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Autex Research Journal, Vol. 24, No. 1, 2024, 20230021, DOI 10.1515/aut-2023-0021

PHONETIC SMART CLOTHING DESIGN BASED ON GENDER AWARENESS EDUCATION FOR PRESCHOOLERS

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Abstract:

Given problems such as the late start of gender awareness education in China, the gender blurring in preschooler's clothing, the lack of integrating gender awareness elements into preschooler's clothing, etc., using children's sensory functions such as vision, touch, and hearing, a phonetic intelligence module with alarm sounds and warning words is implanted into special parts of children's clothing. When children gently touch the part, it can make a sound. This kind of smart clothing for preschoolers, which is both interesting and educational, enables children to understand gender knowledge more intuitively, have a certain gender awareness to better protect their private parts of the body, and develop a correct view of gender roles and a sound personality.

Keywords:

Preschooler, gender awareness education, smart clothing, design

1. Introduction

With the development of the times, the improvement of living standards, and the introduction of China's three-child policy, each family begins to give more and more importance to children. As a result, consumers' requirements for children's clothing are not only limited to comfort and fashion but also some potential functions of clothing [1]. Children's growth, in the preschool period, will produce greater changes both physically and psychologically. It is also a key period for the formation of personal character, temperament, and gender concept in the future [2]. Nowadays, more and more parents are concerned about their children's sexual education during adolescence. Children must learn to protect and care for themselves. However, parents often neglect gender education, which should begin at birth. Gender education is the foundation of sex education for children, the initiation of children's understanding of themselves, and the basis for the formation of a healthy personality [3]. Therefore, it is necessary to start gender education for children from an early age in a scientific way.

At present, the design of clothing for children's gender awareness education in the market is mostly based on bionic design [4]. In this study, we combine the gender awareness education of preschoolers with phonetic smart clothing as the research theme. Considering the psychological and physiological characteristics of children in this period, we design formidable cartoon patterns on private parts of the clothing and incorporate smart wear systems and voice generation modules into the clothing. In daily dressing, it can guide children according to their gender characteristics and protect the private parts of the body, which should not be touched by others at will. In kindergartens or early education institutions, the clothes can be used as a curriculum education demonstration to educate children of different genders.

Research studies found that many children's clothing designers have realized the problem of gender blurring in today's children's clothes [5], coupled with the emergence of more and more tomboys and cross-dressers, all suggesting that we should pay attention to gender awareness education for children in the future. In preschool, we have to develop a correct view of gender roles for children, so that in their future growth and development, their biological gender will be consistent with their social gender, and they will be better able to adapt to society and integrate into it [6]. Therefore, parents and teachers can use such children's phonetic smart clothing to provide reasonable initiation and guidance on gender awareness, which is especially significant.

1.1. Research status and technical analysis of children's smart clothing

1.1.1. Children's clothing market research status

Nowadays, an increasing number of children's clothing brands have emerged and established their brand-style characteristics. But for clothing in the infant period, most consumers rely on the color to distinguish the gender of infants. Based on which, they choose and buy the clothes [7]. For example,

most of the boys' clothes are blue and black, and the girls' clothes are mainly pink and red. As children grow older, especially in the preschool period (3–6 years old), children's clothing does not reflect a clear gender distinction in terms of clothing styles. However, the physiological and psychological growth of preschoolers is most crucial, so it is very important to guide and educate children on gender awareness through clothing [8].

In the general perception of the public consumers, the style of children's clothing can be a reduction of adult clothing [9]. However, the biggest difference between children's and adult's clothing is ignored: the former takes more into account the physiological and psychological needs of children, requiring functional, educational, and protective purposes at the same time. For the needs of children of different ages, the color, style, and function of clothing shall be designed accordingly. For preschoolers, they have a rather faster intellectual development, active thinking, and increased activity. Therefore, the pattern design needs to be integrated with profound educational content for children's enlightenment, and the color shall be based on high brightness and high purity, according to the children's lively, active, curious, and ignorant personality characteristics in this period [10].

Nevertheless, based on the current situation of the domestic children's clothing market, most of the children's clothing design remains on the style, color, fabric, patterns, and other design levels, without much focus and research on the functionality and education of children's clothing itself [11]. At present, the bionic design approach is mostly used to take all living creatures in nature as the object of reference, and directly or indirectly borrow the shape, contours, lines, colors of these creatures to the designing of children's clothing modeling, structures, and colors [12]. For example, in the selection of bionic elements for boys' clothes, dinosaurs, cars, police officers, and other elements that reflect the psychological characteristics of boys are chosen, while for girls' clothes, flowers, butterflies, princesses, and other elements that reflect the psychological characteristics of girls are chosen. However, this single-design approach fails to intuitively reflect gender awareness, and many children still have difficulty distinguishing their biological sex. It is also difficult for children to understand the in-depth education of gender awareness.

