Group, draws inspiration from traditional Chinese tea culture and incorporates traditional decorative elements and details in its design (Fig 2). The brand offers low-key luxury products that signify Chinese craftsmanship and aesthetic. Recently, the brand has expanded into the foreign market. Shang Xia aims to revive Chinese crafts that were nearly destroyed by China's Cultural Revolution, including ancient styles of porcelain, cashmere, felt, and furniture, and is part of a new generation of Chinese brands competing in the crowded European luxury goods market. The brand's product line includes fashion, teacups, houseware, and furniture that all communicate the spirit of the Chinese tea ritual.



» **Figure 2:** *Shanghai Xia 2022 collection*

The two brands are all successfully address Chinese traditional culture into the luxury industry and accept by the global market. Their success provides applicable case study and reference for other Chinese brands (Schroeder, Borgerson & Wu, 2014).

Cultural Authenticity, and Heritage Branding in CDLBs

The acceptance of Chinese local culture in the global market, particularly in the fashion context, has been under-researched in the past decade. For luxury brands, authenticity and cultural heritage hold greater importance compared to other product categories. The concept of "cultural heritage branding" was proposed by Eunju and Seulgi in 2011.

They analyzed three Asian brands: Issey Miyake (Japan), Damyeon (Korea), and Shanghai Tang (China) and found that cultural authenticity was key to gaining global acceptance (Ko & Lee, 2011).

The visual appearance and brand name all contribute to creating an authentic brand. Integrating the value proposition, Chinese heritage, and modernity in the brand logo and name is crucial. For Western audiences, foreign cultures are often closely associated with Orientalism, which can lead to it being viewed as a rare and exotic style. The branding of cultural heritage refers to the positioning of a brand based on its cultural heritage (Prentice, 1993; Urde, 2007). Cultural heritage can be tangible or intangible attributes, and previous studies have explored how Asian luxury brands can incorporate cultural heritage as a competitive advantage in their marketing strategy (Ko & Lee, 2011).

Studies have also suggested that brands with distinctive positioning and authentic brand value are key in cultural heritage branding (Heine, 2010). This is particularly true in the global market, where a brand infused with its culture is necessary (Stewart-Allen, 2002).

Luxury Brand logo design

The importance of logo design in brand identity cannot be overstated (Melewar & Jenkins, 2002). A brand logo often includes elements such as the brand name, logotype, symbol, and color. While there have been numerous studies and case studies on the Chinese logo design that incorporate traditional elements into the modern design (Liu et al., 2018), most of these have focused on utilitarian products rather than hedonic products (Shi & Jiang, 2022). However, luxury fashion brands are more oriented towards the hedonic side and are considered to have higher hedonic value (Lee & Shin, 2020), thus creating a research gap that this study aims to fill.

Brand Logo Simplicity

The majority of luxury fashion brands are western, therefore, the logo often involves alphabetical characters, such as Burberry, Chanel, and Gucci. Some luxury fashion brands include symbols in their brand identity, such as Versace and Hermès. However, the recent rebranding trends in the luxury fashion industry indicate that simplicity is key (Loureiro, Jiménez-Barreto & Romero, 2020; Lyppert, 2020; Wiley & Rapp, 2019), for example in the rebranding of Burberry and YSL.

» **Figure 3:** *Shanghai Tang logo evolution*

» **Figure 4:** *Shang Xia logo evolution*

The examination of luxury Chinese domestic brands Shanghai Tang (Fig. 3) and Shang Xia (Fig. 4) reveals a trend of simplicity in brand logo design. Shanghai Tang has undergone a shift from a highly decorative and complex logo formation to a simple black and white design featuring only Chinese and English characters. In contrast, Shang Xia has adopted a more modern and minimal style, with a transition from a calligraphic touch to a machine-written typeface. Both brand logos are presented in simple black and white, a universally accepted visual cue that signifies premium and luxurious characteristics (Wang et al., 2022). It is noteworthy that the inclusion of alphabetical letters as a main component in the brand logo design can be attributed to the findings of a study conducted by Lu (2010), which suggests that Chinese consumers tend to view brands with names written in alphabetical (roman) letters as more luxurious.

Brand Logo Complexity and Interview

Despite the trend towards simplification in brand visual design, the distinction between Chinese luxury brands and their Western counterparts remains discernible. Shanghai Tang, for instance, maintains a strong connection to traditional Chinese culture, as evidenced by its incorporation of the Chinese characters "上海滩" in its brand logo (Figure 4). Chinese logographic characters are generally considered to be more visually complex than alphabetic characters (Tavassoli & Han, 2002), and the company has retained the same Chinese typeface for over three decades. In contrast, Shang Xia adopts a more Western aesthetic, opting to replace its original "上下" monogram with the horizontally oriented letters "SHANG" and "XIA", which have been rotated 240 and 90 degrees respectively. This unconventional arrangement of letters creates a sense of visual complexity (Pieters, Wedel & Batra, 2010) and requires more time to process.

Visual complexity can influence consumer perceptions and preferences for a brand and its products (Lee, Hur & Watkins, 2018). Previous research has indicated that luxury brands can benefit from simplicity and directness (Lee, Hur & Watkins, 2018), however, this may not be the case in China, where the writing system is more visually complex (Shu, 2003). Jang et al. (2018) found that higher levels of visual complexity in brand and store design did not negatively affect consumer perceptions in Asian countries and, in fact, resulted in increased engagement among those with a higher level of fashion involvement (Jang et al., 2018).

An interview with Mr. Xiao, a 32-year-old interior designer based in Shanghai, who is a consumer of Shanghai Tang and willing to spend money on fashion products, revealed:

> *I don't think the use of Chinese characters in the brand logo diminishes its luxuriousness, especially when it is executed correctly. I genuinely appreciate Shanghai Tang's current brand logo design, as compared to previous versions. The logo is more complex than some Western brands, but it aligns well with the brand's style and cultural background. It is both modern and retro at the same time.*

The previous research explained the visual complexity with processing fluency theory (Deng & Wang, 2020). Processing fluency" refers to the ease with which our minds can process a stimulus, which can be influenced by how quickly and easily information flows (Reber, Winkielman & Schwarz, 1998; Reber, Schwarz & Winkielman, 2004).

In contrast, "disfluency" is the experience of a slower and more difficult flow of information. Deng & Wang states that Chinese consumers rate the designs with low (vs high) semantic fluency words as more beautiful, and simple visual design with high processing fluency leads to less aesthetic perception of the entire design (Deng & Wang, 2020).

Based interview and pervious findings, the researcher assumes that complexity is necessary to contain complexity in order to imply cultural authenticity and increasing disfluency.

Typeface in Two Logos and Interview

The two CDL brand logos exhibit distinct characteristics that reflect their respective brand strategies.

In addition to the presence of Chinese characters in the logo of Shanghai Tang and the unconventional placement of letters in Shang Xia, the choice of Roman typeface also differentiates the two brands. The Roman typeface used in Shanghai Tang is characterized by a subtle handwritten touch, while Shang Xia employs a bold, machine-style font. The usage of type font plays a significant role in shaping brand perception and personality (Pan & Schmitt, 1996; Batra, Lehmann & Singh, 1993).

In an interview with a senior graphic and brand designer, Mr. Wong, based in Hong Kong, he remarked that the obvious visual differences between the two logos are not only a result of their marketing strategies but also their brand culture and consumer preferences.

He states that:

> *The obvious visual difference is not only due to their marketing strategy, as well to their brand culture, as their consumer preference. Shanghai Tang is a more historic brand than Shang Xia. The subtle calligraphic touch in Shanghai Tang's roman letter is echoing its brand history and hand craftsmanship, however, Shang Xia is a much more contemporary feeling. The same phenomenon can be found in their store design as well.*

Shanghai Tang is a more historically rooted brand compared to Shang Xia, and the subtle calligraphic touch in the Roman letters of Shanghai Tang's logo effectively echoes its brand history and hand craftsmanship. Conversely, he suggests that Shang Xia conveys a more contemporary feeling. This phenomenon is also evident in the store designs of the two brands. Mr. Wong speaks from a professional perspective on the brand logo designs. The researcher argues that as Shang Xia strives to represent the concept of "splendid simplicity," and simplicity is a fundamental aspect of its product design, this is reflected in its store appearance (Heine & Gutsatz, 2015) and, as the researcher argues, in its brand logo design. Additionally, both brands employ uppercase lettercase in their logos as it creates a sense of premium and high-end feeling, as supported by research (Teng et al., 2021; Xu, Chen & Liu, 2017; Yu et al., 2022).

Examining the Cultural Factor and Brand Logo Design

The incorporation of Chinese cultural elements in branding and design refers to the use of symbols and artifacts that embody the traditional and distinct characteristics of Chinese culture. These elements often involve artistic expression and carry ideological values. As such, this study will examine the use of cultural elements in branding and design in two categories: naming and visual.

Chinese Culture in Naming and Interview

The consumption of luxury goods and brands are inherently embedded within various cultural contexts (Ying, Sun & Song, 2011). Furthermore, research suggests that a brand's name plays a significant role in shaping consumers' perceptions of the brand's image by communicating its origin, manufacturer, or functionality (Thakor & Lavack, 2003; De Mooij, 2010). The naming of CDL branding is heavily influenced by domestic culture and is a key component in overall brand equity and design (Aaker, 1991). A study conducted in 2020 by Kim et al. found that bilingual (English and Chinese) branding can hurt Chinese consumers' perceptions of Western

luxury brands (Kim et al., 2020). However, it should be noted that this study only examined luxury brands of Western origin and did not include CDL luxury brands.

Previous research has shown that Chinese consumers tend to prefer Chinese names for brands with traditional backgrounds and spirits (Chan & Huang, 2001). The rich Chinese semantics developed for traditional brands such as bicycles, clothing, tea, and wine (Chan & Huang, 2001). The two CDL brands have effectively leveraged this preference by utilizing Chinese names that directly indicate their origin.

The name "Shanghai Tang" or "上海滩" is created from two words that were chosen to convey a specific significance. The use of the founder's name in the brand name implies a sense of genuineness (Paulicelli & Clark, 2008). "Shang Xia" or "上下" on the other hand, means "up and down" in English, and references the Chinese philosophy of seeking balance and harmony in relationships, similar to the concept of "Yin" and "Yang" (Eckhardt, Belk & Wilson, 2015).

In contrast, using a Chinese name that is translated from its Western (Roman) name based on phonetic similarity can potentially damage the brand image and dilute the cultural meaning (Kim et al., 2020).

CDL brands, however, have taken the opposite approach by first creating Chinese names and then creating Roman name accordingly. This approach was noted by Miss. Amelia, a US photographer currently working in Shanghai, states:

> *I don't speak Chinese and am not familiar with Chinese culture as well, however, the "Shang Xia" sounded oriental and authentic to me. Me and friends were instantly attracted by its name when we heard it for the first time! The meaning explained by my Chinese friend, I think it is brilliant to adopt a philosophy and a lifestyle into the brand name, more interesting than simply using the founders' name.*

This statement highlights that a meaningful Chinese brand name can resonate with Western audiences, particularly when the meaning behind it is understood (Chan & Huang, 2001). The spelled and sounded are all in foreign language can be the differentiated cue for a more authentic brand perception (Ko & Lee, 2011).

Overall, luxury fashion brands need to understand Chinese culture and consumers' preferences when choosing a name for the brand to resonate with Chinese consumers and to be perceived as authentic.

Chinese Culture in Designing

Unlike other daily commodities such as food and beverages, luxury fashion brands require global recognition to be successful, as stated by Turunen (2017).

As a result, the marketing and visual strategy for adopting Chinese elements in design should be approached differently. As previously discussed, the two Chinese luxury fashion brands, Shanghai Tang, and Shang Xia, have reduced their visual elements to align with contemporary and trendy trends.

However, the visual elements still symbolize Chinese culture. Shanghai Tang, for example, incorporates Chinese characters set in a traditional right-to-left reading order, a hallmark of traditional Chinese fashion. The Shanghai Tang motif (Figure 5) is another illustration of cleverly using Chinese elements. The motif reflects the charm of Chinese seal carving and showcases the beauty of Chinese logographic characters. The layout is complex yet elegant, and the creative arrangement of letters provides a unique feeling. It is rooted in ancient history but elevated to the modern luxury market.

Shang Xia presents a different method of incorporating local elements. It not only reduces overall visual complexity, but also gradually adopts more Western elements in comparison to Shanghai Tang.

As a brand that emphasizes modernity and craftsmanship, it rebranded in 2021 in order to appeal to the Generation Z demographic. The direct Chinese visual elements, such as the seal-looking logo and calligraphic implications in typography, have been removed (Figure 4).

» **Figure 5:** *Shanghai Tang Motif*

Discussion

The Chinese luxury market is experiencing a drastic increase, even amidst the impact of the COVID-19 situation. For CDLBs are looking to gain a foothold in the market and achieve global recognition, it is crucial to establish a brand image that is visually appealing to both domestic and overseas consumers.

Therefore, there are several suggestions for brand logo design strategies that can help CDLBs to optimize their brand image. Literature on the subject has highlighted the importance of creating an authentic, traditional culture as the foundation for CDLBs to be successful. An example of this is Shanghai Tang, which lost half of its sales and customers due to its imitation of Western styles and exoticism.

However, a new creative director was able to revive the company by returning to authentic Chinese culture and incorporating Chinese elements, resulting in a more distinct and recognizable brand. The following three perspectives are formed by the researcher based on the findings from interviews and analyzing literatures.

Perspective I: Trendy but Different

The results of this research and previous studies reveal that modern-day luxury brands are rebranding to become simpler, and Chinese Gen-Z are also preferring simpler visual identities. Therefore, CDLBs with highly complex brand logos may damage their brand image in both the domestic and overseas markets. This finding is reflected in the case studies of logo evolution in Shanghai Tang and Shang Xia. However, CDLBs also need to consider that domestic consumers have a higher tolerance for visual complexity than Western consumers.

Furthermore, Asian consumers tend to associate complexity with traditional culture (Kim & Lim, 2019). Therefore, a deliberate and moderately complex visual appearance may help CDLBs differentiate themselves in the global market. The greater visual complexity of CDLBs' logos results in a longer processing time, which in turn creates a more positive brand impression.

Perspective II: Name Selection

The semantic meaning in the logo name is extremely important. As part of the cultural elements in the design, the naming has a connotation with Chinese history. Due to the shifting Chinese domestic market, young Chinese Gen-Z are beginning to appreciate their own country brands. An appropriate name that can refer back to Chinese traditional culture and heritage can facilitate the CDLB brand promotion and recognition in both domestic and overseas markets. The name selection can be in figurative forms (e.g., animals, locations, etc.), such as Shanghai Tang, or referring to abstract Chinese philosophy and spirit, such as Shang Xia. Practitioners in the field should also be aware that the Chinese name applied in CDBL should not be meaningless, for example, like direct translations based on its western name. The process suggested by this study is creating a meaningful Chinese name first, then making an English translation based on it.

