Scientific Research Publishing

Transforming Chinese Characters into Product Design: Learning from Nature

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Abstract

Chinese characters are an important intangible cultural heritage in Huaxia civilization. It is a symbol system that originated from nature. Chinese characters are interpreted by humans in ways that coincide with their perception of nature. Connecting creation with nature and pursuing the unity of function and aesthetics, and exploring the configuration of Chinese characters is a problem worthy of study in modeling design, it is also an exquisite embodiment of "learning from nature". In the teaching practice, we have found that fresh design students do not have a clear cognition of modeling design when teaching design, resulting in weak design creativity and connotation. The purpose of this study is to provide guidance to students through the foundation design curriculum concerning the cognitive process of the transformation of Chinese characters, as the object of this study, into product design. This study aimed to lay a solid foundation for students' understanding of modeling design and the teaching methods to be verified through design practice. This study uses literature to explore and construct the teaching mode of Chinese character transformation product design. The feasibility of the teaching model has been practiced through the basic design course, and the effectiveness of the teaching effect has been verified by questionnaires and semi-structured interview. It has been found in this study that: 1) a basic design teaching system with localized characteristics can be established by taking Chinese characters as a study case; 2) through systematic teaching design, students have a clearer understanding of the logical thinking mode of product modeling design which can be integrated and applied into design; 3) through the delivery of themed courses, students have made great improvements in creative thinking and design connotation.

Keywords

Learning from Nature, Chinese Characters, Cultural and Creative Products,

Design Teaching, Design Effectiveness

1. Introduction

Under the influence of design globalization, forming a distinct design style by highlighting cultural characteristics in product design has become an important issue to be discussed in product design teaching. At present, most of the basic teaching of product design in China follows the Bauhaus teaching system. Teachers usually teach students in the form of three classic components (includes plane composition, color composition, and 3D composition), but students are often unable to conduct effective connections with knowledge points which create certain limitations on the cultivation of logical thinking. In addition, students in the learning process are prone to be locked into the cage of design appearances and neglect the transmission of design implications, owing to the ignorance of cultural integration in basic teaching and the emphasis only on discussions of form. The modeling design of a product should not be a boundless thinking activity. Design should be performed in a comprehensive process that is easy to understand, explain, connect and organize (Wang, Ni, & Lin, 2022).

Chinese characters are pictographic. The earliest Chinese characters were created according to the appearance of all things in nature. They were a kind of natural symbols. The evolution of Chinese characters reflects the process of changing from complexity to simplicity. Chinese characters were becoming less similar to original patterns as they changed from figurative to abstract symbols (Lin, Lin, & Hsieh, 2005). Chinese characters are born from nature, while products are indirect bionics of nature to a certain extent which constitutes the design aesthetics of "learning from nature" (Han, 2016). Therefore, Chinese characters developed in a systematic process. The design principles and philosophical thinking contained in Chinese characters help students perceive the formation principles of modeling, and comprehend the distinctive design forms and implications there from. Integrating Chinese characters into basic design teaching will make a difference in the traditional curriculum model conductive to cultivating systematic design thinking, integrating local culture, and fostering future product design pioneers with a global perspective. Based on this taking Chinese characters as a study case and teaching activities as carriers, this study integrates the design principle and design process of "learning from nature" into design teaching through Chinese characters by the introduction of cultural product design methods, evaluates teaching effects in scientific methods, and explores how to improve the native creativity and design integration ability of design students.

- To help students understand the main points of product design in the transformation of traditional Chinese characters through a systematic model, from the perspective of design thinking cultivation.
- To improve the cultural characteristics of design by incorporating the sum-

mary of six categories of Chinese characters in teaching activities with the basic skills of design methods teaching from the perspective of educational practice of design.

- To set up the main line of curriculum design combining theory and pragmatism for the construction of an innovative teaching mode of basic design courses from the perspective of discussion on the teaching process.
- To establish a systematic design evaluation system and standards through performance tests and investigations of design results from the perspective of teaching results evaluation.

2. Literature Discussion

2.1. Chinese Characters Born from Natural Objects

Chinese characters symbolize the origin of the Huaxia civilization. Unlike Western words, Chinese characters are pictographic ideograms (Wang, 1994). Regarding the birth of Chinese characters, it is widely believed that they were created by the mythological figure Cang Jie, but it is too absolute to judge the origin of Chinese characters on this account. The emergence of Chinese characters is not credited to a person. In the academic circle, most scholars prefer the view that Chinese characters originate from natural objects, like flowers, birds, fish, and insects. Human beings obtain the image from natural objects and form the inspiration of Chinese characters (Tang, 1949, 1979; Yan, 1990). Chinese characters developed from natural images of characters, rather than simply from a symbol system (Chen, 1978; Gao, 1984; Li, 1985; Li, 1997; Shao, 1978; Wang, 2011).

Huaxia civilization holds that "man is an integral part of nature", and that "people are my brothers and I share the life of all creatures". In some ancient classics, traces of Chinese characters originating from nature can be found. For example, there are records in the "Later Han Dynasty" and "Book of Changes" that Chinese characters are produced by human beings for the urgent need to name all things in nature, and in order to meet the needs of life. The known Chinese characters in early forms can be traced back to the Neolithic Age or earlier. Pictorial symbols carved by humans on potteries, oracle bones, and jades have been found in Dawenkou Culture Site in the Shandong Peninsula, Shuangdun Neolithic Site in Bengbu, Anhui, Yangshao Culture Site in Banpo, Xi'an, Liangzhu Culture in Zhejiang, Taosi Site in Linfen, Shanxi, and other sites (Guo, 1972). It has been found from the unearthed archaeological data that pictorial symbols exist in two categories: pictographic and abstract symbols. From their nature, Chinese characters originated from pictographic patterns and symbols rather than abstract symbols (Tang, 1949; Wang, 2011). Pictographic patterns and symbols depict natural things and make some simplifications (Gao, 1984). Table 1 below shows the pictorial symbols inscribed on the potteries unearthed from the Dawenkou Culture and the potteries unearthed from the Shuangdun Neolithic Site in Bengbu, Anhui (Du & Jiao, 2011; Tang, 1979; Wang, 2011).

Table 1. Interpretation of unearthed pottery patterns (summarized by this study).