1.1.2. Technical analysis of children's smart clothing

With the arrival and popularity of artificial intelligence technology, there is more and more smart wearable clothing for children consumer groups. They can be roughly divided into the following types according to their functions: smart positioning, smart monitoring, smart interaction, and smart materials [13]. Based on research statistics, in the development of intelligent children's clothing, more applications are types of intelligent interaction [14]. Interaction refers specifically to a phenomenon and behavior that occurs among multiple independent decision-making individuals [15]. Currently, many of the children's smart clothes that we have come across are those with implanted electronic devices via some special design techniques to achieve a specified need through the interaction between the product and the child [16]. For example, Smart PJs from Idaho, USA, has introduced storytelling pajamas, the world's first smart interactive children's pajamas [17]. By downloading a free iOS or Android software and scanning different codes on the pajamas with a cell phone, the device will read stories aloud, sing lullabies, or play pictures that help sleep, such as cute animals. Recognizing the limitations of traditional children's clothing and seeing the huge potential brought by smart technology, the domestic children's clothing brand Majile has reserved a place for smart technology in clothing design, giving this emerging children's clothing an unprecedented smart experience [18]. For example, Smart PJs from Idaho, USA, has introduced storytelling pajamas, the world's first smart interactive children's pajamas. By downloading a free iOS or Android software and scanning different codes on the pajamas with a cell phone, the device will read stories aloud, sing lullabies, or play pictures that help sleep, such as cute animals [19]. Recognizing the limitations of traditional children's clothing and seeing the huge potential brought by smart technology, the domestic children's clothing brand Majile has reserved a place for smart technology in clothing design, giving this emerging children's clothing an unprecedented smart experience. For example, the fabric of children's clothing can change color according to the change of children's body temperature; it can also show different patterns according to the change of weather. In addition, Majile children's clothing also has a fragrance function and can support global positioning system positioning, route presetting and deviation warning, children's sports pedometer and calorie detection, etc., which is a perfect combination of ornamentality, practicality, and safety.

1.2. Gender consciousness characteristics analysis for preschoolers

1.2.1. Gender consciousness characteristics analysis

Gender consciousness, which refers to the individual's physical and psychological cognition of their own and other's gender [20], is the initiation of children's understanding of themselves, moreover, the foundation of sex education. Throughout the current social environment, most of the social hot topics are focused on children's puberty education, and parents also care more about and pay more attention to the psychological education of children at this stage [21]. They tend to educate children on how to protect and love themselves but neglect gender education in preschool. After inquiring about references, we have learned that children's awareness of gender roles begins to be established after the age of 3 [22]. By the age of 3, children can accurately state their gender. During the preschool years, children's bodies grow rapidly. As they grow older, boys and girls gradually differentiate in terms of shoulder width, chest and waist circumference, and other parts of their bodies, and are at a stage when they can identify their gender. As parents, they should provide preschoolers with appropriate gender awareness education, so that children can have a basic knowledge of their bodies, know their private parts, learn to protect themselves, and understand how to respect and love themselves [23]. As a result, they can form a healthy personality, have a correct view of gender roles, and better pass-through adolescence in the future [24].

In addition, gender awareness education allows children to distinguish between their psychological and physical characteristics

and those of the opposite sex so that they can learn from each other's strengths and advantages in their future growth and can better develop gender awareness in the preschool period [25]. Therefore, it is crucial to cultivate children's correct gender awareness during their formative years.

1.2.2. Influence of clothing on children's gender consciousness

Clothing is a comprehensive art, an object composed of color, fabric, structure, and other elements, which can better convey gender symbols [26]. Therefore, in children's clothing design, the use of the three elements of design determines the physical and mental development of children. For example, when children are young, some parents give girls' style clothes such as princess dresses to boys and dress them up as girls, which often causes misconceptions about gender in children and has a great impact on children's future psychology, even affecting their whole life [27].

The development of cognitive skills is a must for every child during the growth stage, especially in early childhood, and is an important factor in the early intellectual development of children [28]. Clothing is a necessity of our life; therefore, it can play the role of a bridge. In the design of children's clothing, we take the cognitive elements as the starting point, combining the practicality and functionality of clothing with the cognitive nature of enlightenment education, so that young children can feel and understand more intuitively and thus have a stronger influence. Gender awareness education has a significant impact on preschoolers' clothing [29], so this study can be designed to incorporate the developmental needs of preschoolers through observation and communication, as well as their psychological changes.