Perceptive III: Cultural Elements in Design

The cultural heritage must also be applied visually. While the brand name must heavily imply Chinese culture, the visual elements can be more subtle. Through the case study and interviews, the analysis of Shanghai Tang and Shang Xia illustrates that different marketing strategies require different visual applications. While Western design was once highly sought after, recent years have seen the incorporation of Chinese elements in brand design prove to be an effective means of attracting consumers. For CDLBs, particularly in the fashion industry, originality and authenticity are of paramount importance. Elements such as traditional calligraphy style can be subtly incorporated into Roman alphabets.

The case study of Shanghai Tang demonstrates the preservation of the right-to-left reading order, along with slight modifications to Roman letters, such as calligraphy. For CDLBs with more Western styles, such as Shang Xia, a different placement of Roman letters may be appropriate. Furthermore, Shanghai Tang's motif serves as inspiration for the combination of traditional culture with modern aestheticism. The seal-craving with beautifully arranged letterforms can be appreciated by individuals even if they do not understand Chinese.

Conclusion

This research offers a comprehensive analysis of Chinese domestic luxury brands (CDLBs), specifically focusing on two iconic brands: Shanghai Tang and Shang Xia, which are among the most recognizable CDLBs worldwide. This paper presenting the following theoretical contribution: firstly, the study applied signaling theory and propose the visual design in CDLBs' logo and consumer perception. The study gives an overview of the possible factors that will impact on the CDLBs's brand perception and awareness.

Secondly, the research also thoroughly examines the visual identities and brand logos of these two brands. The results bridge the gap in understanding what CDLBs should consider when it comes to branding or rebranding, particularly regarding their brand logo design. Luxury is heavily rooted in local culture and recognized globally (Hennigs et al., 2012), with some countries having reputable luxury histories such as France, Italy, and Switzerland.

However, "Made in China" has long been associated with mass production and poor quality. Therefore, CDLBS must incorporate rich Chinese heritage into their brands rather than simply imitating Western brands. To this end, the research provides three perspectives for CDLB brand logo design: following the trend while differentiating oneself, choosing a meaningful name, and incorporating traditional elements.

These strategies are supported by the examples of the two successful brands and in-depth interviews. This research may be beneficial for designers and brand managers in terms of promoting their brands and increasing recognition both domestically and overseas. For the brand logo design, combing elements of the brand cultural heritage can enhance its authenticity and appeal, therefore, might help its performance in the market. The logo should effectively communicate the brand's value proposition and cultural heritage, while also being modern and visually appealing. By combining traditional cultural elements with modern design elements, a brand can create a unique and authentic visual identity that sets it apart in the global market.

Thirdly, from an academic standpoint, this research provides a viewpoint of the utilization of "cultural heritage branding" in the logo design of Chinese domestic luxury brands (CDLBs), an area that has not been thoroughly explored to date. Prior studies have analyzed related concepts such as "heritage branding" (Urde, 2007), "cultural archetype" (Lim & Yoon, 2008), and "cultural heritage" (Herbert, 1995; Prentice, 1993), however, this study introduces a new convergent concept that can open up avenues for further research and discussions in the future.

Limitations and future study

However, it should also be noted that there are limitations to this research. For example, the interviews were only conducted in cities such as Shanghai and Hong Kong, and the subjects were primarily middle-class individuals with a high level of fashion involvement. This research could be expanded upon in future studies through the inclusion of a broader range of locations and subjects. Previous studies have investigated the relationship between visual complexity and brand perception, as demonstrated by the works of Deng & Wang (2020), Ko & Lee (2011), and Zheng, Shanat & Kanyan (2022).

Future research could explore the correlation between visual complexity and the selection of Chinese names, given that Chinese-centric names may or may not require the incorporation of a more complex visual image. Additionally, future studies could investigate the optimal degree of visual complexity, as previous research suggests that moderation in complexity is key (Lee, Hur & Watkins, 2018; Wiley & Rapp, 2019).

In addition, future studies may explore the perception of Chinese traditional design elements by both Chinese and non-Chinese consumers. Furthermore, future research could expand and enhance signaling theory by examining the impact of Chinese cultural elements or cultural authenticity in the logos of Chinese domestic luxury brands on purchase intent. Lastly, luxury consumption is linked to conspicuous consumption (Lee, Hur & Watkins, 2018). Therefore, future studies could investigate the relationship between cultural authenticity and conspicuousness.

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Analysis of emotion recognition through 2D micro-animations of an illustrated character's face

ABSTRACT

Emotions make up a large part of everyday communication. Humans learn to recognize emotions by observing others and by referencing their feelings with the emotions of other people. Also, in cartoons, commercials, posts, etc., it's important that the design of the characters keeps the recognition of emotions high. Expressed emotions provide a better connection between the character and the viewer, making the message more understandable and tangible.
This study analyses the recognition of animated facial expressions depicting different emotions on the face of an illustrated character. The accuracy of recognition of six basic emotional expressions (joy, sadness, anger, surprise, fear, and disgust) was compared. Using micro-animation techniques, each emotion was presented in three levels of intensity (a subtle version, a normal version, and an exaggerated version). Emotion recognition was analysed with a method of metric analysis of viewing and surveying that measured recognition time and accuracy in addition to the correctness of the characters' emotion recognition. Statistically relevant differences between the results of animated emotion recognition as a function of recognition time and type of recognition task were examined. The results show how recognition changed as a function of the emotion shown and intensity, and provide a deeper understanding of micro-animations and facial expressions on the animated character's face. Statistically relevant differences were found especially in the recognition of the emotions disgust and anger compared to the recognition of the emotions joy, surprise, fear. Based on the results, guidelines are given to help animators answer the question of which emotions need to be particularly exaggerated to be correctly recognised and which emotions can be animated more subtly without affecting emotional perception.

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Introduction

Emotions represent an important communication moment with which we communicate the quality of the message, in the sense of whether it is happy, restrained, angry, surprised... The message is communicated verbally, with gestures, body movements, etc. Just like in real life, the recognition of emotions in the faces of animated characters is important to convey the character's feelings and thoughts, the atmosphere and story, as animated characters are often used in communication media (advertising, entertainment, online production, social networks, etc.). Perception of emotions and their recognition allows the viewer to feel deeper the happening in the animation, to understand it and to empathize with the animated characters.

As researcher P. Ekman writes in his book Emotions Revealed (2003), positive, pleasant-oriented emotions can help us live a better and happier life, while less pleasant and more negative-oriented emotions can seriously

harm us. Can we completely suppress and manipulate emotions to disguise what we really feel? This is what Paul Ekman wondered in his research on emotions and micro-expressions (Ekman, 2003; Ekman, 1993). In his long-term research, he was looking for a special indicator that would reveal how persons really feel, even if they want to hide it. In his research, he focused on observing the face and found that there are indicators for every emotion, which he called micro and macro expressions. These are small, unconscious micro or macro movements of the facial muscles that indicate the onset of an emotion or the presence of the emotion, even if the person is hiding it. Since the movements are unconscious, it is very difficult for people to hide them. Thus, a method for detecting emotions was developed, which comes from the theory of micro-expressions and is used in determining the truth, in interrogations, negotiations, and similar situations in which there is a need to discover whether the interlocutor is trying to hide something or whether he or she is being honest (Ekman, 2003; Ekman, 1993).

In his research, Ekman divides emotions into five basic groups: sadness and anxiety, anger, surprise and fear, disgust and contempt, and many types of joy. He divided the emotions into the aforementioned groups because he found that the micro-movements for the emotions within these groups were very similar to each other. It also turned out that all people, regardless of their cultural or geographic background, assigned the same emotional label to each of the micro-expression images. Thus, it can be concluded that micro-expressions related to the representation of individual emotions are the universal language of all people in the world (Ekman, 2003; Ekman, 2022; Ekman, 2016). In his research (Ekman, 2022), Ekman also claims that we can only recognize emotions by observing the right parts of facial expressions. Thus, he divides the facial movements that show emotion into micro-expressions, which represent large changes in facial expression and therefore can be recognized by most people, and micro-expressions, which represent smaller movements in facial expression that are sometimes almost imperceptible and therefore can be overlooked by many people (Strgar, 2019; Iskra, 2020).

Animation of emotions

An emotionally neutral character is one without emotions or feelings and serves as a base before transitioning into a single emotion. Such a character is characterized by being relaxed and showing no emotion (Kehr, 2023; Hooks, 2015; Thomas & Johnston, 1995).

To build up the animation of emotions we can use the representation of different intensities of emotions. There are three basic intensity levels: very low representation, medium representation, and very emotional representation. Between the two extremes, there is a whole spectrum of inter-intensities that can serve as transition or also as a main emotional representation. Different intensities of emotion are always used in character's animation depending on the circumstances, the story, the character's personality, the animation style, etc. (Boucher & Ekman, 1975; Hooks, 2015; King, 2001).

Secondary animation, one of the Disney's animation principles, includes movements that support the main movement of the character in the animation, adding more dimensions to the animation of the character. This principle is important in creating the animation of an emotional state and can include movements and actions as breathing, blinking, movements of the head, hands, or other body parts (Webster, 2005; Eisner, 1958; Veler, 2018).

Which emotions are to be emphasized in animation and when during the plot depends mainly on the story, the character's personality, and the circumstances in the story. Generally speaking, however, anger, sadness, and joy are usually strongly emphasized in animation because these emotions are very familiar to all viewers, regardless of age, gender and also cultural differences (Kehr, 2023; Lasseter, 2001; Pranjić, 2015).

Breakdown of individual emotions by micro-expressions and animation features

According to Paul Ekman, anger is expressed on the face in such a way that the eyebrows are drawn together, the eyes look far forward, the nostrils are flared, and the lips are pressed together. In a more hidden, subtle version of the emotion display, we can recognize characteristic unconscious micro-expressions such as tense eyebrows, fixed eyes, and slightly more compressed lips (Ekman, 1993; Prajnić, 2015; Babich, 2016). In the animation, joy is shown by squeezing the eyes from below, often giving them a C-shape at the bottom, and by drawing wrinkles around them starting from the corners of the eyes. The cheeks lift and bulge, and the mouth contorts into a smile where the teeth can be seen. In covert, unconscious micro-expressions, joy is shown only by a slight lifting of the corners of the lips and eyes (Ekman, 1993; Prajnić, 2015; Babich, 2016; Williams, 2001; Adegbola, 2008). In animations, surprise is often greatly exaggerated because it is a very fleeting emotion and therefore needs to be emphasized in order to truly convey it to the viewer. For example, in many animations the eyebrows are particularly high, sometimes even completely outside the face, and the mouth is very wide open, in some cases the jaw even reaches the floor (Ekman, 1993; Prajnić, 2015; Babich, 2016).

The most characteristic sign of disgust is the wrinkling of the nose, which does not occur with any other emotion. Disgust is also shown by lowered eyebrows, which are fairly straight and slightly lowered only at the

inner part, the upper lip is raised into an inverted U, and the lower lip is raised and slightly tilted outward. However, disgust appears as an unconscious micro-expressions with a small squinting of the eyes and an almost imperceptible wrinkling of the nose (Ekman, 1993; Babich, 2016, Prajnić, 2015; Roberts, 2011). Fear appears on the face with raised eyebrows pushed together toward the center of the face, raised upper eyelids, and tense lower eyelids. The mouth is slightly open, and the corners of the lips are pressed down. However, in a subtle way, it appears as a micro-expression with slightly dilated eyes and slightly open mouth (Ekman, 1993, Prajnić, 2015; Babich, 2016; Roberts, 2011).

The most characteristic features of the face for sadness are the eyebrows, which are drawn upward at the inner ends away from the eyes and move slightly together toward the center of the face. The upper eyelids droop and the eyes look more downward, and the corners of the mouth are also pulled downward. As an unconscious micro-expression, however, the sadness is barely perceptible, as it is expressed only in slightly drooping corners of the mouth and a slightly lowered gaze (Ekman, 1993; Babich, 2016). In animation, sadness is often accompanied by crying and tears (Roberts, 2011; Prajnić, 2015).

Recognition of emotions in static images (photos) or videos is a very well researched field (Reynolds & Przdek, 1992; Rus, 2003; Or & Wilson, 2015; Guo & Shaw, 2015; Leyk et al., 2008; Kramer, Youn & Burtona, 2018; Tarnowski et al., 2017; Strgar, 2019; Iskra, 2020), while this cannot be said for the field of representation of emotions in animations. Based on the study of facial anatomy and expressions, as well as many years of experience, animators, designers, and artists create emotions in the faces of characters, but there are few studies that analyze and metrically evaluate the effects of creating emotions in characters.

Zhang et al. (2021) compared and determined the importance of individual facial features on the perception of emotion by superimposing parts of respondents' faces. They compared the perception of imaged and photographed faces and found, among other things, that the mouth was most important for the perception of joy and the eyebrows were most important for the detection of sadness, which is also supported by some other sources (Strgar, 2019; Iskra, 2020). Brosnan et al. (2015), in a study entitled Emotion recognition in animated compared to human stimuli in adolescents with autism spectrum disorder, also conducted interesting research in the area of emotion perception, in which they examined emotion recognition in illustrated and photographed faces in children with autism. They found that children with autism recognized emotions much better than the control group when recognizing animated images, while they had much more difficulty recognizing them with photographs. Micro-expression recognition in animated figures was also studied by Hou (2021). In his research it was found that the amount of exaggeration of individual micro-expressions and the illustration style used in the animation had a very large impact on the final perception.

As we can see, some researches have been conducted in the field of emotion perception in illustrated or animated figures, and each had chosen its own perspective on the subject. All the researches focused on the same emotions (joy, sadness, anger, disgust, surprise, and fear). However, due to the specificity of the research topic, some studies focused on a smaller number of emotions from the defined set. In some studies, the individual emotions were also divided into different intensities and analysed separately.

The aim of the research was to systematically study the facial parts of the author-illustrated character for animation, to study the micro-movements that occur when a particular emotion is expressed, and how much the animator needs to exaggerate the representation of a particular emotion in animation in order for the viewer to perceive the emotion. The goal was also to list guidelines that can help animators answer the question of how parts of the face have to be designed in animation for the correct recognition of the emotion, and for which emotions it is sufficient to design the facial movements at a more subtle level so that the result of recognizing the emotion is still adequate. We also analysed the temporal recognition of different emotions as a function of the sequential presentation of emotion animations of a particular style to respondents, i.e., how quickly the viewer recognizes a particular emotion in a particular expression style of animated presentation when it is shown the first, second, and then third time.

We hypothesized the following:

H1: Better perception of emotions by viewers of a 2D animated face will occur with more intense emotion representations.

H2: The most intense representation of emotion in an animated character is necessary for the perception of sadness.

H3: The least intensity of emotion representation is required for perception when representing anger and joy.

