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Dimensional Analysis of Children's Clothing Product Design Based on SPSS Factor Analysis

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Article

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ABSTRACT

The impact of the current social environment on people's consumption structure has made children's clothing an increasingly prominent strategic position in the competition in the clothing industry. To study the design dimensions of current children's clothing products, taking children's clothing products as the research object, a sample database and a vocabulary database related to design elements were constructed through market research methods. Initial data was obtained by observing, clustering, and sorting the collected 400 children's clothing samples in combination with the vocabulary database. The initial data was analysed using the factor analysis method in SPSS software, and three independent factors regarding the design dimensions of children's clothing products were extracted: aesthetic factors, care factors, and educational factors. Based on the research process and factor analysis results, we try to optimize the design of children's clothing products. The research results show that the design of children's clothing products is carried out from three dimensions: aesthetics, care and education. Also, the current children's clothing products have deficiencies in multiple design dimensions. Optimized design can be used as a guide for children's clothing design practitioners, and provide optimization directions for children's clothing practitioners to design in line with market development and children's growth needs.

KEYWORDS

dimensional analysis, children's clothing, design dimension, factor analysis, optimised design

INTRODUCTION

The role of design in children's clothing products is becoming increasingly important. Products in the children's clothing market show design trends in terms of style, fabric, and functionality that are in line with parents' consumer awareness and habits. Fashion is not only limited to adults but has swept the children's fashion world. The global children's fashion industry has grown significantly, catering to the changing tastes and preferences of young fashionistas, with an increasing emphasis on style, comfort and sustainability. At the same time, however, children are becoming more self-aware of their aesthetics and preferences and parents' decisive role in purchasing children's clothing is changing. These trends prove the importance of designing children's products that take into account both fashion development and children's physical and mental growth.

From the market's point of view, children's wear products can be divided into patterns, colours, silhouettes, fabrics and other modules of design, each of which is updated and enriched as the environment changes. For example, Figure 1 below shows the Diesel Kids 23SS collection. In keeping with the theme of the digital world that extends from the New Year, the collection emphasizes technological textures in the graphic design of the products, with cool prints of various street fashion characters. The collection is not only in line with fashion trends but also reflects children's imagination and exploratory instincts. Puma Kids, as a sports brand, has demonstrated the spirit of innovation and advancement of the times in fabric design, taking full account of the children's wearing scenarios. Meanwhile, Tie-dye, ruffles and other details take into account the fashion attributes of sports products. These cases above demonstrate that the huge development potential of the children's clothing market is self-evident. The children's clothing industry is progressing towards high-end and fashionable, requiring children's clothing brands to continuously iterate the design of each module to meet consumer demand.



Figure 1. Diesel Kids 23SS collection (<https://lu.diesel.com/en/kid/>)

From an academic point of view, the existing research on children's clothing design is more cutting-edge, providing the market with some constructive design optimization paths. For example, Jingyu D, effectively utilized modern technology to propose a modular design approach for virtual simulation fitting of children's clothing to improve potential problems in the production of children's clothing, thereby improving design efficiency and purchasing efficiency [1]. However, current related research lacks classification and summarization of the various design modules of children's clothing. Scholars in different fields are subjective in conducting design research on children's clothing products. If the design of multiple modules is categorized and summarized, designers will be able to flexibly respond to changes in children's autonomy and deficiencies in the design of children's clothing products.

Designing products that meet the requirements of the times will become a common value recognized by the contemporary children's clothing industry.

To achieve this goal, the method of factor analysis is used to explore the design dimensions of children's clothing products. Factor analysis is a statistical technique that can be applied to a variety of fields. The variability among the observed variables of interest can be described by a smaller number of unobserved variables (factors), which is exploratory and objective [2]. Therefore, this research applies the rational factor analysis method to the perceptual field of children's clothing design and tries to summarize the design dimensions applicable to most children's clothing products through the results of data analysis as a connection between the market and academic research. Firstly, the samples of children's clothing of different brands, styles and price levels are collected through the market research method, and the design-related vocabulary is established at the same time; secondly, the samples are transformed and screened one by one according to the options in the vocabulary, which serves as the initial data for conducting the factor analysis; lastly, based on the results of the objective data analysis, the design dimensions of the children's clothing products are summarized, which provides a reference for the designers to carry out the optimized design of the children's clothing products.