2. Methods

2.1. Questionnaire of phonetic smart clothing for preschoolers with gender awareness education

This survey was conducted using the Questionnaire Star platform and distributed through both online and offline channels. Offline surveys were primarily distributed in areas with high concentrations of children, such as kindergartens, early childhood education institutions, children's clothing stores, and zoos, as well as in densely populated and high-traffic areas. Respondents included parents of preschool children, kindergarten teachers, customers of children's clothing stores, and children's clothing designers, among others. Offline surveys were strategically distributed to different regions based on the convenience of the internet and the geographical scope of the researcher's life and work, with a focus on provinces such as Liaoning, Shandong, and Jiangsu to ensure representation from both northern and southern China. A total of 253 questionnaires were distributed, with 247 valid responses collected, resulting in a response rate of 98%.

The survey covered basic information about the respondents, their understanding of gender awareness education, the appropriate age for children to receive gender education, their attention to gender-ambiguous events in the news, their expectations and willingness to purchase smart children's clothing with gender awareness education features, their acceptable price range, the occasions for which they expect the smart children's clothing to be worn, and their perceptions of the future prospects of this smart children's clothing, among 18 other questions. Among the respondents, 38% believed that the appropriate age for children to receive gender education is between 3 and 6 years (Figure 1). The survey also investigated respondents' views on how gender awareness education can be incorporated into clothing design and their expectations for the functionality of smart children's clothing.

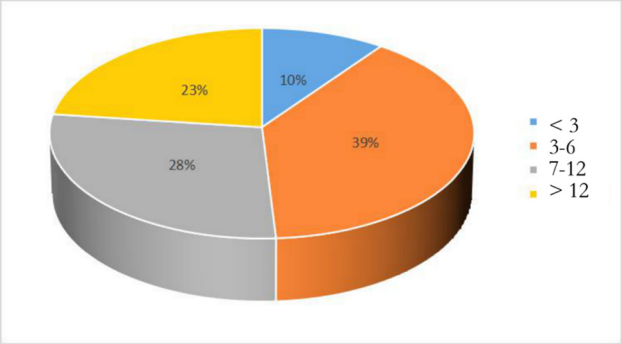

Figure 1. Research analysis of the age groups of children receiving gender awareness education (Credit: drawn by the author).

2.2. Results and analysis

Through the analysis of the questionnaire, the public's knowledge of gender can be roughly divided into two categories. One category is children who grow up with their parents. Most parents of preschoolers today are post-80s and 90s, who have generally received a good education, and they attach more importance to gender awareness education during the growth of children and will convey gender awareness to their children when they are about 3 years old. For example, they will tell the children their genders. But for more in-depth education, they will find it difficult to talk, and it gets embarrassing when they give too much explanation, thinking that the child is too young to understand. Another category is children who grow up with parents who have no time to participate in their growth due to busy work. Instead, they grow up in the company of grandparents and other elders. Such children generally lack understanding of gender awareness, and the elderly often make little of gender awareness education, thinking that they will naturally understand it as they grow older. Therefore, most of these children wear casually, and gender consciousness is not taken into account. The questionnaires were filled out, in contrast, also mostly by young parents. The questionnaires were filled out mainly by parents of preschoolers, teachers from kindergartens, and teachers from early education institutions (Figure 2).

Through the research, we found that with the frequent occurrence of child sexual abuse cases at home and abroad in recent years [30], most of the respondents believe that gender awareness education for children is very important, but in the face of education on this issue, they do not find a more appropriate education method or cannot explain it; there are also a few

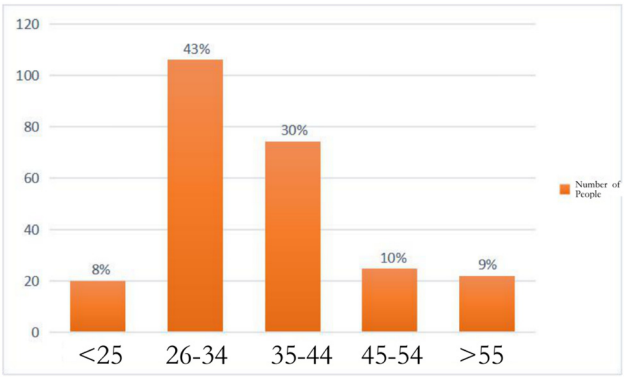

Figure 2. Age distribution of respondents. Credit: drawn by the author.