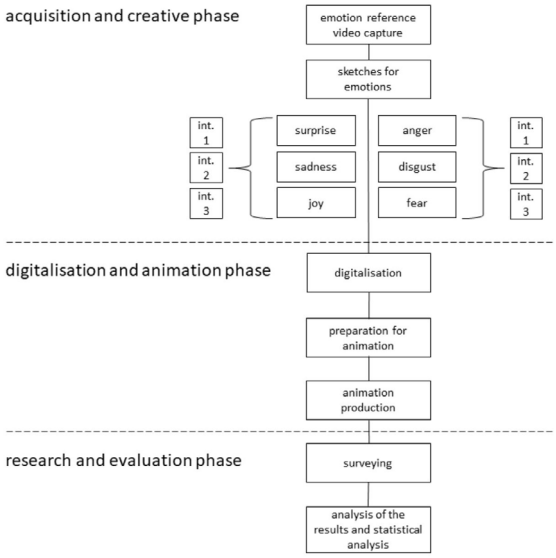
H4: Faster perceptions are recorded for the most intense representation of emotions.

H5: Respondents perceive a representation of joy most quickly.

H6: Respondents perceive a representation of sadness most slowly in time.

Experimental Part

The experimental part followed the flowchart shown in Figure 1, with acquisition and creative phase (illustration and emotion expression), digitalisation and animation phase and research and evaluation phase.

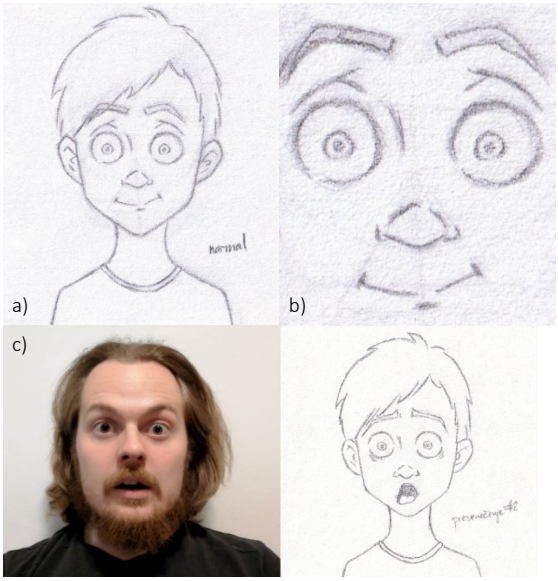


» **Figure 1:** *Organogram showing the flow of research to results (int. means intensity of indicated emotion)*

In this paper, the terms recognition and perception are used to identify the emotions on a character's face. In the literature, the general term recognition is used, while the term perception is used for the recognition of micro-animations. At the beginning of the study, we recorded the selected emotions (joy, anger, fear, disgust, surprise, and sadness) expressed with the human face of three different individuals (a kid – age 12, a young man – age 26 and a man of middle age – age 46).

Participants volunteered to have their faces and expressions photographed. For each person, we recorded three recordings of all three intensity levels of the emotion, i.e., the representation of a mild, subtle version, a normal representation, and an exaggerated version of the representation of a selected emotion (Figure 2).

This was the starting point and reference for preparing the representation of emotion on our illustrated character. We paid special attention to the movements of facial parts such as eyebrows, eyes, mouth, nose, jaw, and the movements of facial folds. When designing the character, it was very important that the basic expression on character's face is as neutral as possible, as shown in Figure 3. In order to show a neutral face, we chose a character's face that eliminates the differences between the sexes as much as possible.

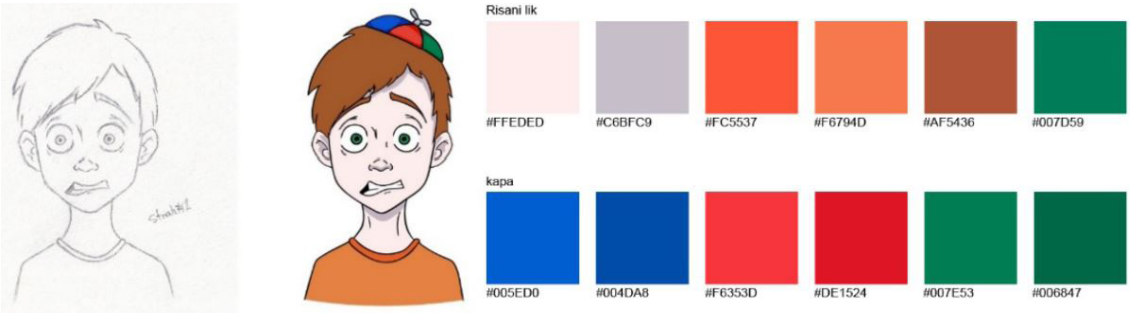


» **Figure 3:** *The original sketch of our character (a), the sketch of the moving parts of the face (b) and the outline of the surprise according to the reference (c)*

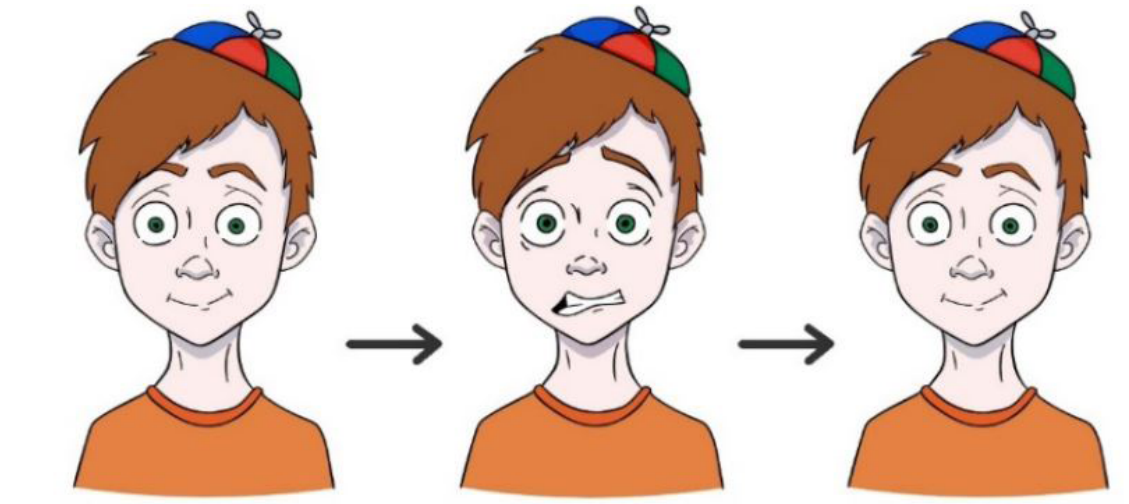
We made eighteen sketches of emotions for three intensities and the representation of each of the six selected emotions (Figure 4 shows joy). We took into account the theory of micro-expressions, which are visible even when the display of emotion is minimal or hidden. We vectorized the drawings and determined the colour palette (Figure 5). The digital illustration of the character and colour palette are shown in Figure 5. The changes from a neutral to an emotional face for the purpose of analysis were animated in such a way that they could be played back in an uninterrupted repeating loop (Figure 6).

» **Figure 2:** *A picture of three intensities of joy on a young man*

» **Figure 4:** *Illustrations of the three joy intensities*



» **Figure 5:** *Digital illustration of the character and colour palette*



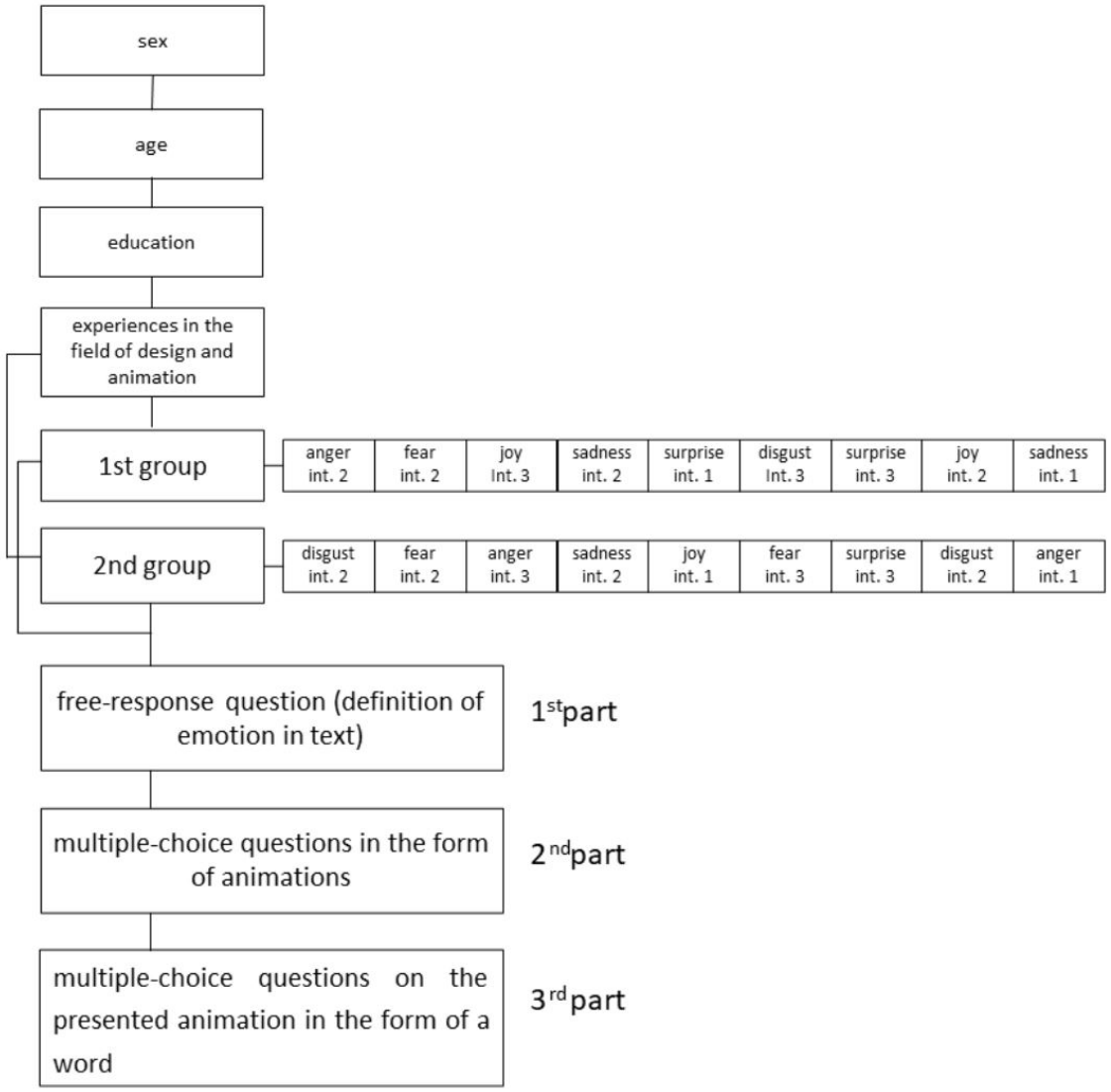
» **Figure 6:** *Display of character emotional expression in a loop*

Surveying

We designed the survey on the 1ka platform (https://www.1ka.si/d/sl). Respondents completed the survey via an online link that it was active for one month, from May 5th to June 5th, 2022, and was completed anonymously and voluntarily. Respondents answered the survey questions in their home environment or in the environment they were in when they answered the survey.

As shown in the organizational chart (Figure 7), the survey was structured to consist of three distinct parts.

Respondents could answer the survey in two ways, with random selection. One half of the selected emotion representations appeared in certain intensity for the first group of respondents, and the other half appeared in the second group of respondents, as indicated in the organisational chart.



» **Figure 7:** *The organizational chart shows sequence of survey questions for both groups of respondents (int. means intensity of indicated emotion)*

Experimental survey design

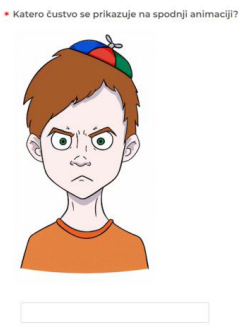
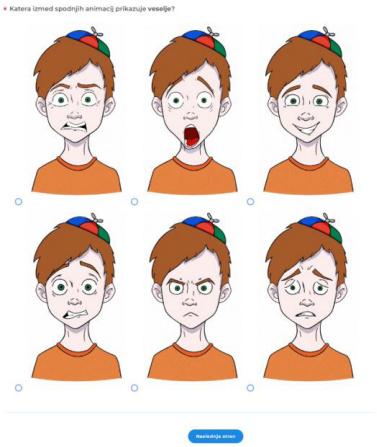
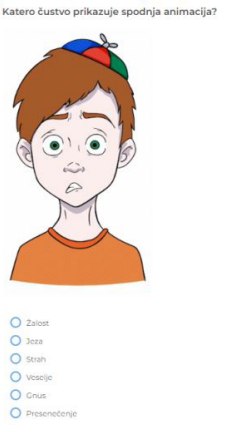
The survey was divided into a part to fill in general data (demographic data, previous experience with design and animation) and a part to evaluate and analyse the emotions depicted on the character (Figure 7). The latter was divided into three parts of analysis of animated emotions. The first part included free-response questions in which the respondents observed a single animation multiple times and then answered the question by writing what emotion they recognised, as shown in Table 1 (Part 1).

In this question, the viewers saw the animation for the first time and did not have previous experience of what the emotion is in the task. The second part consisted of a multiple-choice question with the answers presented in animations in which the viewers selected an animation presenting a particular emotion. The answers the respondents could choose were six different animations that were played until one was clicked and selected, as shown in Table 1 (Part 2).

The animations in the answer choices were different intensity representations of individual emotions and different emotions. The third and final part of the survey consisted of a word (term) choice as an answer, where the respondents answered the question with a selection of the term of which emotion was represented by the presented animation (Table 1, Part 3). In addition to the answers, the time the respondents needed to answer was also measured. We were able to calculate the solution time for each question from the metadata by placing each question in the survey on its own page, between which the viewer moved by clicking on the answer. When the viewer clicked on the answer, the time from when the page was displayed to when the viewer clicked on the answer was recorded in the metadata.

Table 1

Structure of survey questions: An example of a free question in a survey (Part 1), an example of choosing an answer among presented animations in a survey (Part 2), and an example of choosing an answer among selected written emotions in a survey (Part 3)

Survey's part	One	Two	Three
Questions' text	Free-response questions	Multiple-choice questions in the form of animations	Multiple-choice questions on the presented animation in the form of a word
	"Which emotion is shown in the animation below?"	"Which of the animations below shows joy?"	"Which emotion is shown in the animation below?"
Text and images of the questions			
Answer	Respondents typed an answer	Respondents clicked a selected image	Respondents selected one of the listed emotions: "sadness, anger, fear, joy, disgust, surprise"

Statistical analysis

The results were statistically analysed using a t-test for 95 % statistical reliability and a p-value of 0.05. We were interested in the statistical significance of the differences between the results for each emotion according to the responses to the questions, which asked respondents about the textual definition of the emotion (Part 1), the recognition of a particular emotion from the set of illustrations shown (Part 2), and the selection of the expression for the emotion next to the illustration shown, given some response options (Part 3).