LITERATURE REVIEW

Analysis of child development patterns

Children learn about the world through the people and things around them. School-age children are gradually getting rid of their childishness and have a certain degree of imagination and judgment, but they have not yet formed an independent point of view [3]. They are keen to imitate adult demeanour and dress, extremely lively and active, eager to have a sense of freshness, and like to think independently. During this period, young children's sense of thinking is becoming more abstract and their perception of clothing is imaginative and interesting. Against the backdrop of rapid social development and emphasis on student-centeredness in educational methods, children's clothing design no longer only considers the decision-making position of parents in purchasing children's clothing but also takes into account children's aesthetics and preferences. As children grow older, their judgment, aesthetics, and consumer awareness improve. When purchasing children's clothing, children's opinions become increasingly important [4-5]. Therefore, the dependence of children's clothing design on children is becoming stronger. At the same time, children's aesthetics also need to grow and improve through external environments such as clothing. Parents are no longer able to make

choices for their children according to their ideas, and more often than not, parents should respect their children's own choices [6]. In addition, driven by the Internet, mass media has gradually become popular, making it more convenient and rich for people to receive fashion information. Newspapers, magazines, movies, and celebrities are all important reference factors for children's clothing selection, and they also have high requirements for the personalization and functionality of children's clothing [7].

Research on children's clothing products in different academic fields

Existing research has shown that products that evoke positive emotions in children can subconsciously motivate children to learn from the scenarios in which the products are used, so the children's clothing market needs more positive and educational designs than adult clothing [8]. This trend has been demonstrated in some related academic studies.

Rose et al. have analyzed the impact of communication differences between families on children's purchasing power from a business research perspective [9]. It shows that children have some independent choice and judgment in the family and that they play a decision-making role in the process of purchasing children's clothing products. Therefore, children's clothing design needs to fully consider children's physical and mental characteristics and aesthetic preferences. They pointed out that parents consume children's clothing products out of different parenting attitudes and profit motives, emphasizing children's autonomy in dressing. Shortcomings and the increasingly rich and diversified choices in the children's clothing market. Shin et al. have conducted functional children's clothing design through children's behavioural preference research and textile development to reduce the sensitivity of autistic children [10]. From the perspective of children's daily safety, Xuan et al. discuss the inability of children to protect themselves effectively in the face of danger, and their relatively weak mental and physical functions [11]. It is proposed to reduce the possibility of children suffering from accidental injuries through children's clothing products. Although this kind of clothing is limited by technology and cost and is difficult to popularise in the clothing market, the design of children's clothing is no longer just for sales and fashion but is given a more meaningful value. The above research shows that children's physical and mental growth has received more attention. Therefore, the value of children's clothing products is no longer limited to wearing performance but is gradually being endowed with more use functions.

Research on the existing dilemma of children's clothing products

However, there are still some difficulties waiting to be solved in the children's clothing market. In China,

Zhicheng et al. focused on the study of children's clothing from the study of traditional clothing culture history, pointed out that children's clothing ignores children's psychological development, restricts behavioural activities, affects children's vitality and many other problems, and advocates the pursuit of rationalization of children's lives. Through visits to retail stores and face-to-face interviews with consumers, Tongue et al. found that parents and children focus on different priorities when making joint decisions about children's clothing products [12]. Sizing inconsistencies between brands and incomprehensible size code issues plague consumers, a real dilemma in the children's clothing market. The above research outlines the current situation of the industry that pays more and more attention to children's ontological needs. From a design perspective alone, problems such as adultization, homogeneity and insufficient independent innovation in children's clothing have not been eliminated. However, because of the existing problems and market status of children's clothing, no scholars have systematically interpreted it through data analysis, and even fewer have proposed optimization ideas for children's clothing products based on different design dimensions. What are the design dimensions of current children's clothing products? From what dimensions can the existing design problems of children's clothing be analysed and optimized? Therefore, by sorting out many discussions on related topics, we conducted market research, used SPSS analysis software to deeply analyse the initial data of the survey samples, and condensed the information of multiple analysis items into several summary indicators to help children's clothing design practitioners clarify design goals according to different dimensions, to avoid existing design problems in children's clothing and optimize the design of children's clothing products.