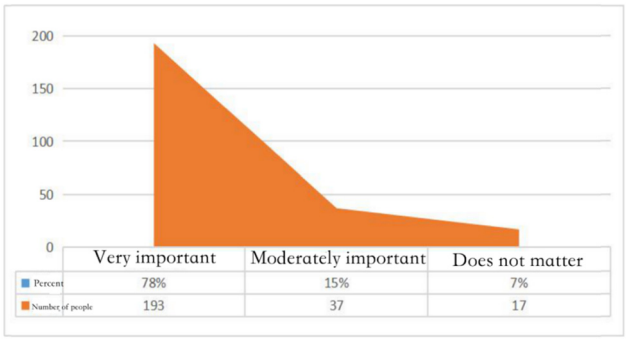

Figure 3. Acceptance of gender education for preschoolers. Credit: drawn by the author.

parents who believe that their children are too young and do not know what to do, so there is no need to educate children on gender awareness. Kindergartens and other educational institutions also rarely offer courses on gender awareness education, and children's understanding of gender awareness is only through simple educational models such as picture books and videos. However, embodying gender awareness education in children's clothing is very much accepted by most parents and teachers (Figure 3). The survey data show that 80% of people are very supportive of the product development of this topic, 75% of parents think that children's gender awareness education is very important, and 55% of parents are willing to spend 100–300 RMB to buy a piece of clothing that can convey children's gender awareness education for their preschoolers.

Based on the questionnaire survey, a lot of information was collected and organized, and it was found that in the daily dressing of preschoolers aged 3–6, there is not much gender awareness in the style of clothing, and the private parts of boys and girls are not designed differently, and the difference between boys' and girls' clothing is only made through the difference in the color. Some parents also often ignore the development of gender awareness in children, believing that children are small and can wear any style of clothing. The difference between boys' and girls' clothing is reflected in the Book of Songs, where it is written "Sons shall be born to him: They will be put to sleep on couches; They will be clothed in robes; They will have scepters to play with; Daughters shall be born to him: They will be put to sleep on the ground; They will be clothed with wrappers; They will have tiles to play with." It can be seen that boys and girls differed in the way they dressed and played, with the ultimate goal for boys to engage in the learning of manners, while girls were more likely to be female workers. It is not difficult to see that in society at that time, everyone's division of labor for different genders has been shown in infancy and early childhood. It also fully reflects that clothing has an important role in children's gender awareness education, which can well convey gender awareness education and can identify the biological sex of children.

3. Results

Combined with the current situation of children's gender education in China, this study designs children's clothing that can reflect gender distinction and applies it to the daily clothing of preschoolers, through which parents can popularize gender knowledge to children in an interactive form, thus deepening children's understanding of gender knowledge. It can also be applied as the curriculum guidance clothing for kindergartens, early education centers, and other related educational institutions. Open gender knowledge courses and then popularize the secrets of the private parts of gender in detail through interactive communication with children and conduct of three-dimensional teaching, which enables children to understand the differences between boy's and girl's private parts intuitively. As a result, they will know how to protect themselves, develop self-respect and self-love, and respect others.

Given the current world, the blending and fusion of science and art is the trend, and smart clothing is accepted and loved by more and more people because of its practical functions and the convenience it brings to consumers with the development of the high-tech era [31]. Smart fashion design is an emerging research field. As an interdisciplinary subject, it incorporates fashion design, computer sciences, and material subjects [32]. Through research, it is found that most of the smart baby clothes developed in the market are used to track the baby's daily activities, sleep conditions, record heart rate and play other roles through sensors [33]. There is still a gap in the fashion design that combines phonetic smart clothing with gender awareness education. In addition, combined with the more traditional education concept in China, most parents or teachers, when explaining gender education for children, often think that gender education is personal privacy. They feel it difficult to talk about and deliberately avoid the topic. However, gender education also includes more on psychology, safety, and values. Therefore, our design about children's phonetic smart clothing gives it more functionality and educability to help us subtly communicate gender awareness education to children in life.

3.1. Design concept

Based on the research findings summarized above, children's smart clothing is currently a popular design direction both domestically and internationally. However, there has yet to be a children's smart clothing product primarily focused on educating children about gender awareness. Therefore, this research project targets preschool children as the primary users, utilizing clothing to guide children in understanding their own body's specific parts, thus

fostering a more intuitive comprehension of gender awareness. In the design process, two intelligent methods: touch and sound, are integrated with clothing design. Through tactile and auditory cues, the design serves as a warning and reminder, not only educating children in a visual manner but also adding fun and interactivity. This facilitates learning during playtime, catering to children's innate curiosity and activity. Additionally, it circumvents the awkwardness teachers and parents may encounter when educating children about gender knowledge, cleverly navigating the scale of children's gender education.

3.2. Design proposal

3.2.1. Functional design

The children's garment emphasizes the display of its front and back patterns, adopting the basic hoodie and suit style. The patterns of the body's specific parts are sewn in three dimensions, incorporating variable memory materials. The garment comprises two types of components: planar and three-dimensional. The three-dimensional components contain sound circuitry devices, emitting prompt and warning sounds upon contact. Children analyze and judge based on the content they hear, guiding them to learn about gender awareness during play. This design not only serves educational, entertaining, and intelligent purposes but also challenges traditional perceptions of clothing design. It transforms children's clothing from mere wearables, decorations into educational tools, thereby expanding the application scope of clothing.