Pottery Symbols Unearthed at Dawenkou Culture Site			
戊 (meaning "axe")	斤 (meaning "wand")	旦 (meaning the sun rises from the ground/mountains)	冠 (meaning "crown")
Pottery Symbols Unearthed at Shuangdun Neolithic Site in Bengbu, Anhui			
月 (meaning "moon")	豬 (meaning "pig")	網 (meaning "net")	邱 (meaning "hill")

Most scholars believe that these pictorial symbols have a high degree of pictography, and are understandable and pronounceable by virtue of their shapes, so that they are combined with the words in the language. Thus, they conform to the nature of early writing and can be called "character-property symbols" (Tang, 1979). Although most of these character-property patterns and symbols are decorative and cannot be used to record the language, they cannot be called characters in the strict sense. Nevertheless, they are indeed a tool for human beings to express intentions and assist communication by carving pictorial symbols (Chen, 1978). They draw inspiration from nature, express the meanings by shapes and have a continuation relationship with the later oracle bone inscriptions. As a result, they can be considered as the source of the formation of Chinese characters (Dong, 1952; Tang, 1949). The inscriptions on oracle bones formed a relatively systematic writing system after a long period of development (Li, 1997). A large number of pictographs and pictures are preserved in oracle bone inscriptions, which are also evidence of the natural origin of Chinese characters. The Nakhi people in China still retain a graphic character "Dongba scripts", which can be translated as "traces of wood and stone", which depicted the original shapes of animals, and had been simplified and abstracted (Zhou, 2019). To sum up, our ancestors have already discovered the secret between nature and Chinese characters thousands of years ago.

2.2. The Procedure for the Design of Chinese Character Transformation Products

The formation of Chinese characters is the thinking expression of the ancients for understanding the world. The esthetics and modeling of Chinese characters can be regarded as the unity of "modeling and connotation" (Fang, 2014; Luo & Zhang, 2020). In *Explaining Words and Analyzing Compound Characters* by Shen Xu (a Chinese litterateur in the Eastern Han Dynasty), the characteristics of the structures of Chinese characters were summarized as "the six categories of Chinese characters", namely, self-explanatory characters, pictographic characters, associative compounds, pictophonetic characters, phonetic loan characters,

and synonymous characters (Xu, 2013). As shown in **Table 2**, examples are given of the characters and font types in Chinese characters with the characteristics of learning from the six categories of Chinese characters. Pictographic characters look like shapes of objects and refer to the original form and outline of things. For example, "RI" (meaning "sun") and "YUE" (meaning "moon"). Self-explanatory characters cannot be described in a concrete image. Based on the pictogram, self-explanatory symbols are added to express abstract concepts. Therefore, self-explanatory characters can be distinguished after being seen, and their meanings can be found after being observed. For example, "SHANG" (meaning "up") and "XIA" (meaning "down") are abstract concepts of orientation. Associative compounds refer to the combination of two or more characters to form a new meaning. Taking "XIN" (meaning "believe"), for example, "XIN" can be combined into "human + believe", which means that people should keep their words. Pictophonetic characters can be divided into "shape symbol" + "sound symbol". "Shape symbol" refers to the attribute of things, and "sound symbol" refers to the pronunciation of characters. For example, "HE" (meaning "river") represents the type of thing by the Chinese character component "SHUI" (meaning "water"), and "KE" is used to indicate the sound of water flowing. Synonymous characters belong to the method of a character application, which means that the time and space of the formation of characters are different, but the meanings of things can be interpreted and used for each other. For example, In *Explaining Words and Analyzing Compound Characters* the synonyms "KAO" (it means "exam") and "LAO" (It means older people). Phonetic loan characters refer to loaning homophonic characters that have been made to replace characters that have not been made. For example, "BEI", refers to the "north" in the direction. From the interpretation of the six categories of Chinese characters, it can be observed that the principle of the configuration of Chinese characters is closely linked to the design.

Table 2. Six categories of Chinese characters and characteristic characters (summarized by this study).

Category	Example	Analysis
Pictographic characters	"RI" (meaning "sun")	⊙ ⊡ ⊟ 日
	"YUE" (meaning "moon")	☽ ⅅ ☽ 月
Self-explanatory characters	"SHANG" (meaning "up")	
	"XIA" (meaning "down")	
Associative compound	"XIN" (meaning "believe")	REN + YAN (meaning "human + belive", people should keep their words.)
Pictophonetic characters	"HE" (meaning "river")	SHUI (meaning "water") KE (indicate the sound of water flowing)
Synonymous characters	"KAO" (meaning "exam")	In *Explaining Words and Analyzing Compound Characters*: LAO and KAO are mutually explanatory.
	"LAO" (meaning "old")	
Phonetic loan characters	"BEI" (meaning "north")	(meaning "refers to two people who are in opposite directions").