EXPERIMENTAL

Methods

Sample collection: purposive sampling method

Based on the comprehensive consideration of the children's clothing market size and the research object, samples are drawn from the children's clothing market on a global scale. Firstly, the children's clothing market is divided, and samples are selected from children's clothing brands with different cultural backgrounds, design styles and product positioning, including high-end luxury brands such as DIOR and FENDI, mid-range brands such as Zara and Gap, and some unbranded children's clothing products, etc. Secondly, it is necessary to ensure that the sample covers a variety of styles, genders and age groups. Secondly, it is important to ensure that the sample covers a wide range of styles, genders and age groups, with the researchers allocating the corresponding sample size themselves.

The methodology was neither prescriptive as in quota sampling nor overly random as in convenience sampling, but rather took into account the context of the study and selected those samples that were most appropriate for the study. A total of 521 samples were collected, some of which are shown in the figure below.

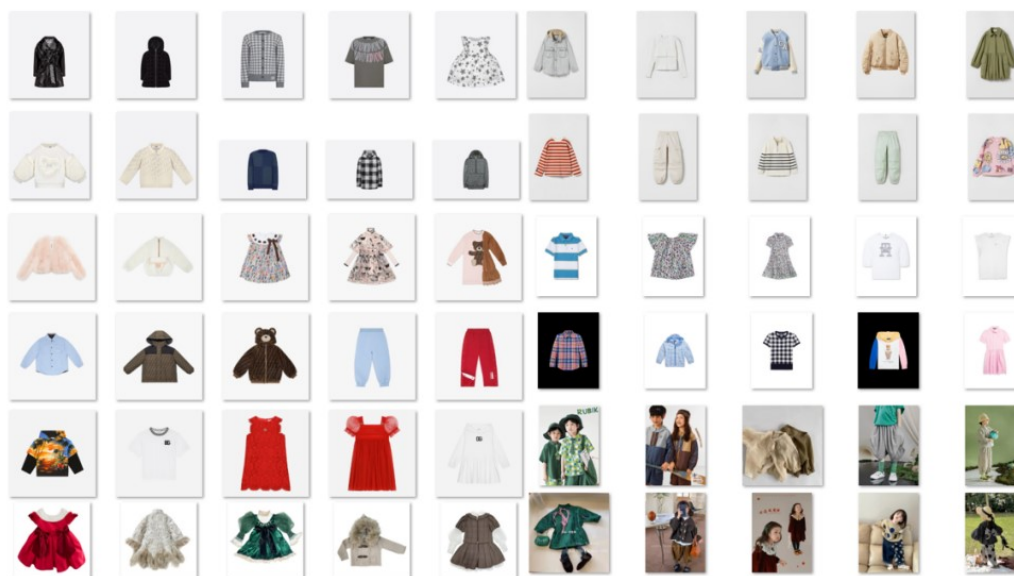


Figure 2. Partial sample

Data Analysis: Factor Analysis

This is a common method of quantitative analysis that quantifies the descriptive characteristics of a sample to reduce the uncertainty of the research objectives and to find interconnections between variables and is therefore objective and exploratory. In this study, the factor analysis process can be divided into two stages: the quantification stage and the analysis stage.

Quantitative phase: construct a vocabulary base for describing children's clothing product design, including pattern description, colour description, silhouette description, accessory description and other aspects. The samples are quantitatively converted one by one against the vocabulary library to get the initial data. This process has some subjective colours, to reduce the influence of the subjective will, 3 volunteers were summoned to quantitatively convert the samples separately, and finally, 3 pieces of data were obtained. The samples with differences between the 3 data were excluded, and finally, 400 valid samples of quantitative data were obtained.

Analysis stage: First, the data from 400 samples were imported into SPSS software for reliability and validity analysis, which was used to confirm the reliability of the data. Secondly, the data were subjected to factor analysis to aggregate the numerous descriptive variables in the lexicon into several

independent common factors. In this paper, the common factors obtained from the factor analysis are regarded as the "design dimensions" of children's clothing products, and the design dimensions of children's clothing products in line with the current market are obtained after naming these "design dimensions".