3.2.2. Style design

Based on the analysis of research questionnaire results and multiple design practice feedback, and considering the limited self-care ability of preschool children, the final-style selection prioritizes simple, easy-to-wear, loose and comfortable casual hoodies (Figure 4). Casual hoodies not only meet the dressing needs of children engaging in various activities in daily life but also offer strong cost control in production and appeal to a wide consumer base, making them accessible to most families.

Regarding silhouette design, tailored to the characteristics of preschool children's body types, the clothing silhouette design emphasizes overall shaping, minimizing the use of waistlines, and presenting an overall silhouette in both A-line and rectangular forms (Figure 5).

3.2.3. Pattern design

Through literature review, it is evident that cartoon patterns convey a lively and genuine aesthetic appeal in children's clothing design. Cartoon patterns, characterized by cute and diverse motifs, often depict adorable characters from animations, greatly favored by children. These patterns exhibit a modern flair, serving as a highlight in children's clothing design. Preschool children, in their stage of physical and cognitive development, exhibit a partial but evolving understanding of the world around them. Thus, patterns closely related to their daily lives, emotions, and prominent external features are likely to capture their aesthetic attention.

In this pattern design, considering preschool children's lively and curious psychology, cartoon animal patterns are adopted and rendered in a three-dimensional manner, creating a strong visual impact. This approach not only stimulates children's imagination, fostering cognitive development, but also enhances their visual perception of pattern representations. By combining aesthetic appeal with educational elements, the design serves both decorative and instructive purposes.

3.2.4. Fabric design

Comfort is the foremost requirement in clothing design and wearability. Rational fabric selection enhances the value of

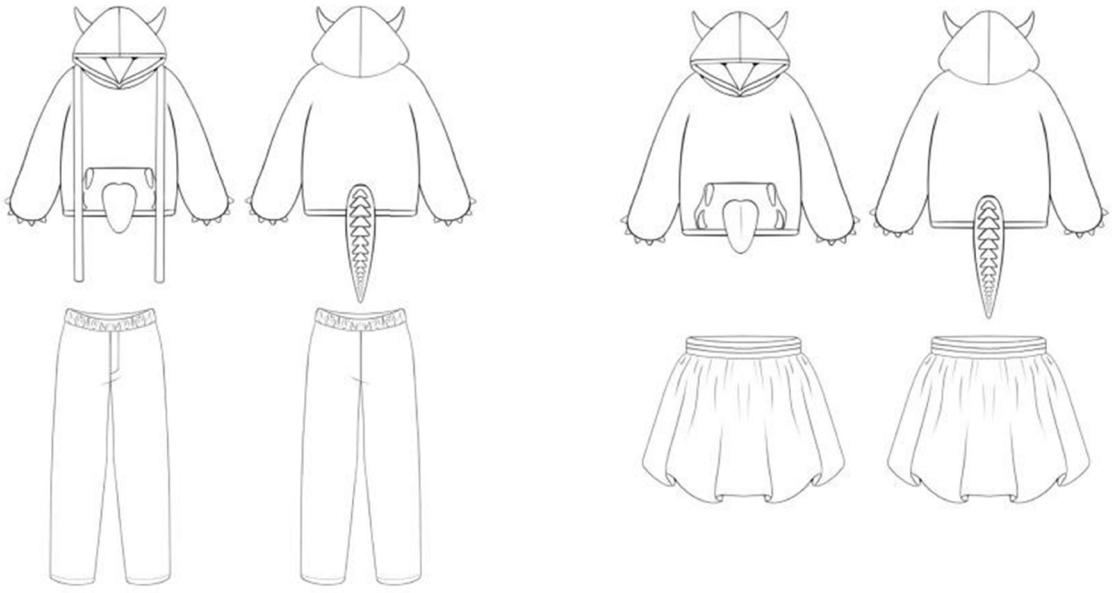

Figure 4. Design draft of clothing style for boys and girls (front and back). Credit: designed and produced by the author.

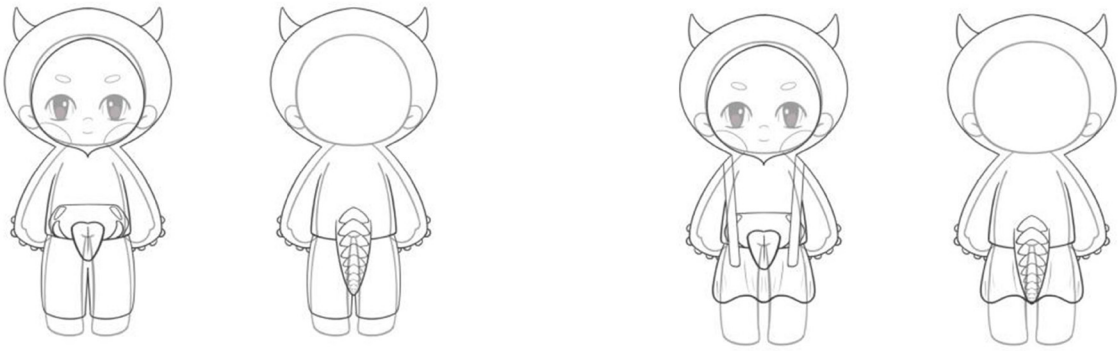

Figure 5. Clothing effect pictures of boys and girls (front and back). Credit: designed and produced by the author.