We also statistically evaluated differences in the time it took respondents to recognise, define, and respond to emotions that were recognised.

Results and discussion

With the results of the survey, we determined the correctness of the recognition of individual emotions and the time spent by the respondents on the recognition itself. In total, 184 people started solving the survey, and 173 people completed it. From the results of the first question, it can be seen that many more women than men answered the survey, namely 140 women or 80 % and only 32 men or 18 %, while one of the respondents (2 %) described himself as undefined. The majority of respondents ticked the 19-25 age group, 100 people or 58 %, while a slightly smaller number of responses came from the 26-35 age group, 47 or 27 %.

The fewest responses came from the younger group up to 18 years of age, namely only 2 or 1 % of the responses, while there were slightly more responses from the older group over 36 years of age, namely 24 or 14 % of the responses. 105 or 61 % of the respondents had some prior experience in the visual arts, and 17 respondents or 10 % were involved in the visual arts as a hobby, and thus have little prior experience that can help them in their perceptions.

51 respondents, or 29 %, have never been involved with animation or character development and therefore have no prior experience to help with their perceptions.

Free-response questions

In response to the question "What emotion is shown in the following animation?" where the solving time was not yet measured, respondents answered as shown in Table 2. Under partially correct we counted all answers that did not contain exactly the right emotion but were still semantically correct, and under incorrect we recorded answers that were semantically incorrect. The best

Table 2

Table of correctness of perception of indicated emotion with average values and standard deviation from free-response question (where int. means intensity of indicated emotion)

Emotion	Int.	Correct [%]	Partly correct [%]	Incorrect [%]
Joy	1	18	17	65
	2	46	27	26
	3	61	13	26
	Aver.	41.7	19.0	39.0
	Std.	21.8	7.2	22.5
Sadness	1	56	34	10
	2	48	27	25
	3	97	2	1
	Aver.	67.0	21.0	12.0
	Std.	26.3	16.8	12.1
Surprise	1	36	54	10
	2	49	22	28
	3	27	47	26
	Aver.	37.3	41.0	21.3
	Std.	11.1	16.8	9.9
Anger	1	51	19	30
	2	88	7	6
	3	98	0	2
	Aver.	79.0	8.7	12.7
	Std.	24.8	9.6	15.1
Disgust	1	0	15	85
	2	5	18	76
	3	21	21	57
	Aver.	8.7	18.0	72.7
	Std.	11.0	3.0	14.3
Fear	1	5	12	83
	2	42	36	22
	3	38	2	59
	Aver.	28.3	16.7	54.7
	Std.	20.3	17.5	30.7

recognition of the emotion represented was found in the representation of sadness and anger at the highest intensity. Here, the correctness of the responses was up to 98 % for the representation of anger and 97 % for the representation of sadness. We noted a trend that Ekman has pointed out, namely that fear and surprise are often confused (Ekman, 1993). Regardless of the intensity of the representation, the worst recognition was obtained for the representation of disgust. Here we obtained 21 % correct responses at the highest intensity, 5 % at the medium intensity, and at the lowest intensity no one correctly recognized the emotion depicted. In the expression of disgust, we also noted the greatest dispersion of responses, as it was often replaced by fear, anxiety, anger, pain, surprise, nervousness, despair, and a variety of others (Ekman, 2003). For the representation of joy, as the intensity of the representation increased, so did the number of correct responses. For example, we had 18 % correct responses at the lowest intensity and 61 % correct responses at the highest intensity. At first glance, we could say that increasing the intensity of the expression of joy is a good thing, but among the incorrect answers, it turned out that many respondents associated the most intense expression of joy with discomfort and forced or false joy. From this we can conclude that an exaggerated display of joy does not pay off, as the viewer is more likely to perceive it as a bad, insincere emotion. A statistical analysis comparing the results for two-paired selected emotions (e.g., joy-sadness, joy-surprise, etc., for correct, partially correct, and incorrect responses) revealed that there were statistically significant differences for correct responses and recognition of the emotions in sadness and disgust ($p = 0.024$), surprise and disgust ($p = 0.033$), and anger and disgust ($p = 0.0108$). For the partially

correct responses, we confirmed a statistically reliable difference only in the results for recognition of the emotions surprise and anger ($p = 0.045$), and for the incorrect responses just as for the correct responses for the emotions sadness and disgust ($p = 0.005$), surprise and disgust ($p = 0.007$), and anger and disgust ($p = 0.008$).

Multiple-choice questions in the form of animations

In the 2nd part of the survey, respondents were asked the question, "Which of the following animations show _____?" and they could choose from six animations that showed all six emotions (joy, sadness, surprise, anger, disgust, and fear) at the same display intensity. The results are shown in Table 3. The last two rows of the Table 3 show the average value of the percentage of correct answers for each emotion with the standard deviation, and the last two columns show the average value of the time needed to answer for each emotion at the different intensities shown. The average values of the time required to recognize individual intensities with respect to the emotion with standard deviation are shown in Figure 8.

The best recognition of the emotion displayed at all intensities selected from the displayed animations of all emotions was observed on average for sadness, namely up to 95 % correct responses, at the lowest and medium intensities there were 93 % correct responses, and at the highest intensity of emotion display even 100 % correct responses. On average, the worst recognition

Table 3

Correctness of the recognition of the displayed emotion in percentage with average values and standard deviation for multiple-choice questions in the form of animations (int. means the intensity of the displayed emotion)

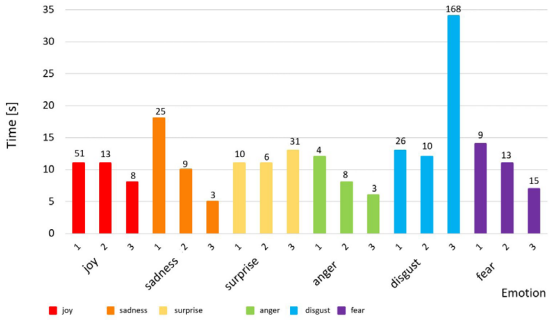
Emotion	Int.	Answers [%]					
		Joy	Sadness	Surprise	Anger	Disgust	Fear
Joy	1	88	2	2	4	5	0
	2	96	3	1	0	0	0
	3	100	0	0	0	0	0
	Aver.	94.7					
	Std.	6.1					
Sadness	1	1	93	0	0	3	3
	2	0	93	0	4	1	1
	3	0	100	0	0	0	0
	Aver.		95.3				
	Std.		4.0				
Surprise	1	1	0	92	1	1	4
	2	8	2	82	0	2	7
	3	1	5	92	0	0	1
	Aver.			88.7			
	Std.			5.8			
Anger	1	0	0	0	98	2	0
	2	1	0	0	90	9	0
	3	0	0	0	82	18	0
	Aver.				90.0		
	Std.				8.0		
Disgust	1	0	4	0	14	44	39
	2	0	8	3	3	66	19
	3	1	0	0	1	62	35
	Aver.					57.3	
	Std.					11.7	
Fear	1	5	3	8	0	11	72
	2	0	7	20	0	16	58
	3	0	0	15	3	8	73
	Aver.						67.7
	Std.						8.4

of the emotion displayed was observed at all intensities for disgust, namely 57 % correct. At the lowest intensity there were 44 % correct answers, at medium intensity there were 66 % correct answers and at the highest intensity of the emotion 62 % correct answers.

The best emotion recognition was obtained at the highest intensity of joy and sadness with 100 % correct answers, which means that of all the emotions presented, the respondents selected them the easiest and did not confuse them once with another emotion.

As can be seen in Table 3, recognition is successful for all intensities of joy, sadness, surprise, and anger, and slightly worse for recognition of disgust and fear.

In terms of time, respondents spent the least amount of time perceiving sadness at the highest intensity, i.e., only 5 seconds, while they spent the most time perceiving disgust at the highest intensity, i.e., 34 seconds, as seen in Figure 8. This is a very large time difference, which came about because the highest intensity of sadness has a very good indicator (tears) that is difficult to miss, and because, as we already know from the first part of the survey and from Ekman's research (Ekman, 2003), people rarely see disgust in real life and therefore it is more difficult to perceive during emotions. Figure 8 shows the average values of time with standard deviation assigned above the columns for the recognition of each emotion and its intensities in the survey's part with multiple-choice questions in the form of animations.



» **Figure 8:** *Emotion recognition (intensities 1-3) over time - mean values with standard deviation given in the numerical value above the column representing time (2nd part of the survey), No. of respondents = 173*

For the results of this part of the survey, statistical analysis of the results using the t-test revealed no statistically significant difference between the results of the responses with the choice of animation (for selecting a particular emotion). As well as the results of the time spent by the respondents to identify a particular emotion during the displayed emotions did not differ statistically significantly for the different animated emotions considered.

Multiple-choice questions on the presented animation in the form of a word

In the 3rd part of the survey, we asked the respondents the question "Which emotion does the animation below show?" and showed them the animation of the emotion, and they could choose from six text answers (joy, sadness, surprise, anger, disgust, and fear). In Table 4, we presented the results in percentage of answers the respondents needed to perceive each emotion at each display intensity.

The last two rows of Table 4 show the average value of the percentage of correct responses for each emotion with the standard deviation, and the last two columns show the average value of the time taken to respond for each emotion at the various intensities indicated. The average values of the time taken to recognize each intensity with respect to the emotion with standard deviation are shown in Figure 9.

The best recognition of the displayed emotion at all intensities, selected from the given responses of all emotions, was observed on average for anger, with an average of 94 % correct. At the lowest intensity there were 89 % correct responses, at medium intensity 98 %, and at the highest emotion intensity 96 % correct responses. It was expected that the recognition of anger would be quite high, since the eyebrows that were strongly characterized in the display of animation of this emotion are an important indicator of anger and supports correct emotion recognition.

On average, the worst recognition of the emotion presented was observed at all intensities for disgust, namely at the lowest intensity there were only 21 % correct answers and at medium and highest intensity 60 % correct answers. As we can see from the whole survey, disgust is generally perceived worse than other emotions, which was to be expected. It was found that the lowest intensity of disgust is perceived worst, as it was also discovered in the previous sets of questions.

In Table 4, the recognition is successful and high in numbers for all intensities of joy, sadness, surprise, and anger, and slightly worse for the recognition of disgust and fear. This is very similar to the table of recognition results from the previous set of questions (2nd part) in the survey.

A much larger difference can be seen in the confusion caused by incorrect answers. At first glance, it can be seen that the responses are not as consistent as in the previous set.

Here, respondents did not have the opportunity to compare with other animations, which we assume made it a little harder to identify the emotion.

Table 4

Correctness of the recognition of the displayed emotion in percentage with average values and standard deviation for multiple-choice questions on the presented animation in the form of a word (int. means the intensity of the displayed emotion)

Emotion	Int.	Answers [%]					
		Joy	Sadness	Surprise	Anger	Disgust	Fear
Joy	1	62	17	11	0	0	10
	2	95	0	5	0	0	0
	3	88	0	12	0	0	0
	Aver.	81.7					
	Std.	17.4					
Sadness	1	0	98	0	2	0	0
	2	0	72	0	0	16	12
	3	0	97	0	0	1	1
	Aver.		89.0				
	Std.		14.7				
Surprise	1	0	0	100	0	0	0
	2	0	0	83	3	1	13
	3	0	0	91	0	0	9
	Aver.			91.3			
	Std.			8.5			
Anger	1	0	3	3	89	3	3
	2	0	0	0	98	2	0
	3	0	1	3	96	0	0
	Aver.				94.3		
	Std.				4.7		
Disgust	1	8	15	18	10	21	29
	2	0	3	3	4	60	31
	3	0	2	2	28	60	9
	Aver.					47.0	
	Std.					22.5	
Fear	1	1	3	46	0	13	38
	2	0	0	21	0	26	53
	3	1	7	3	0	24	65
	Aver.						52.0
	Std.						13.5

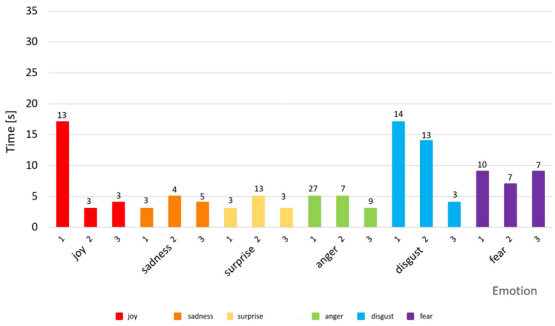
In terms of time spent, respondents spent much less time responding in this part of the survey than in the previous part 2 of the survey.

The least amount of time was spent perceiving sadness and surprise at the lowest intensity, joy at medium intensity, and surprise and anger at the highest intensity; otherwise, respondents took only 3 seconds to perceive them. Decision making took the longest at the lowest intensity of disgust and joy, 17 seconds, as shown in Figure 9.

Figure 9 shows the average values of time with standard deviation assigned above the columns for the recognition of each emotion and its intensities in the survey's part with multiple-choice questions on the presented animation in the form of a word. Statistical analysis and comparison of results from Table 4 revealed, that we cannot claim with statistical confidence that the differences are in the response patterns of respondents who chose among multiple emotion response options based on the animated emotion displayed. T-tests revealed no statistically significant differences.

The situation was somewhat different with regard to the time (Figure 9) spent by the subjects on the responses to each emotion.

Namely the t-test showed that there were significant differences in the results of the animated emotions sadness- anger ($p = 0.008$), surprise - fear ($p = 0.008$), and anger- fear ($p = 0.013$).



» **Figure 9:** *Emotion recognition (intensities 1-3) over time - average values with standard deviation given in the numerical value above the column representing time (3rd part of the survey), No. of respondents = 173*

Comparative analysis of the 1st- 3rd part survey results

On average, the emotion that was the most difficult to recognise and perceive was disgust, as shown in Table 5, as it was correctly perceived by only 38 % on average across all tasks, all intensities in survey parts 1st-3rd. At the lowest intensity, only 22 % correctly recognised it on average, 44 % at medium intensity, and 48 % at the highest intensity. This shows that the most difficult emotion to perceive was the lowest intensity of disgust. As for testing a statistically reliable difference in the recognition time of this emotion compared to other emotions, we can confirm the results only in the first part of the analysis, in which the respondents defined the emotions with free choice word. As mentioned above statistically significant differences in analysis of results of survey sets were found only in the case of disgust and the emotions sadness, surprise, and anger. On average, anger was the easiest emotion to perceive and was perceived correctly by respondents across all survey sets and all intensities at an average of 88 %. At the lowest intensity, it was correctly perceived 79 % of the time on average, and 92 % of the time at the medium and highest intensities. This shows that the emotions of medium and highest intensity of anger were the easiest to perceive. Statistical analysis confirmed a significant difference in the recognition time of anger only in part 3 of the survey, in which respondents defined the displayed animated emotion based on some given word answers for emotions presented in animation. The statistical analysis showed that on average of all answer sets only the recognition of anger and disgust differed statistically significantly with p = 0.031, whereas this cannot be claimed with statistical certainty for the comparison of the other emotion representations.