Children's clothing market research strategy process construction based on SPSS

Taking children's clothing products as the research object, online and offline sample collection and screening were carried out, and a design dimension-related vocabulary library was constructed at the same time[13]. The observation method was used to classify the samples according to the vocabulary database, and after the initial survey data was obtained, it was imported into SPSS software for further analysis. Based on data analysis methods such as factor analysis and combined to extract common factors of children's clothing design dimensions, the children's clothing design research process based on SPSS software is determined, as shown in Figure 3.

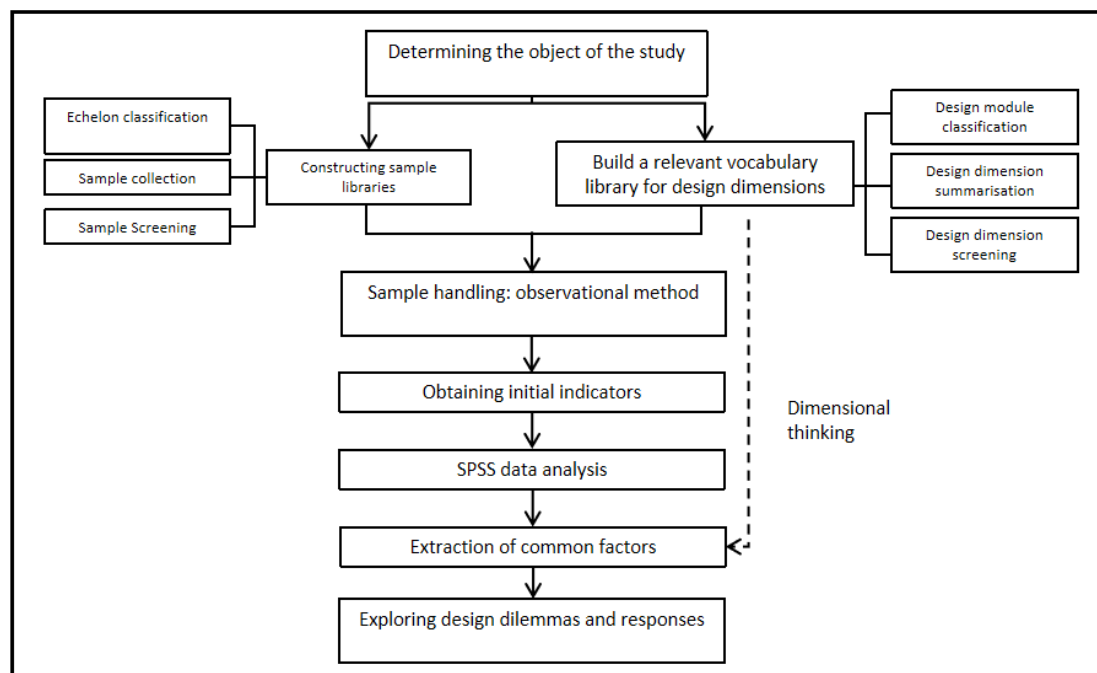


Figure 3. The research process of children's clothing design based on SPSS

Construction of vocabulary database related to representative samples and design dimensions

Comprehensive brand, audience group and product price, a total of 521 children's clothing samples were collected from domestic and foreign children's clothing markets through the brand's official website and offline stores and established a sample library. At the same time, a design dimension-

related vocabulary library is constructed, and the vocabulary library is clustered and integrated, as shown in Table 1 below. The final evaluation categories and number of samples are pattern (C1), number of colours (C2), tone (C3), silhouette (C4), accessories (C5), details (C6), concept (C7), a total of 521 ones sample.