clothing and narrows the emotional distance between individuals and garments. Preschool children, in their developmental stage, are curious about external objects and have delicate skin. Therefore, when selecting fabrics, comfort and practicality should be prioritized, followed by considerations of safety and environmental friendliness. Clothing fabrics for children should not exhibit issues such as inadequate color fastness, excessive formaldehyde content, or abnormal PH levels.

The fabric of this garment primarily consists of soft materials with a high cotton content, selected according to seasonal variations. For spring and summer, breathable fabrics like bubble gauze and linen are preferred to provide a cooler wearing experience. For autumn and winter, fabrics with warmth, moisture absorption, better elasticity, washability, and durability are chosen, such as corduroy twill, twill fabric, cotton fabrics, and knitted fabrics, ensuring comfort during wear. In the innovation of new technology fabrics, the fabric should possess high safety, good moisture absorption, strong expansibility, softness, color fastness, and quick drying, among other characteristics, to protect children's skin and achieve temperature-regulating effects.

3.3. Design principle of clothing and voice integration

In the design, the intelligent system of vocalization is combined with clothing to form an intelligent wear system, which consists of the sensor module, control module, Bluetooth remote module, and vocalization module. The sensor module adopts a TTP223 TonTouchTM-type touch sensor, which is equivalent to an electronic switch. The touch detection IC is characterized by variable area, which can replace the traditional fixed-size button. Given the characteristics of children's clothing design, it has the advantages of low power consumption and wide working voltage. The chip, packed with the SOT method, is used to effectively save space and reduce the size of the whole system. The circuit diagram is shown in Figure 6.

The control module uses the ArduinoNano V3.0 improved version (Figure 7), where the core is based on the minimum system development board ATmega328P produced by ATMEL, which can realize all the functions of ArduinoNano. The control module is the core of the entire system, being responsible for acquiring and processing sensor information, docking the Bluetooth remote module, and controlling the reliable operation of the vocalization

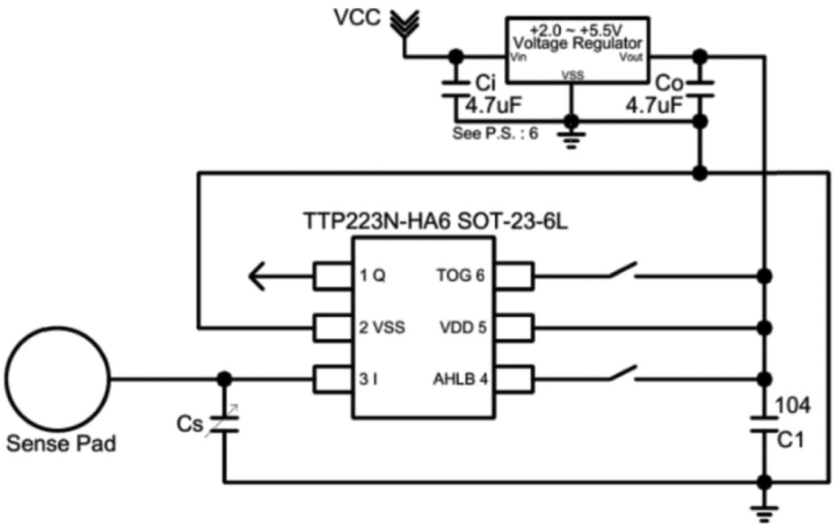

Figure 6. TTP223 circuit diagram. Credit: designed by the author.

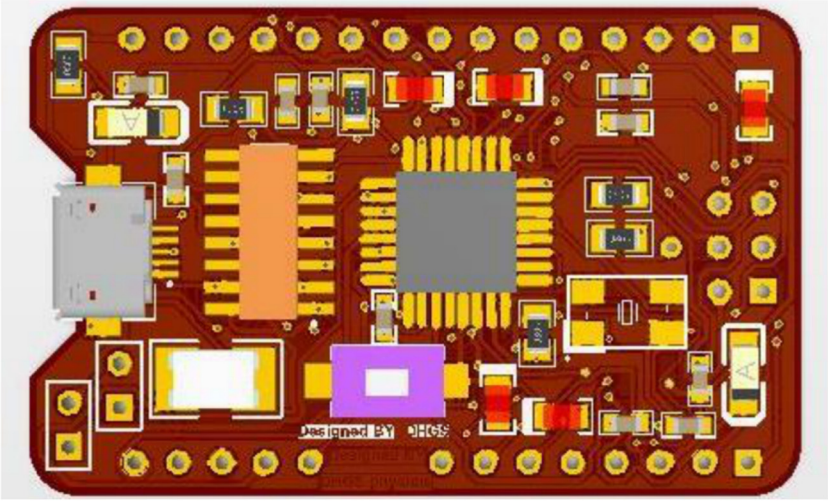

Figure 7. ArduinoNano V3.0 improved PCB design. Credit: designed by the author.