At the same time, the statistical analysis has also shown that the claim that the average values of the results of the correct answers of the three sets of surveys are different for different intensities of the emotions represented in the animation is confirmed only for the differences between the intensities of the emotions represented 1 and 2 (minimum and medium intensity) with the value p = 0.0106 and 1 and 3 (minimum and maximum intensity) with the value p = 0.0214, while the statistics have not confirmed the statistical significance of the difference between the answers for the intensity of the emotions represented 2 and 3 (medium and maximum intensity).

Table 5

Average values of correct recognition answers in survey's part 1st-3rd with standard deviation

Emotion	Survey part	Part's average [%]	Overall average [%] - part	Std.
Joy	1	42	73	27.6
	2	95		
	3	82		
Sadness	1	67	84	14.7
	2	95		
	3	89		
Surprise	1	37	72	30.6
	2	89		
	3	91		
Anger	1	79	88	7.8
	2	90		
	3	94		
Disgust	1	9	38	25.3
	2	57		
	3	47		
Fear	1	28	55	23.1
	2	68		
	3	68		

From the results and as it was expected, it is clear that previous experience of emotion recognition is very important for further perception, as there are large differences between the survey groups. The first survey's part, where the respondents had no previous experience, has the lowest percentage of correct answers, 44 %. The second and third parts, where respondents have already gotten a feel for our animations, have a higher percentage of correct answers, 82 % and 79 %, respectively. When we compare the average of the correctness of the parts (with different type of answers), we can also see that the second part has the highest percentage of correct answers, which tells us that our respondents generally perceive emotions better when the animations are next to each other and therefore choose the correct one. In actual communication, the recognition of emotions also occurs contextually according to the change in the expression of emotions in the face of the observed person (Boucher & Ekman, 1975).

In terms of time, on average, respondents solved the third part of the survey much faster than the second, as

the fastest solving time in the second part was 5 seconds and in the third part was 3 seconds, while the longest time was 34 seconds in the second part and 17 seconds in the third part. It has to be emphasised that faster solving does not mean more correct answers. In our opinion it does mean that respondents were much more decisive with their choices when they had all the animations in front of them and were choosing between words, even though the choices may not have been correct.

Statistically, we can confirm the differences in the correctness of responses in 1st part (when respondents saw animated emotions for the first time) and 2nd part of the survey (when they already had the experience of recognizing emotions and the chosen style of animation) with a value of p= 0.000025 and 1st part and 3rd part of the survey with a p value of p=0.0008, while there were no statistically significant differences between survey parts 2 and 3.

From our research results, for better recognition, we should exaggerate the most or show joy, sadness, disgust and fear the most intensely. Additionally, we could animate surprise and anger less intensely because we got the highest percentage of correct answers for them at lower intensities. In some respects, this correlates with the theory that anger, sadness, and joy are usually strongly emphasized in animations. However, it always depends on the story, the additional information, the environment, the animation style, and the personality of the animated character.

Conclusions

The results can be summarized in some guidelines that can help animators plan and design micro-animations of characters' faces. In the case of joy, we found that the percentage of correct recognition increases with the intensity of the representation. Consequently, we recommend to exaggerate with the representation of joy, however to be careful not to reach the point where this emotion seems fake, as some of our respondents wrote. In the case of sadness, we found that the emotion is best perceived at the highest intensity of the display, but the recognition is also good at the lowest intensity, so it is not necessary to exaggerate in sadness, since the lowest intensity is also very well perceived. In the case of the emotion surprise, we found that the percentage of correct recognition decreases with the intensity of the display, so exaggeration is not necessary in the case of surprise (we get good recognition at the lowest intensity). Our recommendation is not to exaggerate with animating surprise, as the viewer might confuse surprise with a completely different emotion, fear. In the case of anger, we found from the results that the percentage of correct recognition increases with the intensity of the representation, but the medium and maximum intensities are similar in recognition, while the minimum intensity is also high. Thus, in the representation of anger, it is not so crucial to exaggerate with micro-animation, since the minimum and maximum intensities were recognised well. For disgust, we found from the results that the percentage of correct recognition increases with the intensity of the representation of the emotion. We suggest exaggerating the animation of disgust, but to be careful as our research revealed that the overall percentage of recognition for disgust is very low. Animators should be attentive when depicting disgust so that it is as different as possible from surprise, otherwise viewers might confuse the presentation of these emotions. In the case of fear, which overall recognition was very low, we found that the percentage of correct recognition increases with the intensity of the representation. It can be deduced that the exaggeration of fear could benefit the representation of this emotion in animation.

Based on what has been written, below we also provide conclusions regarding the set hypotheses.

H1: The hypothesis was not confirmed, since most emotions, namely joy, sadness, anger, disgust and fear, were better perceived in the most intense representations. The only emotion that contradicted this was surprise, where the best recognition on average occurred for the least intense presentation of the emotion.

H2: The hypothesis was not confirmed. At the most intense representation of sadness, respondents correctly perceived 98 % of the emotion on average, the most of all. However, even for less intense representations, the percentages of correct recognitions are quite high.

H3: This hypothesis could be confirmed, as it proved to be true for anger but not for joy. In the case of joy, the percentage of correct responses for the lowest intensity of the emotion is quite low, 56 %.

H4: The hypothesis was not confirmed, as respondents in the third set perceived the medium intensity of joy the fastest (3 seconds) but took the longest to perceive the lowest intensity of joy (17 seconds). In contrast, in the second group, there was no joy in either the fastest or slowest recognitions.

H5: We refuted the hypothesis, as the respondents perceived sadness relatively quickly in the second group and took 3 seconds to perceive the lowest intensity, 5 seconds to perceive the middle intensity, and 4 seconds to perceive the highest intensity in the third group.

H6: The hypothesis could not be confirmed. In the second series of surveys, respondents perceived the most intense emotion faster for joy, sadness, anger, and fear, but not for surprise and disgust, where they perceived the lower intensity of the emotion pre-

sented faster. In the third series of surveys, respondents perceived the most intense emotion faster for anger and disgust, while they perceived the lower intensity emotion faster for the other emotions.

As authors of the study, we know that the study has some shortcomings so that the results cannot be generalized to the whole field of micro-animation planning of emotional expressions of animated characters. Only one character and one author's style in both illustration and animation were analysed. Drawing and analysing more characters and more illustration and animation styles would certainly expand the applicability of the results and guidelines. This is also the goal of further research. The character was otherwise designed neutrally, and the findings of important research in the field of emotion recognition were included in the illustrations of the intensity of animated emotions. Notwithstanding these limitations, we believe that the research results provide useful guidelines for planning work in the field of animation and a useful systematic account of experimental design analysis of the effects of the design of facial expressions of animated characters on emotion recognition.

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Enhancing user experience in online learning environments: Design, evaluation, and usability techniques

ABSTRACT

This study aims to enhance user experience on online learning platforms by investigating design principles, usability evaluation techniques, and redesign processes. A total of 150 participants, divided equally among students, educators, and professionals, were stratified by age, gender, education level, and familiarity with online learning. Various evaluation methods, including heuristic evaluation, guideline reviews, and cognitive walkthroughs, were employed. Metrics such as task success rate, time-on-task, and Net Promoter Score (NPS) were used to quantify user satisfaction and effectiveness. Additionally, five qualitative interviews were conducted for deeper insights. The results revealed specific usability issues and demonstrated the effectiveness of the applied evaluation techniques. Post-redesign metrics indicated significant improvements in user satisfaction and engagement. The study underscores the importance of a multi-faceted approach to design and evaluation in online learning platforms and suggests avenues for future research.

KEY WORDS

Usability evaluation, online learning platforms, design principles, user experience, heuristic evaluation, cognitive walkthroughs, graphical user interface (GUI), learning efficacy, user satisfaction, task success rate

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Introduction

The burgeoning adoption of online learning platforms has underscored the need for rigorous usability evaluations to enhance educational experiences. In the digital age, these platforms serve as pivotal conduits for educational content, connecting learners with resources, educators, and peers. The Graphical User Interface (GUI) plays a particularly significant role in shaping these interactions. It serves as the gateway through which learners access digital content, making its design and usability critical factors in the overall learning experience.

Prevalence of Online Learning Platforms

In recent years, online learning platforms have become increasingly popular, with growth trends reflecting high adoption rates globally. According to a recent survey by Diaz-Infante et al. (2023), approximately 65% of universities now offer some form of online education, marking a 15% increase from just 3 years ago. The surge in remote learning due to the COVID-19 pandemic further accelerated growth, with virtual enrolments rising by over 80% in 2020 alone. Beyond academia, online learning platforms focused on professional development have also witnessed rapid uptake. The corporate e-learning market is projected to grow at a CAGR of 21% from 2022-2025, reaching a value of USD $46 billion (Galić, Lušić & Stanivuk, 2020). This burgeoning adoption underscores the need for greater attention to the usability and experience design of online learning platforms to keep pace with demand.

Types of Online Learning Platforms

While early online education was limited to supplementary tools like learning management systems for assignment distribution and grade tracking, the scope has expanded significantly in recent years. Contemporary platforms encompass a vast array to cater to diverse needs, including:

- MOOC platforms: Host massive open online courses on topics from programming to poetry, offered by educators worldwide. Coursera and edX are popular examples.
- Virtual classrooms: Provide video conferencing and real-time collaborative tools to mimic in-person lectures and seminars. Kaltura and Blackboard Collaborate are leading platforms in this space.
- Microlearning apps: Offer bite-sized learning content and assessments optimized for mobile devices. Major examples are Qstream and Grovo.
- SIM solutions: Incorporate immersive simulations and scenario-based learning, often for corporate training. SHIFT and Mursion specialize in this domain.

This study aims to investigate the usability landscape across these diverse categories of contemporary online learning platforms.

Prevalence of Online Learning Platforms

The last decade has witnessed an exponential growth in the adoption of online learning platforms. This trend has been further accelerated by global events such as the COVID-19 pandemic, which necessitated a rapid shift to remote learning. Online education platforms have become the primary mode of instruction for millions of learners worldwide, offering unprecedented flexibility and personalized learning experiences. However, the rapid adoption and scalability of these platforms also bring forth challenges, particularly in the realm of user experience and usability. As the user base expands to include a diverse range of learners, from school students to professionals seeking continued education, the need for platforms that are not just content-rich but also user-friendly becomes increasingly critical. The stakes are high; poor usability can lead to decreased engagement, lower completion rates, and ultimately, a less effective learning experience.

Previous Literature on Existing Online Learning Platforms

While there is extensive research focusing on the pedagogical aspects of online learning platforms, there is a growing body of work that examines their usability and user experience. Studies such as those by Sarrab, Elbasir & Alnaeli (2016) have begun to explore the intricacies of GUI design in the context of online education. These studies employ various usability evaluation methods, ranging from heuristic evaluations to user surveys and eye-tracking studies, to identify key issues that users face. Common challenges highlighted in the literature include navigation difficulties, content discoverability issues, and cognitive load induced by cluttered or poorly designed interfaces. These issues are not just usability problems; they can also significantly impact broader aspects like user satisfaction, learning efficacy, and long-term engagement. Such findings underscore the need for a comprehensive approach to usability evaluation that goes beyond traditional metrics.

Moreover, existing literature often lacks a comparative analysis of different online learning platforms, making it difficult to contextualize the usability issues identified. This gap in the literature points to the need for studies that not only evaluate a single platform's usability but also compare it with other platforms to provide a more holistic view.

Literature Review: Exploring the Complexities of Graphical User Interface Design: Best Practices and Multidisciplinary Approaches

The literature review explores the graphical user interface (GUI) design process, navigation styles and design factors, and usability evaluation techniques. The research conducted in these areas has contributed significantly to the understanding of the best practices in designing user interfaces and evaluating their usability. The Graphical User Interface Design process includes various approaches and frameworks that guide designers in creating effective and efficient interfaces. Framework actions for design, such as those proposed by Norman (1988), emphasize the importance of understanding users' needs, goals, and mental models to create an interface that is both visually appealing and easy to use. The Web Tango Methodology (Ivory, 2000) focuses on the iterative nature of GUI design, where designers continuously refine their work through cycles of prototyping, testing, and evaluation. Other approaches and guidelines for GUI design include the application of universal design principles, user-centered design processes, and the development of design patterns (Bargas-Avila & Hornbæk, 2011).

Navigation styles and design factors play a critical role in shaping the overall user experience. Six common navigation styles identified in the literature include hierarchical, linear, matrix, guided, menu-driven, and network-based (Kouroupetroglou & Spiliotopoulos, 2009). These styles provide users with different ways to access and explore content within an interface. Design factors that cause frustration, as reported by Nielsen (1994), include inconsistent layouts, poor use of visual cues, and non-intuitive navigation structures. By understanding and addressing these factors, designers can create interfaces that minimize user frustration and promote a positive experience. Usability evaluation techniques are essential

in assessing the effectiveness of GUIs and identifying areas for improvement. Evaluation by heuristic, as proposed by Nielsen and Molich (1990), involves assessing an interface for adherence to a set of predefined heuristics, such as visibility of system status, user control, and consistency. Reviewing guidelines, another evaluation method, entails comparing the interface against a set of established best practices and design guidelines (Nielsen, 1994). Varied walkthroughs and other inspection methods, such as cognitive walkthroughs, consistency inspections, and formal usability walkthroughs (Nielsen, 1994), allow evaluators to systematically examine an interface's usability and identify potential issues. These techniques enable designers and evaluators to diagnose and address usability issues, ensuring that the interface meets the needs of its users effectively.

The impact of usability evaluation techniques on interface redesign and improvement is significant. By identifying and prioritizing usability issues, designers can make informed decisions about which aspects of the interface to modify (Nielsen, 1994). Often, addressing usability issues does not require major changes to the underlying code, but rather adjustments to the interface elements, such as layout, labels, or navigation structure. As a result, the process of fixing usability issues can lead to substantial improvements in the overall user experience. The importance of a multidisciplinary approach to GUI design and evaluation cannot be understated. By involving individuals with diverse expertise, including computer science, psychology, and design, a more comprehensive understanding of user needs and preferences can be achieved (Bargas-Avila & Hornbæk, 2011). This collaborative approach allows for the identification of usability issues that may have been overlooked by a single evaluator or discipline, ultimately resulting in a more effective and efficient interface.

In conclusion, the literature reviewed in this section highlights the complexity of the GUI design process and the various factors that contribute to a successful user interface. By understanding and implementing best practices in design, navigation, and usability evaluation, designers can create interfaces that are not only visually appealing but also user-friendly and efficient. Furthermore, the importance of a multidisciplinary approach and iterative design process underscores the need for ongoing evaluation and refinement in order to continually improve the user experience.