Table 1. Vocabulary library associated with design dimensions

Serial number	Category	Options						
		1	2	3	4	5	6	7
C1	Pattern	Phonetic symbol	Abstract pattern	Motif	Brand logo	Continuous pattern	Composite pattern	The rest
C2	Colour quantity	Pure colour	Two-toned	Three colours and above	-	-	-	-
C3	Hue	Softer	Bright and colourful	Dark color	Monochrome	-	-	-
C4	Style	Liberal	Fitted/tight	-	-	-	-	-
C5	Accessories	Buckle	Velcro	Drawstring or Lace-up	Zips	The rest	-	-
C6	Detail	Reversible	Bionic shape	Deconstruct	Partially removable	The rest	-	-
C7	Conceptual dimension	Story topics	Folk culture	Brand Style	Environmental Philosophy	Inclusive Philosophy	The rest	-

According to Table 1, the associated words of the design dimensions have corresponding options after clustering. Table 1 and 521 samples were distributed to 3 students. They submitted the samples after analyzing them one by one from 7 different categories using the observation method. As shown in Figure 4 below, 3 copies of data were obtained from the 3 students, the inconsistent data were filtered and eliminated, and the remaining consistent sample data were averaged. Finally, 400 valid samples and corresponding initial data were obtained.

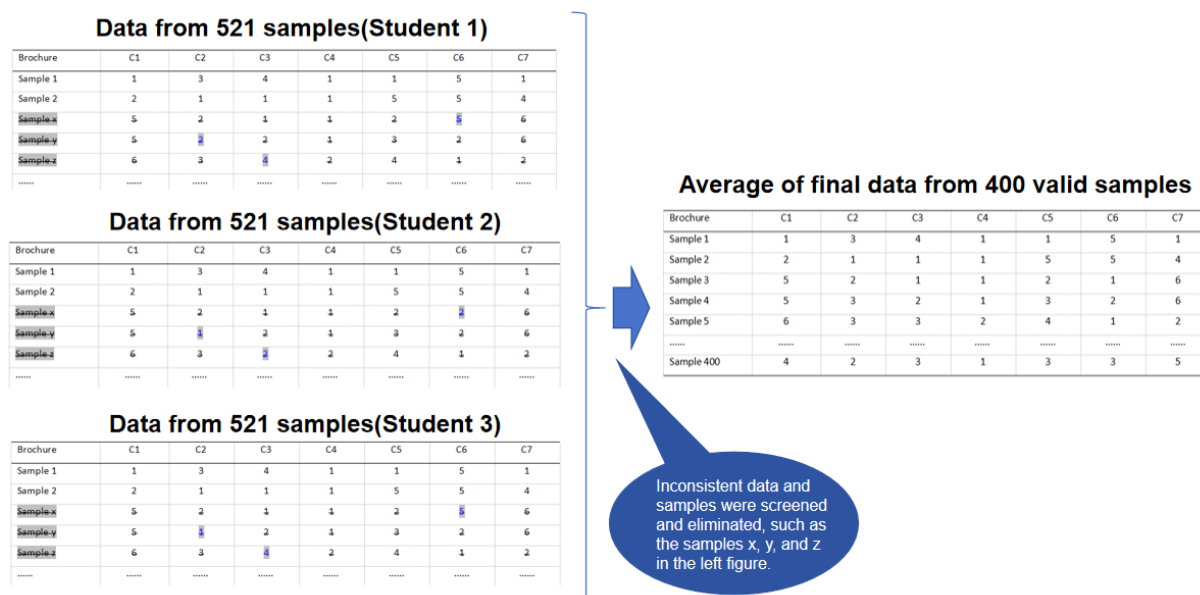


Figure 4. The research process of children's clothing design based on SPSS

Methodological choices for data analysis

Since the subjective level of analysing samples from different evaluation categories has cross-influence effects and it is difficult to accurately represent the design dimensions of the entire sample database, the SPSS factor analysis method was chosen to conduct an in-depth analysis of the initial indicators. The factor analysis method uses the idea of dimensionality reduction to synthesize a few independent factors from multiple initial indicators, that is, cluster the words in Table 1 above, and attribute the words with higher correlation to the same common factor, that is, a design dimension [14]. This ensures most of the information in the original data and enables an overall ranking of multiple design dimensions based on influence scores from an objective level to comprehensively evaluate the factors that affect differences in children's clothing design.

KMO and Bartlett's test of sphericity

KMO and Bartlett's test of sphericity were used to determine whether the original data were suitable for extracting the common factors by factor analysis, and the results are shown in Table 2. As can be seen from the table, the KMO value in this study is 0.815 (>0.500) and the significance level of Bartlett's test of sphericity approximates 0.000 (<0.010), indicating that the original data is suitable for factor analysis.