The concise and abstract configuration of Chinese characters is the best embodiment of the characteristics of "abstract" and "freehand brushwork" (Luo, 2014). The six categories of Chinese characters can echo with the shape features, function features and impression features of product design which have important reference values for the study of the modeling of Chinese characters and the creative design derived from Chinese characters. In addition to modeling, the most important thing in the design of the cultural products of Chinese characters is how to express their meaning and esthetic principles in a reasonable way (Zhou, Qu, & Huang, 2020). As shown in **Figure 1**, Lin (2005) summarized the procedure for the design of Chinese character transformation cultural products. Firstly, analysis of the meaning of Chinese characters. Secondly, analysis of the formation of Chinese characters. The three Chinese characters "YI," "MING," and "CHEN" are the practice of analyzing the form and structure of Chinese characters and indicate the meaning of the six categories of Chinese characters. The two-dimensional pattern of "YI" is the transformation of pictographic characters and self-explanatory characters, representing the analysis of the form feature. The two-dimensional pattern of "MING" is the transformation of associative compounds and pictophonetic characters representing the analysis of the
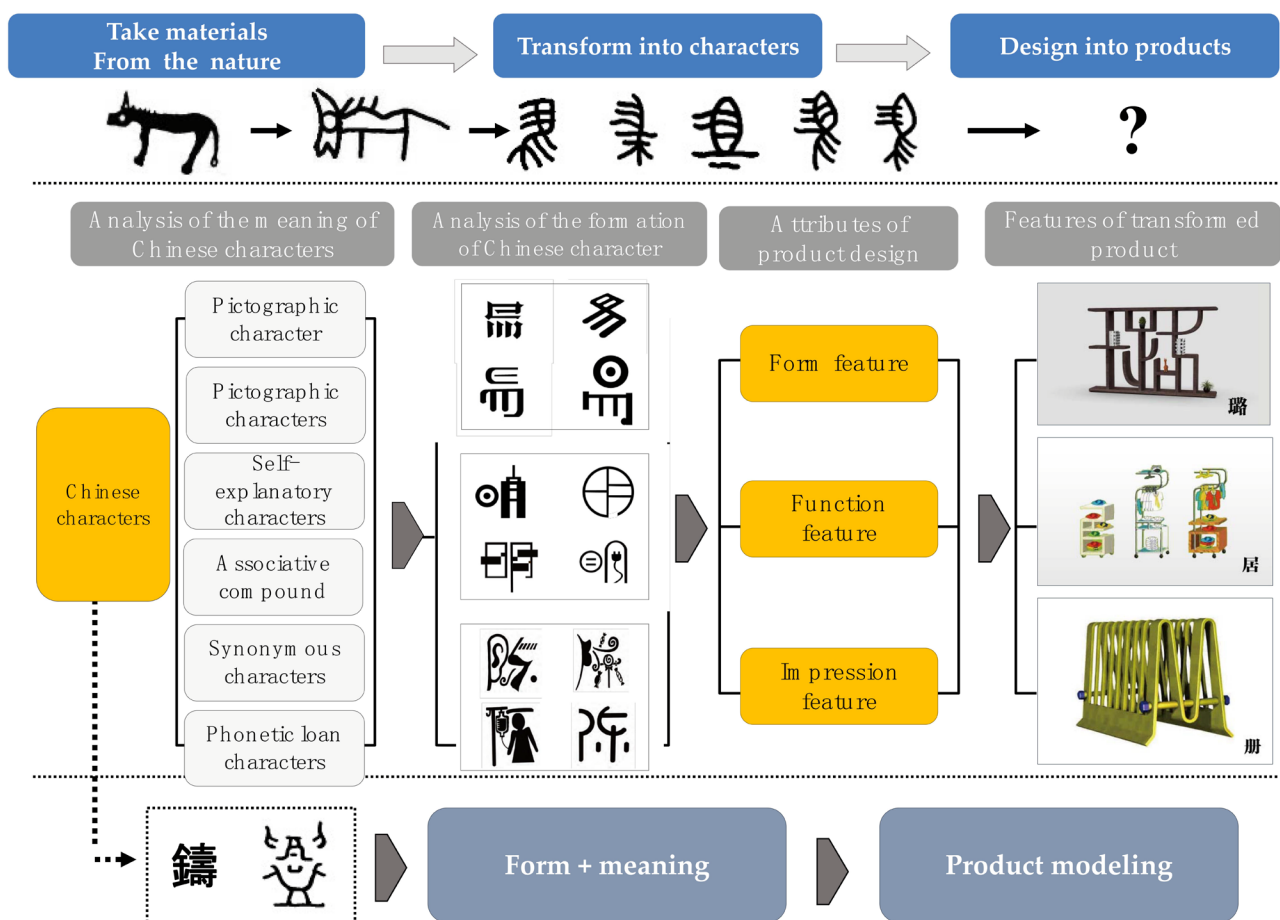

Figure 1. Product design procedure for imitating six categories of Chinese characters (Adapted from Lin, 2005).

function feature. The two-dimensional pattern of "CHEN" is the transformation of synonymous characters and phonetic loan characters, representing the analysis of the impression feature. Thirdly, transforming to three-dimensional product design. The designer triggers synesthesia imagination through two-dimensional patterns, integrates the semantics of two-dimensional graphics through the three characteristics of six categories of Chinese characters and product form, and visually extracts the factors of forms to construct product design. The supporter transformed by the character "LU" comes from the variation and deconstruction of the form features of Chinese characters. "JU" means dwelling and house in Chinese characters. As a supporter design, it is the embodiment of shape following function. The CD shelf transformed by the character "CE" is derived from the meaning of ancient bamboo books which display impressions and cultural connotations.

2.3. Integrating Chinese Characters into Basic Design Teaching Steps

Studies have shown that the thinking mode of novice designers will go from simple abstraction, first through the stages from representation to abstraction, simplifying shape, reorganizing structure, and adding personal imagination (Fu, Sun, & Yang, 2018). This study should lay a good foundation for product design learning by application of Chinese characters on the basis of understanding, improving students' creative thinking, and shaping cultural products with cultural characteristics. Therefore, according to the product design procedure for imitating the six categories of Chinese characters in Figure 1, the course of basic design based on Chinese characters can be disassembled into three stages. The first step is to analyze the relationship between Chinese characters and design. This stage requires students to experience the relationship between Chinese characters and nature and understand the meaning of "the six categories of Chinese characters".

The second step is to master the modeling features of product design. Lin summarized the formation of each pattern form, including but not limited to three modeling features: shape feature, function feature, and impression feature, which can be understood as: 1) shape feature which indicates object shape and reflects the natural correlation between object and original shape. 2) Function feature which guides designers in seeking structural principles during design thinking and matching the design image. The modeling and style of objects are transformed through the function feature. 3) Impression feature which describes the perceptual impression of the design theme which not only reflects the specific shape but also focuses on expressing the abstract concept symbols of the objects (Lin, 1987; Lin, 1994). Wu and Lin also have tried to use the nautilus as an example to explain the relationship among the three features of natural objective images and shapes (Wu, Sun, & Lin, 2022). Therefore, when practicing the design principle of "learning from nature," designers do not simply carry out imitation but extract and summarize the organic forms of nature (Coelho &

Versos, 2011; Luo, Zhang, Bian, & Shan, 2018). Simplification is an important way to extract and summarize natural images (Arnheim, 1997; Lu, 2009; Rinaldi, 2007).

As shown in Figure 2, taking the Chinese character "MING" (meaning bright) as an example, in each of the three features, any two-dimensional pattern or three-dimensional product can be transformed from "MING". This example can show the process from shape, image or function feature to the representational, abstract, or arbitrary design which is full of creativity.