module through algorithmic decisions. The ArduinoNano is very small for easy system integration and features 14 digital inputs/outputs (6 of which are used as PWM outputs), 8 analog inputs, a 16 MHz crystal oscillator, a mini-B USB port, an ICSPheader, and a reset button.

The Bluetooth remote module adopts the HC-08BLE4.0 master-slave CC2540 communication transmission module, whose specification conforms to Arduino standard. Based on the BluethoothV4.0 standard protocol, the communication distance is up to 80 m. The antenna adopts an onboard snake antenna, and the chip adopts a stamp-type package to reduce the size as much as possible. The high-precision crystal oscillator has a frequency of 32 MHz, with no pairing code required. Simply install Bluetooth APP LightBlue of BLE on your phone to connect it (Figure 8).

The phonetic module uses DFPlayer mini-MP3, which can be directly connected to the speaker, and the specification conformed to Arduino standard. The module itself perfectly integrates the hard decoding of MP3, WAV, and WMA, and the phonetic prompt part of the system adopts MP3 hard decoding, supporting the user to use a TF card to expand the voice package, where FAT16 or FAT32 file system can be adopted.

After finishing the system software programming and hardware debugging, it is hidden and fixed into the pattern or pocket of the clothing. When children wear this kind of clothing, they just tap the special part of the clothing gently, then different information can be sent to the phonetic synthesizer or monitor through infrared signal, and a beeping alarm sound or children's phonetic warning language can be issued, which can educate children intuitively and increase the fun and interactivity. For children in kindergartens and other educational institutions, teachers can educate them with relevant courses, or for children in daily life, parents can guide and teach the children anytime.

The body structure of boys and girls is different. For boys, the genitals and buttocks are private parts; for girls, the genitals, buttocks, and breasts are private parts. In gender education, with such phonetic smart clothing (Figure 9), children are correctly told the name of each body part. They will learn how to protect the private parts of their body, and not to let others touch them at will, and they will not touch the private parts of others, so they can develop self-protection and gender awareness early.

3.4. Mobile APP smart operation design principle

Use LightBlue APP for IOS and Android to achieve agile system development, and LightBlue supports Bluetooth 4.0. If the HC-08 module works normally, the interface on the main screen of the cell phone will be displayed as shown in the figure. At this

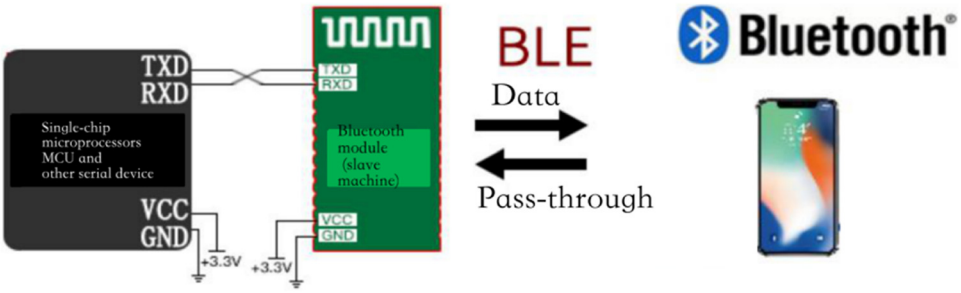

Figure 8. System overall communication link schematic. Credit: designed by the author.

Figure 9. Display of children's phonetic smart ready-made clothing. Credit: designed and produced by the author: (a) girls' phonetic smart clothing ready-made and (b) boys' phonetic smart clothing ready-made.

point, the Bluetooth connection is successful and the Bluetooth LED will light on. 0xFFE1 attribute is Read Write Notify. Clicking 0xFFE1, it will enter the "Start Notify" state, then the phone can conduct pass-through communication with the Bluetooth remote module, and the received data will be displayed in formats of ASCII, HEX, and Decimal, respectively (Figure 10).

The corresponding cell phone APP is designed, and when opening this software, we can control the Bluetooth module remotely through the smart system. When the switch of the cell phone is on, the special part of the clothes will produce sound, and *vice versa*, thus ensuring that the clothes can be worn normally as ordinary clothes during daily activities. In addition, considering the young age of preschoolers, it is more reasonable for parents to control the clothes on their behalf.