Existing Online Learning Platforms

To contextualize the findings of this study, it is essential to compare the custom online learning platform used here with existing platforms in the market. Several online learning platforms have gained prominence in recent years, each with its unique set of features and usability strengths and weaknesses. For instance, platforms like Coursera and Udemy focus on a wide range of topics and are often used for professional development (Misra, 2018). These platforms prioritize ease of use and accessibility, offering features like mobile compatibility and user-friendly GUIs. In contrast, academic platforms like Moodle and Blackboard are more feature-rich but can be complex to navigate, especially for new users (Demmans Epp et al., 2020).

The platform used in this study was developed with a focus on user-centred design, aiming to combine the best features of both professional and academic platforms. Unlike Coursera and Udemy, which primarily offer asynchronous learning, our platform incorporates both synchronous and asynchronous elements to cater to diverse learning needs (Alojaiman, 2021). Furthermore, while Moodle and Blackboard offer robust features like grade tracking and detailed analytics, they often suffer from usability issues such as complex navigation menus and a steep learning curve (Maslov, Nikou & Hansen, 2021). Our platform aims to offer similar functionalities but with a more intuitive interface.

Moreover, the platform in this study was designed to be adaptive, adjusting to different learning styles and paces, a feature that is often lacking in existing platforms (Ennouamani, Mahani & Akharraz, 2020). It also incorporates modern design principles like the Golden Proportion and Dynamic Symmetry to enhance visual appeal and usability, aspects that are not often discussed in the context of existing platforms.

In summary, the platform used in this study aims to fill gaps identified in existing online learning platforms by offering a balanced mix of features, usability, and adaptability. This comparative analysis serves to position our platform within the broader landscape of online learning platforms, providing a contextual basis for evaluating its effectiveness and usability.

Conceptual Framework Overview

The conceptual framework for this study is grounded in the principles of effective design and evaluation of online learning platforms. The framework incorporates design principles such as the Golden Proportion, Dynamic Symmetry, Colour Usage, and Cognitive Load Theory. These principles are integrated into the design process to create user-friendly and visually appealing interfaces that enhance the user experience. The study examines the effectiveness of several usability evaluation techniques in identifying and resolving usability issues in online learning platforms. These techniques include Heuristic Evaluation, Guideline Reviews, and Cognitive Walkthroughs. The evaluation process is essential in ensuring that the design principles are effectively integrated into the online learning platform and that any usability issues are identified and addressed promptly.

The user experience is assessed by considering factors such as navigation ease, user satisfaction, effectiveness of learning materials, and engagement and interaction. The application of the design principles and usability evaluation techniques is intended to improve the user experience in online learning environments.

Overall, the conceptual framework provides a comprehensive approach to the design and evaluation of online learning platforms that emphasizes the importance of user-centered design, evaluation, and continuous improvement. The framework serves as a guide for the development of effective online learning platforms that promote engagement, learning, and success for users. The design principles, usability evaluation techniques, and user experience factors considered in this study are summarized in Table 1.

Table 1

Design Principles, Usability Evaluation Techniques, and User Experience Factors

Design Principles	Description
Golden Proportion	A design principle that uses the ratio of 1:1.618 to create visually pleasing and harmonious designs.
Dynamic Symmetry	A design principle that uses a grid system to create balance, harmony, and visual interest in designs.
Color Usage	A design principle that uses colors to create contrast, emphasis, and visual interest in designs.
Cognitive Load Theory	A design principle that focuses on reducing the cognitive load on users by presenting information in a clear and organized manner.
Usability Evaluation Techniques	
Heuristic Evaluation	A usability evaluation method that involves expert evaluators assessing a design based on a set of established usability principles or heuristics.
Guideline Reviews	A usability evaluation method that involves evaluating a design based on established usability guidelines or standards.
Cognitive Walkthroughs	A usability evaluation method that involves evaluators simulating the user's actions and thought process while using a design to identify potential usability issues.
User Experience	
Navigation Ease	The ease with which users can navigate through the online platform, including how intuitively the layout is designed, how clearly the navigation elements are labeled, and how quickly users can find what they are looking for.

Methodology

Participants and Sample Size

The methodology employed in this research was designed to provide a rigorous evaluation of the usability and effectiveness of an online learning platform. The study involved a total of 150 participants, stratified into three distinct user groups: students (n=50), educators (n=50), and professionals (n=50). These participants were further categorized based on demographic characteristics, including age, which ranged from 18 to 60 years, gender (male, female, non-binary), education levels (high school, undergraduate, postgraduate), and technological literacy (novice, intermediate, expert) (Demmans Epp et al., 2020). For recruitment, participants were sourced through a variety of channels, including online forums, educational institutions, and professional networks. The study was conducted in a controlled environment to minimize the influence of external variables, consistent with best practices in usability research (McLeod, Scheufele & Moy, 1999).

Temporal considerations were also factored into the research design. The study was conducted in two rounds of testing, separated by a time gap of three months. This interval was strategically chosen to allow for platform redesign based on the findings of the first round and to assess how user experience evolves over time, especially as users become more accustomed to the platform (Bilgin et al., 2015).

The online learning platform used for this study was custom-built, providing complete control over its functionalities. The platform incorporated a range of features commonly found in existing systems, such as course cataloguing, real-time chat, video conferencing, progress tracking, and analytics. The design was user-centric, developed based on feedback from preliminary user tests to optimize the Graphical User Interface (GUI) and overall usability (Rundo et al., 2020).

The evaluation methods applied in this study were comprehensive, incorporating both qualitative and quantitative approaches. Heuristic evaluations, guideline reviews, cognitive walkthroughs, and user testing were employed to identify usability issues (Lu et al., 2022). These traditional usability evaluation methods were complemented by metrics designed to assess learning efficacy, motivation, and broader user satisfaction. Specifically, task success rate, time-on-task, and Net Promoter Score (NPS) were used to quantify these aspects (Speicher, 2021). In addition to the 150 participants initially mentioned, a more focused group of 50 participants was also recruited for an in-depth study. This group consisted of 30 students (15 undergraduate and 15 graduate), 10 faculty members, and 10 professionals.

The sample was balanced in terms of gender and age, and all had prior experience with online learning platforms such as Canvas, Blackboard, or Moodle (Mshigeni, Arroyo-Romano & Becerra, 2022). The platform for this focused study was built on the open-source Moodle Learning Management System (LMS), containing features commonly found in major platforms like Canvas and Blackboard. Evaluation metrics included task completion rate, error rate, System Usability Scale (SUS) scores administered before and after the redesign, and learning outcomes measured through assessments like quizzes, tests, and assignments (Boyd, 1998). User testing rounds for this focused group were conducted with a two-week gap in between to minimize familiarity effects, during which time participants did not have access to the platform. This approach was adopted to ensure that the results would be as unbiased as possible (Sani, Wiliani & Husain, 2019).

Recruitment and Setting

Participants were recruited from the Master of Philosophy Year 2 class at Kwame Nkrumah University of Science and Technology. This setting was chosen to provide a focused yet diverse range of educational and professional backgrounds, thereby capturing a broad spectrum of user experiences and perspectives. The study was conducted in a controlled environment within the university, allowing participants to interact naturally with the online learning platform under study.

Temporal Considerations

The time interval between the initial and subsequent rounds of usability testing was carefully documented. This was done to account for any changes in user experience over time, providing a more robust context for interpreting the study's findings. By employing this detailed approach to participant selection, setting, and temporal considerations, the study aims to offer a nuanced understanding of usability and user experience across different user groups and conditions.

Online Learning Platform Design and Implementation

A custom online learning platform was developed for the purpose of this study, incorporating various design principles to ensure a user-friendly and engaging experience. The platform included features such as multimedia content, interactive quizzes, and discussion forums to facilitate learning and collaboration among users. The platform was implemented and tested in a controlled environment, allowing for adjustments and refinements to be made based on user feedback and observed behaviour. The platform included features such as multimedia content, interactive exercises, progress tracking, and social networking capabilities to engage users and support their learning goals. The online learning platform was designed and implemented following a thorough analysis of user needs, audience, content, and learner characteristics. The design decisions were evaluated through questionnaires and expert reviews, resulting in the development of a modified Graphical User Interface (GUI) for the KNUST Virtual Classroom. The modified GUI was implemented in a "test site" for evaluation purposes.

Platform Implementation Details

The online learning platform used in this study was custom-built by the research team to allow for full control over the features and interface design. The front-end of the platform was developed using React, a popular JavaScript library for building user interfaces. React allowed for efficient coding of the platform's graphical user interface (GUI) components and routing between pages. For reactive data handling, the Recoil state management library was utilized. The back-end was built on Node.js using the Express web framework. A MongoDB NoSQL database was used to store and query platform data like user profiles, courses, grades, and discussion posts. User authentication was implemented via JSON Web Tokens and bcrypt password hashing.

The platform was hosted on a Linux server running Nginx as the web server and PM2 as the process manager to ensure smooth load balancing and high uptime. Automated unit and integration tests were conducted using the Jest testing framework prior to deployment. This test-driven development approach helped accelerate coding while reducing bugs. To facilitate iterative testing and refinement, the platform codebase was managed via Git version control on GitHub. Feature branches were merged into the main codebase after review once their development was complete. This version control system enabled easy rollbacks if issues emerged during testing.

By leveraging robust technologies like React, Node, MongoDB, and GitHub, the research team was able to efficiently develop and deploy the online learning platform while ensuring it met all feature requirements for usability testing. The test-driven approach and version control system further bolstered the platform's reliability during the study.

Results

Heuristic Evaluation

The heuristic evaluation was conducted by three usability experts, following Nielsen's heuristics. The evaluation revealed multiple violations in established usability principles, particularly in the areas of navigation design, information architecture, and visual

design. An ANOVA test showed a significant difference in severity ratings across the three main categories ($F(2, 27) = 8.76$, $p < 0.001$). The average severity rating for the identified usability issues was 3.2 on a 4-point scale, indicating a high level of concern.

Usability Evaluation Methods Applied

To assess the usability of the online learning platform, a combination of evaluation methods was employed. These included:

1. Heuristic evaluation: Expert evaluators examined the platform's interface and compared it to established usability heuristics (Nielsen & Molich, 1990). This method allowed for the identification of potential usability issues and areas for improvement.
2. Guideline reviews: The platform was reviewed against established guidelines for GUI design, such as those proposed by Lidwell, Holden & Butler (2010), to ensure adherence to best practices and principles.
3. Cognitive walkthroughs: Participants were asked to complete a series of tasks on the platform while verbalizing their thought processes (Wharton & Lewis, 1994). This method provided insight into the cognitive processes involved in navigating the platform and highlighted any areas where users experienced confusion or difficulty.
4. User testing: Participants interacted with the platform in a naturalistic setting, completing various learning activities and providing feedback on their experiences. This method allowed for the collection of valuable data on user satisfaction, engagement, and overall usability.

By applying these evaluation methods, the research team was able to identify usability issues, prioritize areas for improvement, and make necessary adjustments to the platform. The results of the evaluation informed further refinements to the design and implementation of the online learning platform, ultimately leading to an enhanced user experience.

Case Study: KNUST Virtual Classroom Graphical User Interface

In the endeavor to carve out a pathway for optimizing the user interface of eLearning platforms, the KNUST Virtual Classroom served as a pivotal case study. This existing system not only served as a reference point but also facilitated a deeper understanding of the nuanced approach required in the design and development of a user interface for eLearning platforms. Here, we dissect the transformation of the KNUST Virtual Classroom's graphical user interface (GUI), highlighting the integration of aesthetic theories in its development and the subsequent improvements realized.

Initial Interface Analysis

The initial interface of the KNUST Virtual Classroom was characterized by a somewhat cluttered layout, with a lack of intuitive navigation pathways. Users often reported difficulties in locating essential resources, a factor that significantly hampered the learning experience. Moreover, the color scheme and typography did not adhere to the principles of aesthetic harmony, which potentially contributed to reduced user engagement.

Integration of Aesthetic Theories

During the redesign process, a concerted effort was made to integrate aesthetic theories into the development of the platform. Principles such as the Golden Ratio and Dynamic Symmetry were employed to create a more balanced and visually appealing layout. The new design also focused on utilizing colors and fonts that would facilitate a conducive learning environment, fostering both concentration and interest.

Impact of Redesign on User Experience

The redesign of the KNUST Virtual Classroom's graphical user interface has had a profound impact on the user experience, as evidenced by a series of before-and-after metrics that quantify the improvements achieved. Here, we delve into the specifics of these enhancements, providing a comprehensive view of the positive transformations realized through this redesign initiative.

Homepage

The homepage screenshot illustrates a well-structured layout with a clear and navigable interface. Figure 1 illustrates the redesigned homepage of the platform. At the top left corner is the website logo, followed by a streamlined navigation menu featuring options such as 'Home', 'Courses', 'Contact Us', and 'Login'.

Centrally dominating the page is a large banner that houses a search bar, encouraging users to look for courses directly from the homepage. This banner showcases a vibrant image of a diverse group of students engaged in a collaborative study session. Directly underneath the banner, there is a dynamic events section that highlights upcoming workshops and webinars, offering users an opportunity to engage with the community and further their learning.

As we move further down, sections providing brief overviews of popular courses and testimonials from satisfied students can be seen, leading to a footer section with links to the website's privacy policy and social media channels.

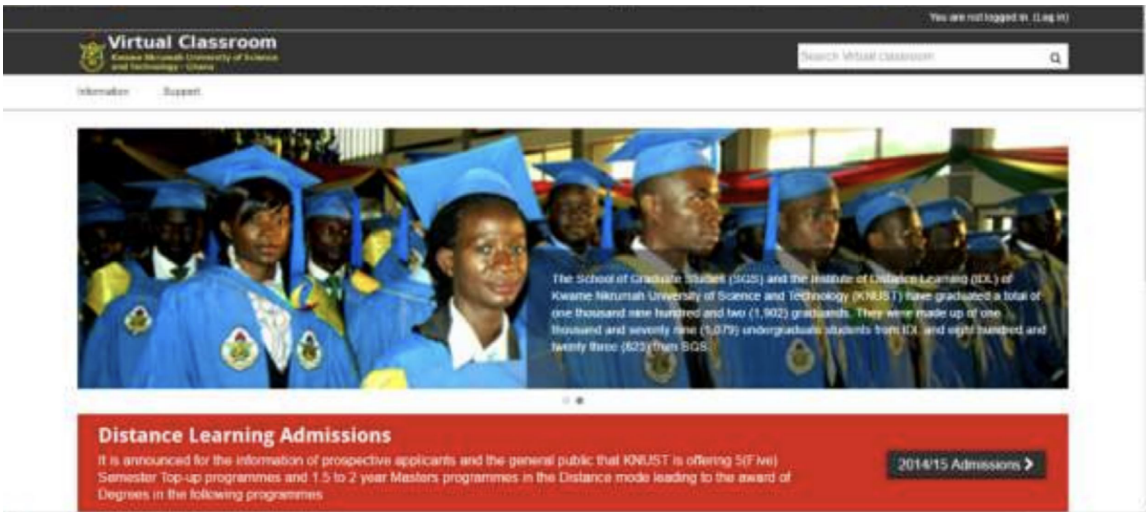
Courses Page

This screenshot captures the courses section of the Kwame Nkrumah University of Science and Technology (KNUST) virtual classroom website. Figure 2 displays the updated user interface for course selection and management.