The last stage is to integrate the morphological composition principle of Chinese characters and product design attributes, analyze the corresponding relationship between the six categories of Chinese characters and design, and then transform Chinese characters into a three-dimensional product modeling design. The graphic cases of plane transformation generate associations, think about the relationship between pictogram, pointing, understanding, pictophonetic, annotation, loaning, and design, and find relevant product design cases for analysis. Then, according to the understanding of cultural product design procedures (Hsu & Lin, 2011; Hsu & Wang, 2018; Kress & Van Leeuwen, 2020), case appreciation and situational story methods, students are trained to bring flat thinking into the thinking and logic of three-dimensional design (Campbell, 1992; Nardi, 1992; Ni, 2019; Tang & Lin, 2011). Finally, the products that conform to the modeling principle and have a certain design meaning are designed.

The following Table 3 illustrates the cases interpreting product design thinking by the six categories of Chinese characters to support discussion and analysis by students. Though these cases, students could further realized the application of the six categories of Chinese characters in interpreting the meaning of product design echoes the use of nature to interpret the design intention.

Figure 2. Features of "Ming" word transformation (Source: this study).

Table 3. Product design cases explained in the six categories of Chinese character.

Category	Case	Explanation	Picture
Pictographic characters and design	Bookshelf	From the perspective of Pictographic design, it is the most intuitive, with the thinking of directly expressing product modeling. The design lettered "A" is a bookshelf pattern with the Chinese character "YUE" (meaning moon). The modeling is close to the character itself.	
Self-explanatory characters and design	Bottle opener	From the perspective of Self-explanatory characters and design, it is an abstract symbol that guides the action, idea, or state of a thing, and the meaning it represents may be found after observation. The combination of the character "KAI" (meaning open) with the bottle opener meets the meaning and implication of the self-explanatory design (Zizai, 2021).	
Associative compounds and design	Cup	From the perspective of associative compounds design, products need to be of metaphorical or analogical property, which is a puzzle-like thinking mode that can combine designs to produce a product with new functions. This design is a porcelain cup transformed from the Chinese character "QIU" (meaning hill).	
Pictophonetic characters and design	Pot	From the perspective of pictophonic characters and design, the combination of "pictographic" and "phonic" symbols should be considered in product design, and the senses such as hearing and smell should be identified as product semantics to stimulate emotional resonance. This design is a flute-sounding pot designed by Alessi (Ggwer, 2018). When the water in the pot is boiled, it will make a bird-like sound, which interprets the relation between the pictophonic symbols and the design.	
Synonymous characters r and design	Chair	Based on its concept, synonymous designs may be considered as products with the same function and different shapes created at different times, spaces, and backgrounds. The design is a Chinese chair designed by Hans J. Wegner and improved based on the Chinese Ming-style armchair (Hans, 2018), which interprets the different design expressions of the same type of product at different times and spaces	
Phonetic loan characters and design	Furniture	From the perspective of phonetic loan design, it borrows an already built product and applies it to the product to be designed. The design is an example of applying the radicals and radicals of Chinese characters to the design of the shelf (Nendo, 2018).	

2.4. Summary

In this section, the literature discussion expounds the relationship between Chinese characters and nature. And then this study discusses the relationship between the morphological composition principle of Chinese characters and product design. Finally, according to the figure of Product design procedure for imitating six categories of Chinese characters, three steps of transforming Chinese characters into product design teaching are listed. The next section of teaching practice will verify the feasibility and teaching effect of design procedures and teaching

models.

3. Research Method

This study mainly uses literature discussion, questionnaire surveys, and semi-structured interviews as research methods to examine the teaching results. First, through the teaching objectives, this study analyzes the literature and points out the teaching mode of transforming Chinese characters into cultural and creative products. This study then implements the three-stage teaching process and publishes the teaching results according to the model established by the literature discussion and the teaching experience of the research team. After the teaching, a questionnaire was used to evaluate the learning effect. Finally, semi-structured interviews were used to summarize the opinions of relevant teachers and students, explore the effectiveness of this teaching model, and put forward reflection. The specific research framework and steps are described briefly as follows:

The research framework is shown in Figure 3. The study was divided into three stages. The first stage was the planning of the teaching objectives, building the theoretical framework of the course design, and helping students understand the significance, concepts, and related design theories of "learning from nature." The second stage was teaching implementation with the teaching content implemented according to the course design. The third stage was a questionnaire survey and interview. Four teachers with professional backgrounds in design were invited to screen the teaching results, select representative works, and use statistical methods to explore the teaching results. In addition, three students and four teachers who participated in the course were selected to conduct semi-structured interviews to summarize and reflect on the teaching design. It is hoped that the final results will be conducive to the teaching of cultural product design by shortening the gap between theory and pragmatism.
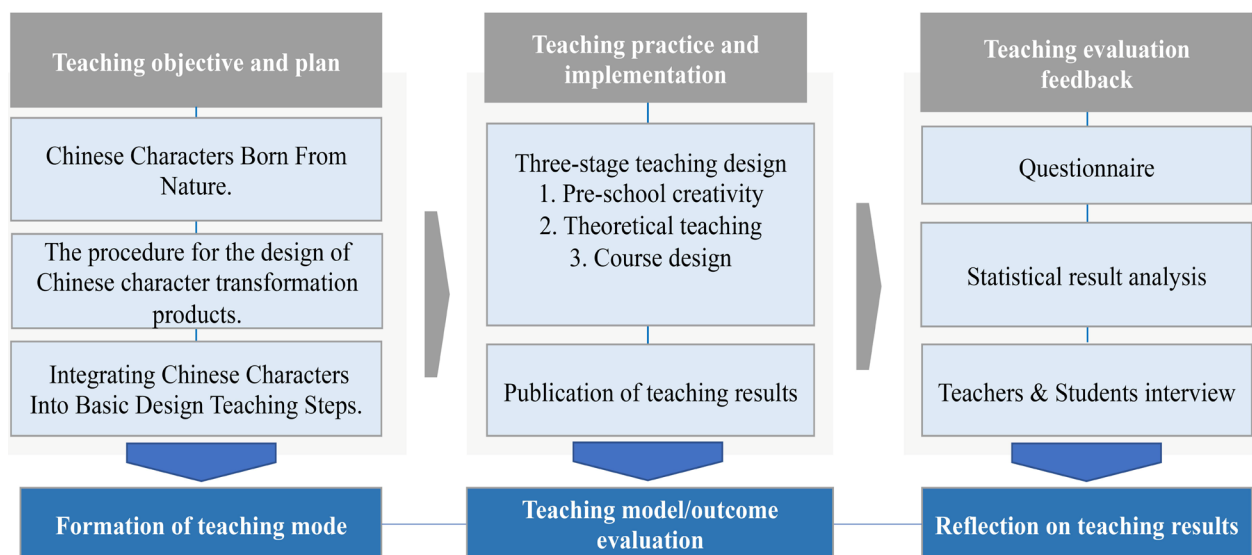

Figure 3. Research framework.