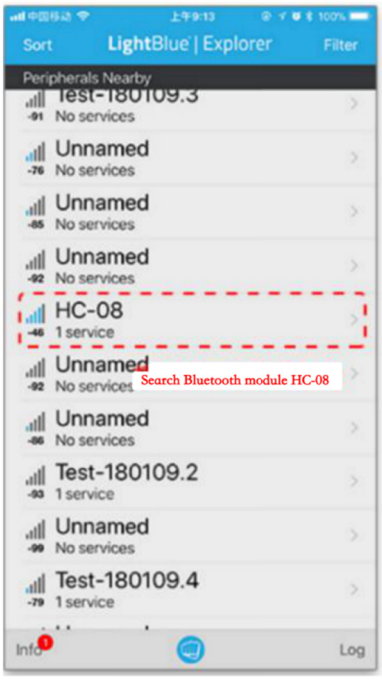

Figure 10. Bluetooth module connection diagram. Credit: designed by the author.

4. Discussion

Children, as a highly concerned group in recent years, have a significant demand for smart clothing. Currently available smart children's wear on the market lacks precise segmentation for users. Intelligent clothing for children aged 3–6 mainly focuses on monitoring and positioning functions. There is currently no

educational smart clothing specifically addressing gender awareness for children on the market. This design practice aims to address the learning needs of primary users – preschool children – for gender awareness and the educational needs of secondary users – parents and teachers, thereby attracting attention to gender awareness education for children from various social strata, including families, kindergartens, and society at large.

The author conducted extensive literature review and analysis of the physiological and psychological characteristics of preschool children, combined with market and user research, to propose four design principles: safety, comfort, usability, and fun. In terms of design, vibrant colors, comfortable skin-friendly fabrics, simple and generous structures, and lively and adorable patterns are employed to express the innocence and playfulness of children while meeting the functional design requirements of smart children's wear, enabling the product to provide corresponding services according to the needs of children in different usage scenarios.

The preschool stage is the period when children's receptivity and growth rate are fastest. Habits formed and knowledge acquired during this period will accompany them throughout their lives, influencing their growth in various ways in the future. With rapid economic development in China and improvements in people's levels and quality of life, coupled with advancements in scientific theory, technology, and design, it is believed that products targeting the preschool children group will become more closely aligned with real-life needs, providing more intimate services and better education in the future.

Due to the limited research in this field domestically and internationally, and relatively sparse academic literature collected, future work will continue to delve deeper, systematically categorizing scattered information and continuously seeking more favorable evidence.

5. Conclusion

Smart children's wear has vast development prospects, offering powerful functionality to better care for children and bringing about a different lifestyle. This project focuses on the topic of "Designing Voice-Enabled Smart Clothing Based on Gender Awareness Education," aiming to guide children in understanding their body's specific parts to enhance gender awareness. It serves as a reference design approach for other researchers. Targeting preschool children as the primary users, this research utilizes methods such as literature review and questionnaire surveys to promote gender awareness education among children. Key conclusions drawn from this innovative design practice include:

- In recent years, numerous smart children's wear products have emerged in the Chinese market, but most of them lack differentiation in functionality. There is a notable absence of smart clothing specifically designed for gender awareness education among preschool children. The preschool stage is a crucial period of rapid growth and change, with distinct physiological and psychological characteristics. Therefore, this project is grounded in the gender awareness characteristics of preschool children, aiming to explore interactive clothing designs that align with their cognitive and psychological development.

- Integrating touch and sound as intelligent modes into clothing design serves as a means of sensory alert and reminder. This not only provides intuitive education for children but also enhances engagement and interactivity, facilitating learning during playtime. It also helps circumvent potential awkwardness for teachers and parents when educating children about gender knowledge, effectively addressing the sensitivity of gender education for children.

- Considering the young age and limited self-control of preschool children, a corresponding mobile app is designed alongside the clothing. Parents and teachers can remotely control the clothing's smart system via their smartphones according to the actual wearing needs of the garment.

- The children's clothing to combine the humanistic nature of cognitive education with the practicality of preschooler's clothing. It has broken our perception of traditional clothing design, making children's clothing not only practical, decorative, and warm-keeping, but also fun, smart, and educational. Moreover, it can intuitively guide children to form a correct view of gender roles, promote the formation of gender stability in children, and broaden the application scope of children's clothing.

Funding information: This research was supported by the Liaoning Provincial Department of Education Scientific Research Project [JYTMS20230410], the Key Project of Philosophy and Social Science Research of Ministry of Education [21JZD048], and the Shaanxi Higher Education Teaching Reform Research Project [21BZ046].

Conflict of interest: The authors declare no conflict of interest.

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