Table 2. KMO and Bartlett's test

KMO value	Bartlett's test of sphericity		
	Approximate chi-square (math.)	(number of) Degrees of freedom (physics)	Significance
0.815	2330.026	21	0.000

Principal factors extraction

After analysing the analysis items, the common factor variances are obtained, as shown in Table 3 below. It can be seen that the common factor variances of the seven set evaluation categories are all greater than 0.5, indicating that the seven groups of factor analysis are effective. The gravel plot of factor contribution is shown in Figure 5 below. The inflexion point appears at the second factor, and the polyline becomes flat after the fourth factor, so we chose to extract three common factors. The total variance explained is shown in Table 4 below. The cumulative variance explanation rate of the three common factors reaches 87.400%, indicating that these three common factors have less loss in factor explanation and can better explain the choice of children's clothing product design dimensions.

Table 3. Results of the variance of the common factor

	Starting (point)	Withdraw (from a bank or warehouse)
C1	1.000	0.907
C2	1.000	0.910
C3	1.000	0.920
C4	1.000	0.998
C5	1.000	0.799
C6	1.000	0.904
C7	1.000	0.678

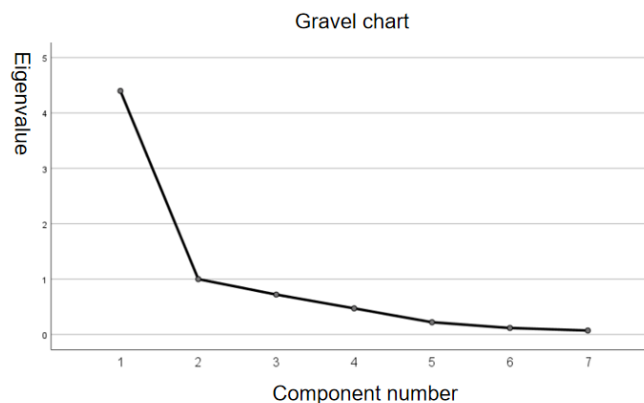


Figure 5. Initial gravel map for design dimensional principal component analysis

Table 4. Contributions of factors to the design dimensions

Total Variance Explained									
Factor (math.)	Initial eigenvalue			Extract the sum of the squares of the loads			Rotational load sum of squares		
	(grand) Total	Percentage of variance	Cumulative per cent	(grand) Total	Percentage of variance	Cumulative per cent	(grand) Total	Percentage of variance	Cumulative per cent
1	4.398	62.832	62.832	4.398	62.832	62.832	3.323	47.472	47.472
2	0.999	14.274	77.106	0.999	14.274	77.106	1.748	24.973	72.445
3	0.721	10.294	87.400	0.721	10.294	87.400	1.047	14.955	87.400
4	0.472	6.745	94.145						
5	0.221	3.154	97.299						
6	0.117	1.677	98.976						
7	0.072	1.024	100.000						

Factor naming

To interpret and name the factors more intuitively, the loading matrices of the three extracted male factors were rotated using the maximum variance method, and the relationship between the rotated loading matrices and the original indexes is shown in Table 5 below, where Z1, Z2, and Z3 represent the male factor 1, male factor 2, and male factor 3, respectively.

Table 5. Table of factor loadings after rotation

	Ingredient		
	Z1	Z2	Z3
C1	<u>0.741</u>	0.589	0.106
C2	<u>0.930</u>	0.145	0.155
C3	<u>0.931</u>	0.144	0.182
C4	0.163	0.043	<u>0.985</u>
C5	0.790	<u>0.416</u>	0.049
C6	0.174	<u>0.935</u>	0.024
C7	0.601	<u>0.558</u>	0.074