3.1. Research Input and Object

The scope and implementation of this study are as follows:

1) Teaching research is a compulsory course for freshmen implemented in the Department of Art and Design. The course name is "Basic design". It totals 48 class hours and is completed in six weeks.

2) The course is a compulsory core course divided into three-stage independent units. It is required for students to master the basic skills and related concepts of two-dimensional and three-dimensional design in teaching.

3) Evaluation of teaching results (students): After each stage of the course, teachers issued mutual evaluation forms, and students were asked to observe and evaluate the works. Every student was required to record their learning experience at each stage to promptly grasp the implementation effect of the teaching design proposed in this study at the corresponding stage and let students blend in the teaching activities.

4) Evaluation of teaching results (teachers): The teacher took back the students' self-evaluation form and learning experience form to evaluate and score the three assignments according to the students' performance in the classroom. In addition to the course teachers, four teachers with rich teaching experience were invited to score the results.

There were 37 student participants served, including 25 female students (67.5%), 12 male students (32.5%), and one teacher. At the end of the course, three other teachers with professional backgrounds in art design were invited to participate in scoring. A total of four teachers participated in scoring. These four teachers possessed many years of teaching experience and design creativity. All students had basic drawing ability and calculator model-building skills and completed the course in an individual teaching unit.

3.2. Teaching Design and Practice

The teaching design implemented in this study is comprehensively formulated based on the analysis of the above literature, the researcher's teaching experience, and the suggestions from expert interviews. As shown in Table 4, this study divides the teaching design into five units. The course design sets a gradual course framework and content, analyzes and evaluates the excellent works produced by the course after the teaching is implemented, and finally reveals teaching results and reflect.

Unit 1: Pre-school Creativity

The course takes the Chinese names of students as an example. On the condition that the teacher does not teach basic design theory, students use the three Chinese characters which from their names for designing a cultural and creative product. Figure 4 shows a lamp transformed from the Chinese character "LIU" (lamp), a locker transformed from "QIAO" (cabinet), and an umbrella stand transformed from "YU" (umbrella holder).

Unit 2: Thinking Inspiration

Table 4. Teaching design (Designed by this study).

Teaching Order	Class Hour	Unit Name	Content of Courses	Teaching Focus
Unit 1	8	Pre-school creativity	1. Creative products; Students whose names are only two words can choose the third word freely and draw it by computer.	• Experience the creative process. • Explore the design creative thinking of "learning from nature."
Unit 2	12	Thinking inspiration	1. The relationship between Chinese characters and nature (type characteristics, functional characteristics, and impression characteristics) 2. According to the three Chinese characters selected in the first unit and the form feature, function feature, and impression feature, look for the origin and relevant meanings of Chinese characters and make relevant two-dimensional designs.	• Understand the relationship between Chinese characters and nature. • Master form, function, and impression. • The concept of feature and the possibility of combining with Chinese characters. • Be able to appreciate and analyze relevant excellent cases. • Be able to design plane graphics with the characteristics of "learning from nature."
Unit 3	12	Design theory	1. Principle of the situational story method and case appreciation. 2. Simplified and abstract principles and case appreciation. 3. Cultural product design principles and case appreciation.	• Recognize the application of the situational story method in product design and appreciate cases. • Understand the application of simplification in design and application methods. • Understand the design procedure and connotation of excellent cultural products.
Unit 4	12	Design practice	1. According to the previous several Chinese characters related to your own character, set the situation, tell the story, write the script, design the product, and remake the transformation of Chinese characters from 2D to 3D according to the trilogy of design steps. 3D product design concept. 2. Standard scale dimension drawing and three-view drawing of product design. 3. Computer-aided model construction.	• Master the four steps of the situational story method. • Master the basic method of 2D to 3D transformation. • Be able to design cultural and creative products with the characteristics of "learning from nature." • Be able to master the design logic of Chinese character transformation cultural products.
Unit 5	4	Summary and reflection	1. Student group presentation and evaluation of their own design. 2. Teachers' summary, after-school evaluation, and thinking expansion.	• Design presentation and evaluation capability • Integration and reflective teaching

Figure 4. Pre-school creative works (designed by participants of this study).

Starting from "learning from nature," the universality and importance of "learning from nature" are conveyed to students, and the relationship between Chinese characters and nature is emphasized. The origin and thinking of the transformation of Chinese characters from their six categories are illustrated. After mastering basic theoretical knowledge, students simplify and abstract their Chinese names and design 2D visual transformations. Figure 5 shows a two-dimensional form variation transformation of the Chinese characters "CHEN" and "ZI".

Unit 3: Design Theory

Carry out systematic and scientific teaching of course design theory and master the design principles and theories related to "learning from nature". Design theory is subject to the Chinese character transformation product design procedures shown in Figure 2. Students are taught with simplified and abstract theories in the study of analyzing the shape and structure of Chinese characters. Through the understanding of design theory, students can deepen their thinking of design and pave the way for cultural product design theory in the next unit.

Unit 4: Course Design

This part consists of comprehensive training following the first three units. According to the four steps of the situational story method, this study discusses the feasibility and possibility of Chinese character design of one's own name. This part is to test students' mastery of teaching mode, and their ability of software and express the design effect. Figure 6 shows the cup design transformed from the Chinese character "QIU". The lamps and lanterns transformed from the Chinese character "MING" are formed by analyzing Chinese characters. The coaster transformed from the Chinese character "FENG" means that it is associated with the custom of "*Feng Cha*" (a tea ceremony, it means serve tea to someone) in China.