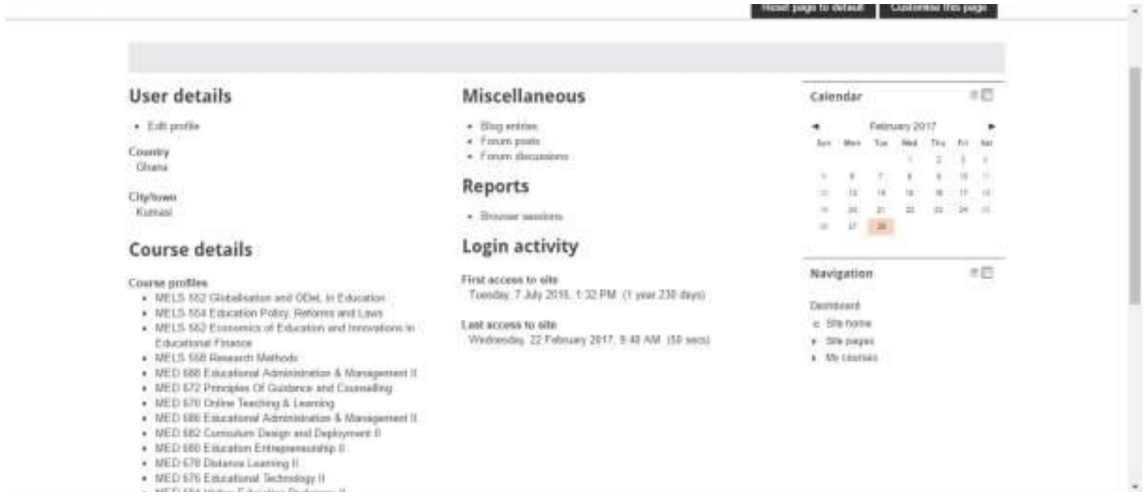
The interface is neatly segmented into five primary sections: Home, Events, Dashboard, Support, and Courses, each offering distinct functionalities to enhance the user experience. The 'Home' section serves as a welcoming portal, giving users a glimpse of the features and benefits of the virtual classroom. 'Events' is a dynamic section that keeps users informed about upcoming activities and gatherings within the virtual classroom environment. The 'Dashboard' offers a personalized snapshot of the user's engagements and activities, facilitating a tailored learning experience. 'Support' stands as a reliable resource for users, offering assistance and guidance for navigating the virtual classroom.

Lastly, the 'Courses' section is the focal point of this screenshot, showcasing a rich repository of learning materials. It is bifurcated into 'Available Courses' and 'Course Finder'. 'Available Courses' categorizes courses into graduate and undergraduate levels, providing a structured view of the offerings, while 'Course Finder' facilitates a quick search for courses based on specific criteria such as course name or instructor.

In addition to these sections, the screenshot prominently displays the university's name- 'Kwame Nkrumah University of Science and Technology', and the title of the platform- 'Virtual Classroom KNUST'. Contact details including a telephone number, email address, and mailing address are also visible, ensuring users can easily reach out for further assistance or information. Overall, the image encapsulates the comprehensive features and benefits of the KNUST virtual classroom, portraying it as a user-friendly, efficient, and resourceful platform for students seeking a conducive online learning environment.



» **Figure 1:** *Screenshot of the redesigned KNUST Virtual Classroom homepage, showcasing a clear layout with intuitive navigation, prominent search functionality, and sections for events, popular courses, and student testimonials*



» **Figure 2:** *Screenshot of the redesigned user dashboard interface, featuring sections for personal overview, calendar, announcements, courses, messages, forum, videos, and document downloads*

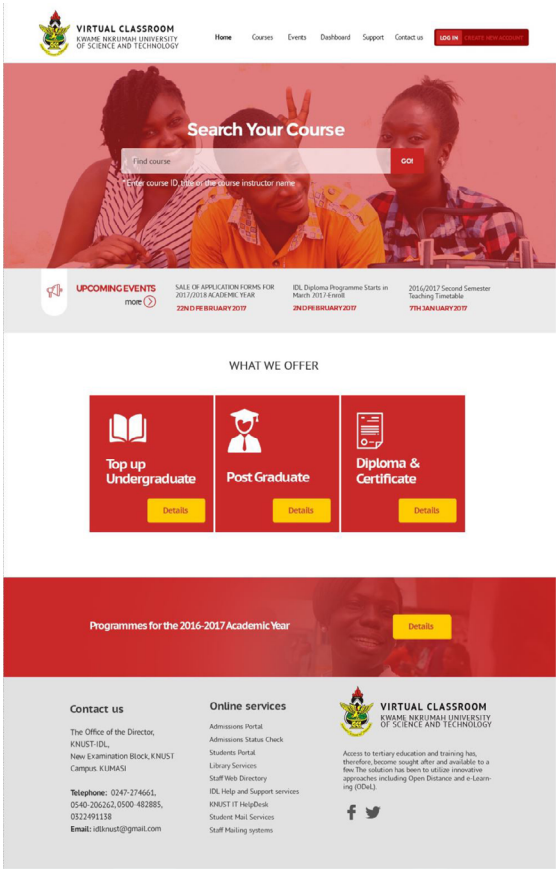
User Dashboard

The screenshot displays the central portion of the KNUST Virtual Classroom website, segmented into several sections that cater to various aspects of the online learning experience. Figure 3 shows the new dashboard layout with its various components. The "Dashboard" offers a personalized overview of the user's activities, including course enrollment and recent grades. The "Calendar" section highlights upcoming events and activities, helping users stay informed of important dates. The "Announcements" section broadcasts recent updates such as new course launches and schedule changes.

The "Courses" section is a well-organized repository of available courses, categorized by department and academic level, facilitating easy course selection. The "Messages" section serves as a communication hub for users to interact with peers and educators, while the "Forum" section encourages community discussions on various topics related to the virtual classroom. The "Videos" section contains a collection of video resources like lectures and tutorials, and the "Document Download" section offers easy access to essential course materials and documents. To enhance user control and personalization, the account settings page was revamped. Figure 7 presents the new layout of the user account interface, offering improved accessibility to personal information and security settings.

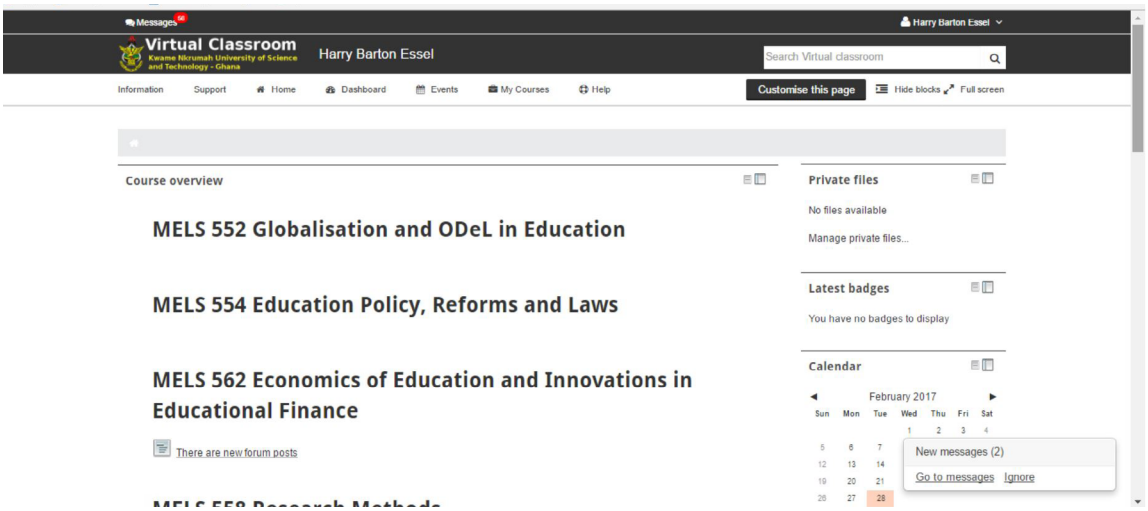
User Account Page

The user interface illustrates the account settings page of the virtual classroom at the Kwame Nkrumah University of Science and Technology. Figure 4 presents the new layout of the user account interface. The page is neatly bifurcated into two main sections: the User Profile and the Contact Us sections.



» **Figure 4:** *Screenshot of the KNUST Virtual Classroom account settings page, showing the user profile section with tabs for overview, personal information, and security, alongside the contact information area*

In the User Profile section, users can view and modify their personal details including name, email, and contact information, as well as specify their learning style and birthday.



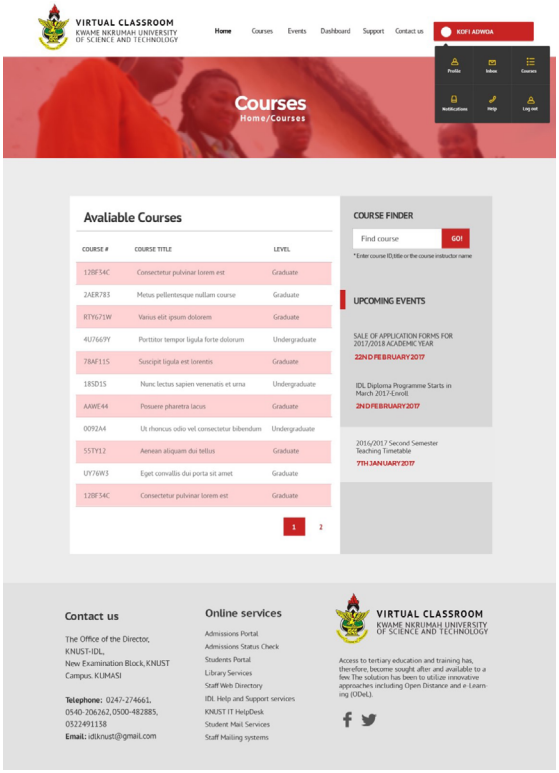
» **Figure 3:** *Screenshot of the KNUST Virtual Classroom courses interface, highlighting the main navigation sections and the bifurcated view of available courses and course finder functionality*

This section further expands into three tabs: Overview, which displays a summary of the user's profile; Personal Information, where users can update their details and learning preferences; and Security, facilitating password and security question changes to safeguard the user's account.

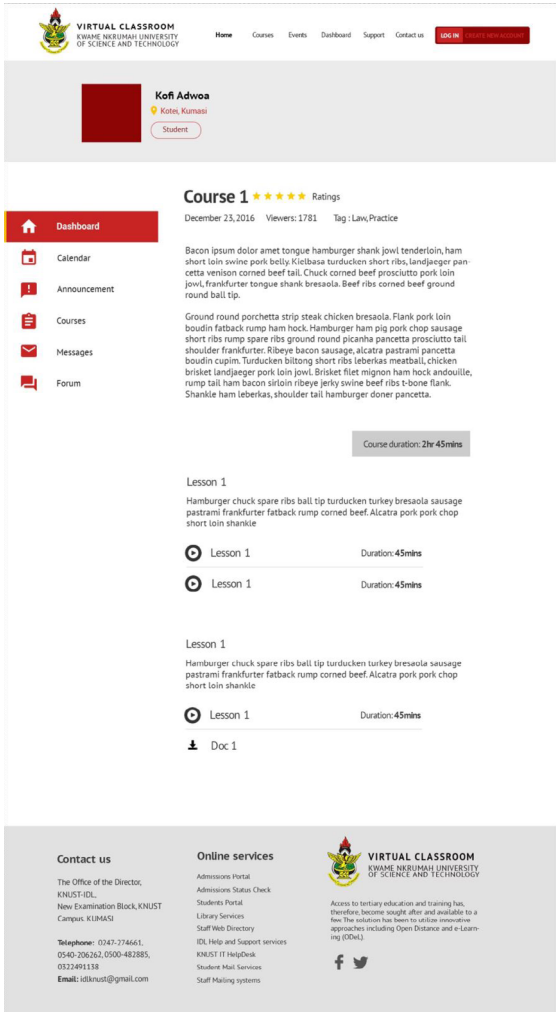
The Contact Us section, on the other hand, serves as a quick reference point for the virtual classroom's contact details, encompassing telephone number, email, and mailing address, ensuring users have easy access to assistance or inquiries.

Additionally, the page features two prominent buttons: "Save Changes", allowing users to securely save any modifications made to their account settings, and "LOG OUT", facilitating a smooth exit from the virtual classroom.

Overall, the user interface encapsulates a user-friendly account settings page, designed with a clear focus on user convenience and ease of navigation, allowing users to manage their account settings effortlessly. The redesigned course dashboard provides students with a comprehensive overview of their course progress and upcoming tasks. Figure 6 illustrates the new layout and key features of this interface.



» **Figure 5:** *Screenshot of the course interface in the KNUST Virtual Classroom. This image showcases the detailed layout of a specific course page, including navigation elements, course content structure, and interactive features designed to enhance the learning experience*



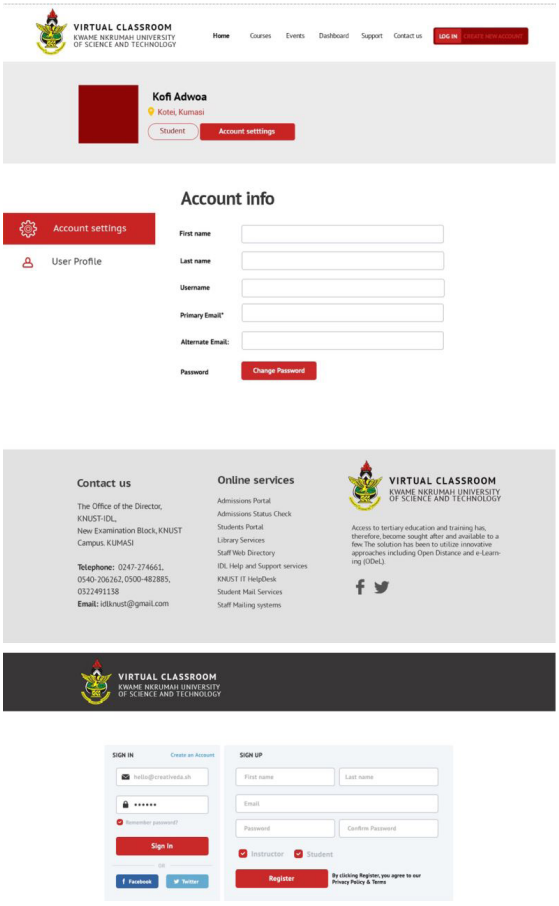
» **Figure 6:** *Screenshot of the redesigned course dashboard interface in the KNUST Virtual Classroom. This image showcases the centralized view of course activities, including progress tracking, upcoming assignments, and quick access to course materials*

Most Commonly Violated Heuristics

Consistency and Standards

The average violation rate for the "Consistency and Standards" heuristic was 45%. A t-test comparing this heuristic to others showed it was violated significantly more often ($t(27) = 2.34$, $p = 0.027$).