The component of each factor is composed of the larger absolute value of the loading coefficient in each indicator. It can be seen from Table 6 that the common factor Z1 is determined by C1 (0.741), C2 (0.930) and C3 (0.931), and the overall contribution rate is 47.472%. These three indicators represent

the related vocabulary of the three categories of children's clothing pattern, colour quantity and hue, which jointly guide children's aesthetics. Therefore, the common factor 1 is named the aesthetic factor. The common factor Z2 is determined by C5 (0.416), C6 (0.935), and C7 (0.558), with an overall contribution rate of 24.973%. This reflects the associated vocabulary of the three categories of accessories, details, and design concepts of children's clothing design. For children, It has certain action and cognitive educational significance, so the common factor 2 is named the educational factor. The common factor Z3 is determined by C4 (0.985), with an overall contribution rate of 14.955%, reflecting the style and silhouette vocabulary in children's clothing design. Therefore, the common factor Z3 is named the care factor. These three common factors constitute a comprehensive index to explain the design dimensions of children's clothing products. From the contribution rate, it can be seen that the aesthetic factor is the main consideration dimension when designing children's clothing products, followed by the education factor and care factor. Designers can use this to optimize the design of children's clothing products that are more in line with the growth needs of consumers and children.

Children's clothing design practice based on SPSS factor analysis results

Through the research and analysis of 400 samples, three common factors were extracted: "Aesthetics Factor", "Care Factor" and "Education Factor". The results are shown in Figure 6 below.

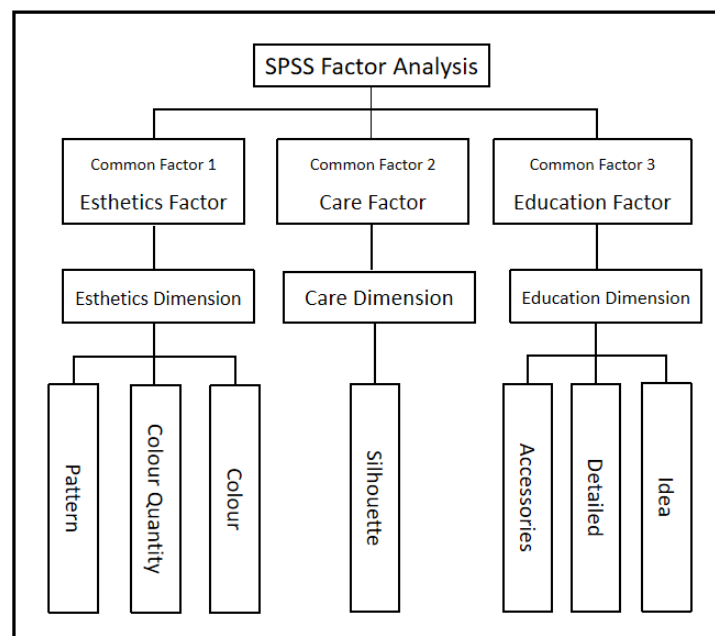


Figure 6. Metrics and Design Dimension Extraction Results

With the extracted common factors and design dimensions as the design guide, the design practice of the light outdoor clothing series for middle and small children is carried out, and the product effect is shown in Figure 7 below.



Figure 7. Rendering

A) Aesthetics factor: The rabbit imagery represents the original exploratory instinct in children's nature, as the embodiment of children's essence, it is marvellous and childish. Combined with the sensitivity of children to patterns, the two forms of the rabbit are abstracted and simplified, and arranged and combined to form a continuous pattern. In terms of colour selection, combined with the trend of children's fashion colours, selecting outdoor tones and incorporating a sense of digital technology colour scheme, while adding light fog yellow as a brightening embellishment, the whole group of colourful but not complicated, in line with the children's endless imagination at the same time full of fashion sense.

B) Care Factor: The collection's exterior silhouette is sharp, while the layering is enriched by the use of multiple dividing lines and double-layered structures. As a light outdoor style children's clothing, the choice of fabrics is based on soft and comfortable, waterproof and wear-resistant, to ensure that the children wear comfort as a prerequisite, supplemented by functional fabrics. Avoiding overly complicated accessories, Velcro, snap buttons and invisible zippers are the main materials to ensure that children are provided with sufficient care in the expected wearing scenarios.

C) Education Factor: The concept of lenticular animation is integrated into the clothing in the following way: the lenticular is parametrically designed and printed on the outside layer of transparent fabric,

the rabbit pattern after lenticular processing is printed on the inside layer of fabric, and the double layer of fabric is superimposed to produce relative displacement during the wearer's activities [15], to obtain the rabbit pattern that "seems to be moving and not moving". This process greatly increases the playfulness of children's clothing and accomplishes the interaction between children and clothing. With this idea, we can continue to utilize clothing for other aspects of education and cognition, such as early enlightenment or mind training.