Unit 5: Summary and Reflection

In the summary and discussion part of the course, students, and members of the teacher group evaluated and scored the final works, respectively. The score comes from three parts: teacher expert group member evaluation, student mutual evaluation, and public evaluation. Students are asked to state their work to test their presentation and expression abilities. Figure 7 shows a scene of students' mutual evaluations and teachers' evaluations of assignments for students.
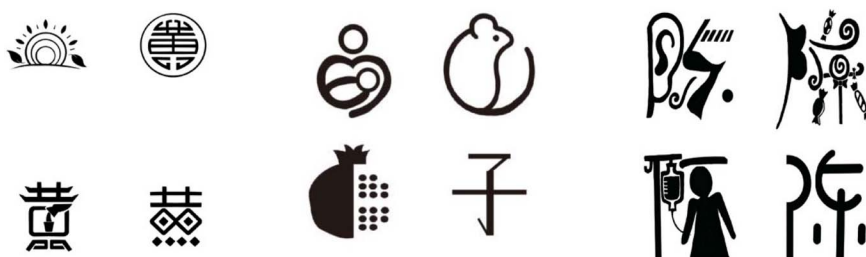

Figure 5. Two-dimensional variant transformation (designed by participants of this study).

Figure 6. Course design works (designed by participants of this study).

Figure 7. Students' mutual evaluations and teachers' explanations (prepared by this study).

3.3. Evaluation of Teaching Results

Lehmann (2016) pointed out the mode of design thinking teaching that aims to provide a set of evaluation criteria for design work and proposed the model of "design language". In the process of teaching and learning, teachers further emphasize the application of interaction and thinking process, guide students to think about phenomena and inner qualities, and think through the following pairs of concepts: concrete and abstract, complex and simple, association and creation, evaluation and solution. Therefore, to evaluate students' design results, a set of systematic evaluation criteria and standards will be needed (Wiggins, 1998). However, the evaluation criteria need to be distinguished according to the category of the actual works. The evaluation standards of design works can be comprehensively considered from the aspects of esthetic perception, modeling and creativity, and the mutual evaluation among students will promote the effect of learning (Liu, 2021a; Liu, 2021b; Yan & Sun, 2008). Therefore, this study will examine the teaching effect of this course according to the results of teacher-student scores, questionnaires and semi-structured interviews, understand the teaching results and serve as a basis for course optimization in the future.

There are three assignment links in the course: pre-school creativity, thinking inspiration, and course design. After the course, four teachers, experts, and students participating in the course will score the work of preschool creativity and course design and select the best as the case for the follow-up questionnaire. As an exercise unit, thinking inspiration will not be scored, and the evaluation rules are shown in Table 5.

After the course, a total of 336 works was received. Through the screening of teachers, 98 relatively complete design works were selected. Finally, six preschool creativity works, six course design works, and one award-winning work were selected. A total of 13 cases that could represent creative products of Chinese character transformation were selected as discussion cases of course results. As a teaching process, the works of two-dimensional design were not included in

Table 5. Results evaluation rules (Designed by this study).

Evaluation Dimension	Performance Indicators
Form 20%	The work can reasonably express the form feature and variation according to the form feature of Chinese characters and has the esthetic perception of modeling.
Function 20%	The work can express the harmony of shape and function and expresses the characteristics of form following function.
Impression 20%	The work can express the cultural meaning of Chinese characters with story and design depth.
Creative Performance 40%	The expression of the work is innovative, original and imaginative, and it is full of design tension and has no plagiarism.

the discussion of course results after comments in the course. An important link in the design process was to develop relevant scales to evaluate the public's response to the design so as to judge whether the designer effectively conveyed the design concept (Jagtap & Jagtap, 2015). Therefore, in this study we tested whether teaching concepts and modes were effectively conveyed by means of the questionnaire shown in Table 6. The questions took the creativity theory updated by Amabile et al. and the three dimensions of product form (Amabile, Collins, Conti, Phillips, Picariello, Ruscio, & Whitney, 2018), function, and impression proposed by Prof. Lin as the reference basis for preparing the evaluation items of the scale (Lin, 1994). There was a Likert 5-point scale ranging from "low" to "high" for each of the 10 questions, and the definition of the question came from the purpose of this study and the theoretical analysis of relevant literature in "II. Literature discussion". All the questions were based on theory to find out what the key factors of design based on nature and culture are (Tsao & Liao, 2013). 110 subjects were selected as questionnaire respondents and divided into three groups: 37 students "attending the course" numbered G1, 38 "Teachers" numbered G2, and 35 "other students" numbered G3. The backgrounds of the "other students" were students who did not participate in the course but had a design background, such as product design, digital media art, and visual communication. The questionnaires were distributed on the network.

4. Results and Discussion

4.1. Outcome Evaluation

This study tested the course effect by analyzing the questionnaires with SPSS 26.0 and the overall reliability and validity test of each observation dimension according to the evaluation of product form, function, impression, and overall creativity. One-hundred and ten valid questionnaires were collected, and the overall reliability coefficient using Cronbach's alpha, which was .974 ($p < .001$). This showed that the questionnaires were of good reliability. Factor analysis was used to measure construct validity. The factor load of validity ranged from .64

Table 6. Questionnaire evaluation attributes (Source: this study).

Dimension	Evaluation Project	Evaluation Attributes
Form	1. Shape Association	Low 1□2□3□4□5□ High
	2. Element Extraction and Variation	Low 1□2□3□4□5□ High
	3. "Physical and Spiritual Compatibility"	Low 1□2□3□4□5□ High
Function	4. Reasonable "Structure"	Low 1□2□3□4□5□ High
	5. "Function" Harmony	Low 1□2□3□4□5□ High
	6. Strong "Usability"	Low 1□2□3□4□5□ High
Impression	7. "Storytelling"	Low 1□2□3□4□5□ High
	8. Sign and Symbol	Low 1□2□3□4□5□ High
	9. Cultural Meaning	Low 1□2□3□4□5□ High
Overall Evaluation	10. Creativity	Low 1□2□3□4□5□ High

to .93, and the factor load was greater than .5, which also had convergent validity. The explanatory variation between the nine elements of form, function, and impression, and the dimensions of overall creativity, was between 74% - 89%. Therefore, the questionnaire design is more reasonable, and its results can be used for further in-depth analysis.