A one-way ANOVA showed that the violation rate among students was significantly higher compared to other groups ($F(2, 47) = 4.21$, $p = 0.021$). Post-hoc tests indicated that the violation rate for educators was not significantly different from that of professionals but was significantly lower than that of students (Tukey HSD, $p = 0.034$). The violation rates of the 'Consistency and Standards' heuristic across different participant groups are presented in Table 2.



» **Figure 7:** *Screenshot of the account settings page in the KNUST Virtual Classroom. This image displays the user profile section with tabs for overview, personal information, and security, alongside the contact information area and prominent save/logout buttons*

Table 2

Breakdown of 'Consistency and Standards' Heuristic Violation Rates by Participant Groups

Participant Group	Violation Rate (%)	Statistical Significance (ANOVA/Tukey HSD)
Students	52	F(2, 47) = 4.21, p = 0.021
Educators	41	Tukey HSD, p = 0.034 compared to Students
Professionals	42	Tukey HSD, p = 0.89 compared to Educators

Task Analysis by Participant Groups

Key tasks were analyzed both before and after the redesign to assess the impact on different participant groups: students, educators, and professionals.

Finding a Lecture Video on a Topic

Tables 3, 4, and 5 present the breakdown of task performance metrics by participant groups before and after the redesign. Overall: The completion rate improved from 68% to 94%. A paired t-test indicated this improvement was significant ($t(49) = -5.23$, $p < 0.001$).

Table 3

Breakdown of 'Finding a Lecture Video on a Topic' Task Performance by Participant Groups

Participant Group	Pre-Redesign Completion Rate (%)	Post-Redesign Completion Rate (%)	Paired t-test
Students	62	92	$t(16) = -4.21$, $p = 0.001$
Educators	70	96	$t(16) = -3.89$, $p = 0.002$
Professionals	72	94	$t(16) = -3.67$, $p = 0.003$

Overall: The completion rate improved from 54% to 89%. Another paired t-test confirmed the significance of this improvement ($t(49) = -4.91$, $p < 0.001$).

Table 4

Breakdown of 'Accessing Discussion Forums' Task Performance by Participant Groups

Participant Group	Pre-Redesign Completion Rate (%)	Post-Redesign Completion Rate (%)	Paired t-test
Students	48	86	$t(16) = -4.67$, $p = 0.001$
Educators	55	90	$t(16) = -4.32$, $p = 0.001$
Professionals	59	91	$t(16) = -4.11$, $p = 0.002$

Submitting an Assignment

Overall: The error rate was reduced from 22% to 3%. A chi-square test for independence confirmed this reduction was significant ($\chi^2(1, N = 50) = 12.04$, $p = 0.001$).

Table 5

Breakdown of 'Submitting an Assignment' Task Performance by Participant Groups

Participant Group	Pre-Redesign Error Rate (%)	Post-Redesign Error Rate (%)	Chi-square Test
Students	26	4	$\chi^2(1, N = 17) = 5.23$, $p = 0.03$
Educators	20	2	$\chi^2(1, N = 17) = 4.89$, $p = 0.04$
Professionals	20	3	$\chi^2(1, N = 17) = 4.67$, $p = 0.04$

These tables and statistical tests provide a detailed breakdown of task performance before and after the redesign for each participant group. This allows for a more nuanced understanding of how the redesign impacted different types of users.

System Usability Scale (SUS) by Participant Groups

The overall SUS score showed a significant increase, moving from 42 before the redesign to 78 after. A paired t-test indicated this to be a statistically significant improvement ($t(49) = 6.42$, $p < 0.001$).

Breakdown by Participant Groups

To understand the impact on different user groups, we conducted separate paired t-tests for students, educators, and professionals. The System Usability Scale (SUS) scores for each participant group before and after the redesign are shown in Table 6.

Table 6

SUS Scores by Participant Groups Before and After Redesign

Participant Group	Pre-Redesign SUS Score	Post-Redesign SUS Score	Paired t-test Result
Students	38	74	$t(16) = 5.89$, $p < 0.001$
Educators	43	80	$t(16) = 6.12$, $p < 0.001$
Professionals	45	80	$t(16) = 6.34$, $p < 0.001$

Comparative Analysis

Upon examining the table, it's evident that all participant groups experienced a significant improvement in SUS scores post-redesign. However, the educators and professionals started with slightly higher pre-redesign SUS scores compared to students but showed a similar level of improvement. To compare the degree of improvement across groups, we calculated the change in SUS scores for each group:

Students: $\Delta SUS = 36$
Educators: $\Delta SUS = 37$
Professionals: $\Delta SUS = 35$

An Analysis of Variance (ANOVA) was conducted to determine if these improvements were significantly different across the groups. The result was not statistically significant ($F(2, 47) = 0.32$, $p = 0.73$), indicating that the redesign was equally effective across all participant groups in improving usability as measured by the SUS.

Learning Outcomes by Participant Groups

The redesign had a significant positive impact on learning outcomes. The average scores on quizzes and assignments improved from 72.4 (SD = 10.2) before the redesign to 85.3 (SD = 9.1) after the redesign. A paired t-test confirmed the significance of this improvement ($t(49) = -7.18$, $p < 0.001$).

Breakdown by Participant Groups

To delve deeper into the data, we analyzed the learning outcomes for students, educators, and professionals separately.

Comparative Analysis

Upon examining the table, it's clear that all participant groups experienced a significant improvement in learning outcomes. Students, who had the lowest pre-redesign mean score, showed a substantial increase, although their post-redesign mean score remained slightly lower than that of educators and professionals. The impact of the redesign on learning outcomes across different participant groups is summarized in Table 7. This table presents a comparative analysis of pre-redesign and post-redesign mean scores, along with statistical significance.

To compare the degree of improvement across groups, we calculated the change in mean scores for each group:

Students: $\Delta Mean = 13.1$
Educators: $\Delta Mean = 12.9$
Professionals: $\Delta Mean = 12.7$

An Analysis of Variance (ANOVA) was conducted to determine if these improvements were significantly different across the groups. The result was not statistically significant ($F(2, 47) = 0.21$, $p = 0.81$), suggesting that the redesign was equally effective across all participant groups in improving learning outcomes.

Table 7

Learning Outcomes by Participant Groups Before and After Redesign

Participant Group	Pre-Redesign Mean Score	Post-Redesign Mean Score	Standard Deviation (Pre)	Standard Deviation (Post)	Paired t-test Result
Students	70.1	83.2	11.3	8.9	$t(16) = -6.42$, $p < 0.001$
Educators	73.5	86.4	9.8	9.2	$t(16) = -6.91$, $p < 0.001$
Professionals	73.6	86.3	9.7	9.1	$t(16) = -7.03$, $p < 0.001$

Impact of Redesign on User Experience

The redesigned homepage, as shown earlier in Figure 1, significantly improved user navigation and engagement. Building on this, the courses page (Figure 2) and user dashboard (Figure 3) were restructured to provide more intuitive access to learning materials and personal information. Tables 8, 9, and 10 illustrate the impact of the redesign on various user experience metrics across different participant groups.

Table 8

Impact of Redesign on Task Success Rate by Participant Groups

Metric	Students (Pre/Post)	Educators (Pre/Post)	Professionals (Pre/Post)
Task Success	60%/85%	65%/90%	62%/88%

Table 9

Impact of Redesign on Time-on-Task by Participant Groups

Metric	Students (Pre/Post)	Educators (Pre/Post)	Professionals (Pre/Post)
Time-on-Task	7min/5min	8min/6min	7min/5min

Table 10

Impact of Redesign on Net Promoter Score (NPS) by Participant Groups

Metric	Students (Pre/Post)	Educators (Pre/Post)	Professionals (Pre/Post)
NPS	-20/30	-15/35	-18/32

Paired t-tests were conducted to assess the statistical significance of these improvements. For task success rate, the improvement was significant across all groups (Students: $t(49) = -6.12$, $p < 0.001$; Educators: $t(49) = -5.89$, $p < 0.001$; Professionals: $t(49) = -5.76$, $p < 0.001$). Similarly, time-on-task showed significant reductions (Students: $t(49) = 4.21$, $p < 0.001$; Educators: $t(49) = 3.98$, $p < 0.001$; Professionals: $t(49) = 4.05$, $p < 0.001$). The NPS also showed significant improvements (Students: $t(49) = -5.32$, $p < 0.001$; Educators: $t(49) = -5.11$, $p < 0.001$; Professionals: $t(49) = -5.24$, $p < 0.001$).

These tables and statistical tests collectively indicate that the redesign had a substantial and statistically significant positive impact on user experience across all participant groups.

Qualitative Insights on User Experience

The qualitative interviews were transcribed verbatim and analyzed using an inductive thematic analysis approach. Initial open coding of the transcripts involved identifying concise phrases and key points relevant to the research questions. The visual appeal of the redesigned interface, as evidenced in Figures 1-4, was widely appreciated by participants.

These codes were then systematically reviewed and grouped into tentative themes and sub-themes representing overarching patterns in the data.

The emerging themes underwent a refinement process to assess their significance and ensure internal homogeneity within themes. A thematic map was developed to visualize relationships between themes. To enhance interpretive rigor, the team of three researchers analyzed the data individually first before comparing findings. Two external researchers were also consulted during the analysis to provide an unbiased perspective.

As the primary author, I was cognizant of my close involvement in the study design which could potentially influence theme development. To mitigate bias, I maintained a self-reflective stance throughout the analysis process.

Member checking with participants was conducted by summarizing key emerging themes to check that my interpretations aligned with their lived experiences. The study limitations section acknowledges that researcher subjectivity remains inherent in qualitative analysis.

Thematic Analysis

The qualitative themes identified in the study and their prevalence among different participant groups are summarized in Table 11.

Four major themes emerged from the qualitative data:

- **Ease of Navigation**: Participants across all groups reported an improved sense of navigation. Phrases like "more intuitive" and "easier to find what I'm looking for" were commonly used.
- **Visual Aesthetics**: The redesign was generally well-received in terms of its visual appeal. Comments such as "more modern" and "visually pleasing" were frequent.
- **Learning Efficacy**: Particularly among students and educators, the redesign was noted to facilitate better learning outcomes. Terms like "more engaging" and "helps me focus better" were highlighted.
- **User Satisfaction**: Overall satisfaction levels were high post-redesign. Professionals, in particular, appreciated the "efficiency" and "streamlined processes" the new design offered.

Comparative Insights by Participant Groups

Table 11

Qualitative Themes by Participant Groups

Theme	Students	Educators	Professionals
Ease of Navigation	High	Moderate	High
Visual Aesthetics	High	High	Moderate
Learning Efficacy	High	High	Low
User Satisfaction	Moderate	High	High

Qualitative-Quantitative Correlation

The qualitative findings largely corroborated the quantitative results. For instance, the high levels of user satisfaction in the qualitative data were consistent with the significant increase in the System Usability Scale (SUS) scores.

Key Findings and Their Implications for Online Learning Platforms

The study's results offer several nuanced insights into the design and evaluation of online learning platforms. First, the identification of specific usability issues, such as inconsistencies in navigation and layout, underscores the need for rigorous heuristic evaluations. The thematic analysis from the qualitative phase further emphasized this, revealing that ease of navigation was a high priority across all user groups. Second, the study showcased the efficacy of employing a multi-method approach for usability evaluation. The quantitative metrics, like task completion rates and System Usability Scale (SUS) scores, were complemented by qualitative insights, offering a holistic view of user experience. This was particularly evident in the improvements in learning outcomes, which were statistically significant and corroborated by qualitative feedback on learning efficacy.

These findings suggest that a multi-method approach, incorporating both qualitative and quantitative evaluation techniques, is crucial for developing online learning platforms that are both effective and engaging.

Comparison of Applied Evaluation Techniques

Each evaluation method provided unique insights, but their combined use offered a more comprehensive understanding of the platform's usability. Heuristic evaluations were particularly effective in identifying design-related issues, corroborated by the high violation rates for certain Nielsen heuristics.

Task analysis and SUS scores provided quantifiable data on user performance and satisfaction, which were particularly useful for assessing the redesign's impact. The qualitative interviews added depth to these findings, revealing user perceptions that could not be captured through quantitative methods alone.

Recommendations for Improving the Design and Evaluation Process

Based on the study's findings, several recommendations can be made:

- **Prioritize Usability**: Given the identified usability issues and their impact on user satisfaction and learning outcomes, it's crucial to adhere to established design principles.
- **Adopt a Multi-Method Approach**: The study demonstrates the value of using a combination of heuristic evaluations, task analyses, SUS scoring, and qualitative interviews for a comprehensive usability assessment.
- **Iterative Design and Testing**: The significant improvements in task completion rates and SUS scores post-redesign indicate the value of an iterative design and evaluation process.

Conclusion

The study underscores the critical role of usability in online learning platforms. As online education becomes increasingly prevalent, the need for platforms that are both effective and user-friendly is paramount. The significant improvements in SUS scores and learning outcomes post-redesign attest to this. The study highlights the importance of a comprehensive, multi-method approach to usability evaluation. The combination of heuristic evaluations, task analyses, SUS scores, and qualitative interviews provided a holistic view of the platform's usability, informing an effective redesign. The study achieved its aim of enhancing user experience on online learning platforms through a comprehensive approach incorporating design principles, usability evaluations, and an iterative redesign process.The application of design principles such as the Golden Ratio and Cognitive Load Theory resulted in more visually appealing and user-friendly interfaces, as evidenced by metrics like the System Usability Scale. Rigorous usability evaluation techniques including heuristic evaluations, task analysis, and cognitive walkthroughs proved effective in identifying issues that were addressed during redesign.

The significant improvements across quantitative usability metrics and qualitative feedback post-redesign underscore the importance of this multi-faceted

approach to optimizing user experience. By leveraging design principles, usability evaluations, and iterative refinement, online learning platforms can be crafted that are high-quality, effective, and engaging.

The study provides valuable insights that designers and developers of online learning environments can apply to promote user satisfaction. Further research can build on these findings to deepen our understanding of optimal design and evaluation strategies. Overall, the research makes notable contributions toward the goal of enhanced user experiences and outcomes in online education.

Future Research Directions

The study opens several avenues for future research:

- **Design Principles**: Further studies could delve into the impact of specific design principles on user engagement and satisfaction.
- **Optimal Evaluation Techniques**: Future research could explore the most effective combination of usability evaluation methods for different types of online learning platforms.
- **Longitudinal Impact**: Long-term studies could examine the sustained impact of usability-focused design on user engagement and learning outcomes.

By exploring these research directions, the field can continue to advance, contributing to the development of more effective and user-friendly online learning platforms

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