Design practices were carried out under the guidance of the three dimensions of "aesthetics", "care" and "education". From the designer's point of view, the design efficiency of children's clothing products has been effectively improved. However, in the face of the huge children's clothing market, the validity of the results of the study cannot be effectively verified only through a single design, and the results of the study must be applied in the market to collect feedback from end customers to truly verify the role of the three design dimensions in the design of children's clothing products.

RESULTS AND DISCUSSIONS

Key results: A description of the design dimensions of children's clothing products

Figure 8 below demonstrates the results of the factor analysis of the SPSS software, which proves on an objective level that the three dimensions of aesthetics, pampering, and education work together to explain the design of children's clothing products. Among them, the aesthetic dimension is the most representative in the design of children's clothing products.

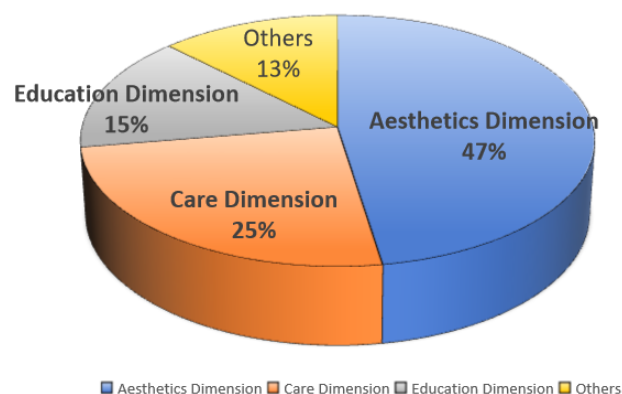


Figure 8. Percentage of explanation rate for three design dimensions

Suggestions and prospects for children's clothing product design

Good children's clothing should contain positive design in three areas: aesthetics, care and education.

In addition to meeting the basic performance of children's clothing, we can also refer to the colour trends of children's clothing, as well as integrating the interesting lenticular animation into children's clothing, to enhance the fun and interactivity of the products.

Shortcomings and reflections of this study

A) Due to the wide scope of the study and the small number of samples, the data obtained cannot fully represent the relevant children's clothing brands. In the course of future research, the scope of the study should be narrowed, the object of the study should be precise, the reasonableness of the research form should be improved, and the samples and data obtained from the study should be screened more rigorously so that the results of the study can be more convincing.

B) Figure 4 above demonstrates the process of filtering and acquiring initial data, but there is still room for optimization in the way the initial data are acquired and the degree of matching of the data with the factor analysis method, and these limitations should be emphasized and remedied in subsequent studies.

C) The verification of the reliability of the results of this study cannot only rely on design practice but should also continuously collect production and sales intelligence from the children's clothing market, as well as real feedback from consumers and children. Only in this way can the reliability of the research results be verified and become more convincing.

It is believed that with the diversification of product production methods, the functions and types of children's clothing will be more abundant, and the role of children's clothing in the physical and mental growth of children will be more emphasized by designers. We will try to continue to optimize the design of children's clothing products in the future with the help of the findings and ideas of this study. It is expected that children's clothing products can be used to realize children's early enlightenment or other aspects of education and cognitive activities such as mind training.

CONCLUSION

This study summarized the current design dimensions of children's clothing products from an objective level, which is important for the optimized design of children's clothing products with more social responsibility. The study extracted the current design dimensions of children's clothing products: aesthetic dimension, care dimension and educational dimension from the objective level through SPSS analysis software. Combining the whole process of the research and the constructed sample library, it was attempted to optimize the design of children's clothing products. They were consciously designed from different design dimensions and injected with positive educational concepts. This idea provided

an optimization direction for children's clothing practitioners to carry out a design that meets the needs of market development and children's growth.

Author Contributions

Conceptualization –Yin W and Lin S; methodology – Yin W and Lin S; formal analysis – Yin W and Lin S; investigation – Yin W; resources – Yin W and Lin S; writing-original draft preparation – Yin W; writing-review and editing – Yin W; visualization – Yin W and Lin S; supervision – Lin S. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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