In this study, creativity was regarded as a separate evaluation attribute and the other nine questions representing form level, function level, and impression level were summarized into three dimensions. The average scores of the three dimensions were obtained for comparison. Table 7 shows the two works with the highest overall creativity evaluation scores and the two works with the lowest overall creativity evaluation scores given by all expert teachers and their design intentions. The two highest scoring designs were the CD rack design transformed from P3 "CE" and the lamp design transformed from P4 Chinese character "MING". The two lowest scoring designs were the umbrella stand transformed from P12 Chinese character "YU" and the bookshelf transformed from P11 Chinese character "PEI". P3 was the award-winning work, and P4 was the course design work, which was completed after the teaching of course theory and models. P12 and P11 were pre-school creativity works that were completed by students according to their own understanding before teaching the course content. The "Teachers" who participated in the test in this study were highly professional. A total of 39 teachers participated, including eight teachers with a master's degree and 31 teachers with a doctor's degree or above. All of them had high art and design literacy. Therefore, the four works of the scoring results of the teacher group were used as the standard for the discussion of the research results.

Table 8 shows the specific average scores given by different test groups in creativity, form, function, and impression. The following points can be found in Table 6. 1) Different test groups had different creativity evaluations on the four products. The creativity evaluation order of P3 was G1 > G2 > G3; the creativity
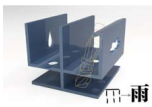
Table 7. Representative cases and design intent.

Chinese characters	Chinese phonetic alphabet	Design cases	Main content
册 (P3)	CE		CD rack: "CE" represented an article in ancient China, for the characters were written in bamboo slips. Many bamboo slips were connected in series to become "one volume". The design used CD rack to interpret the understanding of "CE."
明 (P4)	MING		Lamp: "MING" means light and brightness. The design interprets the understanding of "MING" with the morphological variation and literal meaning of Chinese characters.
雨 (P12)	YU		Umbrella holder: means rain and rainy day. The design interprets the understanding of "YU" with an umbrella stand.
裴 (P11)	PEI		Bookshelf: "PEI" is the last name of the creator. The design is based on the analysis of the two-dimensional form of Chinese characters.

Table 8. Result scores of representative cases.

Rank	1	2	3	4
No.	P3	P4	P12	P11
Product				
Students attending the course (G1)				
Creativity	3.65	4.08	3.17	3.01
Form level	3.77	4.24	3.87	3.52
Function level	3.61	4.11	3.77	3.50
Impression level	3.61	4.08	3.38	3.21
Teachers (G2)				
Creativity	3.45	3.3	2.7	2.50
Form level	3.94	3.97	3.08	3.36
Function level	4.00	3.74	3.05	3.00
Impression level	3.94	4.04	2.87	2.90
Other students (G3)				
Creativity	3.30	3.85	3.62	3.71
Form level	3.27	4.08	3.41	3.90
Function level	3.35	3.91	3.52	3.63
Impression level	3.34	3.95	3.43	3.58

evaluation order of P4 was G1 > G3 > G2; the creativity evaluation order of P12 was G3 > G1 > G2; and the creativity evaluation order of P11 was G1 > G3 > G2. It can be found that "students attending the course" numbered G1 and "Teachers" numbered G2 had the same view in the creativity evaluation. Taking P3 as the reference and P3 as the award-winning work, it was a model that could represent the design of Chinese character transformation products. "Other students" numbered G3, who did not participate in the course training, had low evaluation on its creativity. Overall, "other students" numbered G3 obtained the lowest creativity evaluation score on P3 among the four products. It shows that the trained students were better than the untrained students in the judgment of creative thinking. 2) Different groups of subjects evaluated the four products differently in the three dimensions of form, function, and impression. Overall, "students attending the course" numbered G1, and "Teachers" numbered G2 had the same views. Still taking P3 as the reference, the evaluation order at the form level, function level, and impression level was G2 > G1 > G3; "Teachers" numbered G2 had the highest recognition of P3 and was followed by "students attending the course" numbered G1. Based on the three dimensions of the other three products, "other students" numbered G3 had a lower evaluation of work P3 than works P4, P12 and P11. P12 and P11 were the works completed by students before the course, and the scores of "students attending the course" numbered G1 and "Teachers" numbered G2 were significantly lower than those of P3 and P4. It can be inferred that "other students" numbered G3 did not fully understand the meaning of the work P3 and did not realize its value and cultural meaning.

To sum up, "students attending the course" numbered G1 and "Teachers" numbered G2 had a clear understanding of these four works. Although the overall creativity evaluation scores and the three dimensions of form, function, and impression were sometimes high or low, the overall view was relatively consistent. The cognition of course design work P4 and award-winning work P3 was higher than that of "other students" numbered G3. It can be explained that the students who had been trained in the course model had significantly higher cognition of the creative understanding of works and the three dimensions of creation form and function impression than those who were not trained. This proves the effectiveness of the teaching model.

4.2. Course Feedback

To understand the feedback of teachers and students participating in the course, this study was conducted at the end of the course. Interviews were conducted with two professional teachers and six students who did not need learning performance. Through feedback, it helped examine the teaching results, reflect, and sort them out. The interview questions were as follows:

1) From the perspective of learners/teachers, what do you think are the advantages and disadvantages of this course?

2) From the reviewers' perspective, what do you think is your greatest feeling

when evaluating other people's work?

3) What do you think is the biggest gain from the course?

The feedback of the student interviews was summarized as follows: First, the teaching model of the course was relatively novel. In the past, we thought that design was a wild imagination. Good design depends on the talent of designers. When thinking about design, we did not follow any method. The course gave students a thinking mode to let them understand that design was also methodical. Second, students who participate in the course can participate in the evaluation of other students' work, and they have the opportunity to observe the work of others more closely and then rate them according to the evaluation criteria set by this study. This was very important. It was no longer possible to give scores according to subjective will or friendship between students. After completing the course, although the students' work had advantages and disadvantages, they learned how to measure and appreciate the advantages and disadvantages of the work. Third, by studying the concept of "learning from nature" and Chinese characters, students could understand the definition of cultural product design, which created a good foundation for professional learning in the future. Finally, it practiced students' imagination and creative thinking and improved students' design and expression abilities.

The feedback of the teacher interviews was summarized as follows: First, this method was adopted in the basic design class for the first time. In the past, the basic design was taught separately from three-dimensional modeling design and two-dimensional design. Traditional methods of teachers' teaching, students' practice, and after-school comments were mainly used, and there were few construction exercises of design thinking. The new course design discovered students' creative thinking and cultivated students' motivation for active learning. This is vital in design education. Second, technology and thinking must go hand in hand in design. In the past, students thought hard in class, hoping to get inspiration from "brainstorming". This course provides thinking methods. These methods help them think and get inspiration. Students will not get used to using some design methods to assist in thinking about design creation at the beginning, but these methods will help them in the later design process. Third, the unit setting of the course gives students a space to think repeatedly and helps them deepen their thinking step by step. Finally, according to the mutual evaluation mechanism of evaluation criteria, students can not only find a little bit from other people's works but also can judge the level of their own works again with the thinking of examining other people's works.

The feedback of participants is not only the supporting proof of the questionnaire data but also the specific suggestions for the improvement of the future curriculum model.

4.3. Regression Analysis and Discussion

Based on Table 8 (Section 4.2), this study evaluates the results of teaching prac-

tice through the data of the questionnaire. Based on course feedback (section 4.3), show that students and teachers have a high acceptance of the course design. To further indicate the effectiveness of the teaching model, this study selects P3 with the highest creativity evaluation score and P11 with the lowest creativity evaluation score and carried out multiple regression analysis with "students attending the course" numbered G1. The test took the nine basic attributes as independent variables, taking the subject's overall creativity evaluation of stimuli as a dependent variable and discussed which variable affected the subject's judgment. The results are shown in Table 9.

For the CD rack design transformed by the Chinese character "CE" of the stimulus P3, the multiple regression F value for the creativity of the work was 10.296, reaching a significant level ($p < .001$), and its predictability was 69.9%. According to the regression coefficient, the significant evaluation of "creativity" was "F2 element variation and extraction".

The bookshelf design of work P11 was transformed by the Chinese character "PEI". It can be found from Table 10 that the multiple regression F value of "students attending the course" numbered G3 on the creativity of the work was 14.513, reaching a significant level ($P < .001$), and its predictability was 72.2%. According to the regression coefficient, "F6 usability" and "F8 symbol" were significant in the evaluation of "creativity."

From the multiple regression analysis of the above two products, "students attending the course" numbered G3 judged the creativity of the works from three dimensions: form, function, and impression. Students believed that the best work in P3 was "F2 form variation and extraction" which showed that the course model of this study cultivated students' abilities to analyze the shape and structure of Chinese characters in the thinking inspiration link. Students evaluated the work according to their knowledge when evaluating the works. In

Table 9. Multiple regression analyses with fundamental relations as the dependent variable.

Independent Variable	Predictor Variable	B	r	β	t
	f1	.034	.676***	.033	.186
	f2	.617	.780***	.647	3.030*
	f3	−.655	.729***	−.622	−1.761
	f4	.074	.724***	.078	.311
	f5	−.187	.680***	−.194	−.974
	f6	.286	.760***	.270	1.516
P3	f7	.317	.700***	.340	2.027
	f8	.039	.737***	.039	.174
	f9	.399	.768***	.397	1.246
R = .880	R2 = .699		F = 10.296***		

N = 37, *$p < .05$ **$p < .01$ ***$p < .001$.

Table 10. Multiple regression analyses with fundamental relations as the dependent variable.

Independent Variable	Predictor Variable	B	r	β	t
P11	f1	−.284	.628***	−.239	−1.496
	f2	.491	.740***	.463	1.724
	f3	.369	.782***	.336	1.549
	f4	.064	.788***	.058	.226
	f5	.145	.757***	.124	.685
	f6	.635	.800***	.625	3.342*
	f7	.095	.674***	.089	.624
	f8	−.998	.695***	−.903	−3.526*
	f9	.415	.755***	.401	1.981
R = .829	R2 = .722	F = 14.513***			

N = 37, $^*p < .05$ $^{**}p < .01$ $^{***}p < .001$.

work P11, students thought that "F6 is highly useful" and "F8 symbol" was weakly expressed. In this study, the concept of the "form-following function" was deeply discussed in teaching. P11 was pre-school creativity work. The designer did not consider the practical function of design as the attribute of the shelf and directly took the font as the transformation without deconstruction analysis and lacked the meaning of the symbol. Students found these two defects in the questionnaire evaluation. It can be explained that after the course teaching was completed, students had an in-depth understanding of the three levels of form, function, and impression and could apply them to the evaluation of teaching results.

To sum up, Qualitative and quantitative analysis can prove the effectiveness of the teaching model. This indicated that teaching could help students understand the essence of "learning from nature" design.

5. Conclusion

Based on the research purpose, this study summarized four conclusions of the cultivation of design thinking, design teaching practice, theoretical and pragmatic teaching process and teaching result evaluation. At last, this study states the research difficulties in the process. From the analysis of the collected data, the following conclusions can be reached:

1) Research data and feedback show that the teaching model could improve the cultivation of design thinking. Students said that this teaching approach is more conducive to their understanding of design and can lay a good foundation for in-depth professional learning in the future.

2) This study can enhance the emotional experience and local cultural characteristics of the design through the design teaching practice. By the teaching practice, students are encouraged to explore the essential connotation of Chinese

character culture. The original "perceptual" abstract cultural elements and connotations are extracted and transformed into the thinking guidance of "rational" logic to improve students' creativity and imagination.

3) Through the modular course design, this study can bridge the gap between teaching procedures and design practice. The course guides students to explore problems step by step, and convey the design process of "the six categories of Chinese characters". Under the teaching design with systematic, the innovative teaching mode of the basic design course can be constructed.

4) Teachers' evaluation of teaching results no longer stays in their subjective evaluations, and students' cognition of work is not limited to personal evaluation. Through the data results, it can be found that the teaching objectives are consistent with the teaching results. Through effective evaluation methods, the teaching evaluation system and standard can be established. This standard can also provide a reference for the same type of products.

This teaching study was carried out by each student independently. The design theme is formulated by the teacher before class, and the teacher plays the roles of guidance, questioning and supporting. Therefore, not every student can make smooth progress in the teaching implementation of the five units, and the teacher gives additional after-school guidance to the students with slow acceptance. Although there are difficulties, all students successfully completed the course. Besides the knowledge provided by the cases shared by teachers in the course, a good peer learning model can drive students to observe and learn from each other and actively explore knowledge and methods, which will help improve the learning effect and coordinate the teaching objectives.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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