Research on the Design of Intelligent Educational Products for Left-Behind Children Based on Perceptual Engineering

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Abstract: In the context of China's urbanisation, the issue of left-behind children has always been of great concern, and the physical and mental health development of left-behind children has also received continuous attention from society. With the help of technology, remote interaction has become more convenient, but parent-child interaction products and services for left-behind families have yet to be improved, and left-behind children are facing problems such as little parent-child interaction, lack of family education and companionship, and worrying psychological conditions. Therefore, it is important to provide suitable parent-child interaction products for left-behind children, so that they can feel the love and companionship of their parents from afar. At the same time, gamification is widely used in education and is also conducive to family interaction, which can increase the motivation and participation of family members. Therefore, this paper attempts to integrate gamification elements into parent-child interactive products for left-behind children from the perspective of gamification to promote parent-child interaction and parent-child education, so that parents and left-behind children can be together even though they are separated from each other, in order to provide new research perspectives and practical experiences for parent-child interactive products for left-behind children. This paper is divided into three parts: theoretical analysis, user research and design research. This paper is divided into three parts: theoretical analysis, user study and design study. Children's smart products use a combination of perceptual and engineering techniques to quantitatively analyse the user's emotional layer, which not only quantifies the user's perceptual needs, but also enables the product to be personalised. At present, the main functions of children's smart products include children's educational counselling, children's robot toys and cloud-based parental monitoring and communication functions. The design is evaluated through an interactive prototype, and an evaluation scale is designed based on system usability, user interface satisfaction and gamification purposes.

1 INTRODUCTION

Over the past few decades, China's rapid socio-economic development has facilitated large-scale rural-to-urban population movements. According to the China Aging Development Report 2013, there are 70 million left-behind families in China, involving 240 million people, of which 77% are left-behind families in rural areas. According to the sample data of the Sixth Population Census of China in 2010, the scale of left-behind children in rural areas nationwide reached 61.025 million, accounting for 37.7% of rural children and 21.88% of children nationwide.

Translated with www.DeepL.com/Translator (free version)According to the seventh national census, in 2020, the urbanization rate of China's resident population is 63.89%, but the urbanization rate of the household registration population is still only 45.4%, and there are 3.76 billion people in the floating population, of which about 130 million are children of the floating population, only about 1/3 of

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the children of the floating population live with their parents, and nearly half of the children of the floating population are separated from their parents at the compulsory education stage.

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The concept of left-behind children is defined as "children who are left at home while their parents work or study outside the home for many years", while other researchers define left-behind children as "children under the age of 16 whose parents or one of them is working in another city and the children are left behind to be taken care of by other relatives". With the gradual increase in the population of left-behind children in rural areas, left-behind children grow up without timely shelter from their parents and are unable to enjoy a complete family education. As a result, they are powerless and panic-stricken in the face of the dangerous environment outside. If they are not given the sunshine and rain they need during the critical period of their growth, they will not be able to grow up healthily. Although children are independent individuals, they are also the hope and future of their families and countries. Giving proper and timely emotional care to this special group of children left behind in rural areas is the key measure necessar (Xue-Fei Huang,Xue-Xin Ouyang, 2017)

In recent years, intergenerational care has become the main form of upbringing for families with left-behind children. Due to the low level of education of grandparents, the burden and heavy responsibility of life dragging on during the weekdays, and the physical illness of some elderly people themselves, there is usually a certain care bias in ensuring the physical and mental development, good habits and education of left-behind children.

Through the analysis of the research background of left-behind children, the number of left-behind children is increasing at this stage, and there are usually certain care deviations in safety and health, living habits and education. Through the literature research method: search on the Internet or use other methods for domestic and foreign papers and literature, etc., analyze the problems and current situation of left-behind children, the drawbacks and shortcomings of intelligent accompanying products for left-behind children at the present stage, and summarize and improve them. Using research methods to analyze the problems of left-behind children, based on the concept of perceptual engineering, we finally decided to design an intelligent product that can provide emotional companionship, health monitoring and learning help for left-behind children, interact with parents from a distance and send parental care, and accompany the growth of left-behind children instead of parents who work outside. On the basis of this, we can realize the appearance to meet the needs of children and achieve the humanized design that combines form and function.

Therefore, children's smart products can be used to accompany left-behind children instead of their parents. Children's smart products are quantitative analysis of the user's emotional layer using a combination of sensual and engineering technology, which not only quantifies the user's sensual needs, but also enables the product to be personalized. Through the form of the product itself, the joint with the cell phone APP and the additional functions it has to deliver some emotional information to the user.

2 STATUS OF DEVELOPMENT

China's domestic robotics market has entered a phase of rapid development, with an increasing demand for service-oriented robots. From 2018, the overall market size of China's robots is expected to reach $8.74 billion, of which $1.84 billion of service robots account for 21%, while sales of domestic-style service robots reached $0.89 billion of the total market size, accounting for 48.4%. In terms of the number of robotics-related patent applications, the number of patent applications grew at a fast rate, reaching a total of 27060 applications in 2017 (Foresight Industrial Research Institute,2018).

The market size of service robots in China is growing rapidly, and there is huge potential and development space for service robots in China as the demand for aging and healthcare and education increases.The overall industrial scale of service machines in China expanded from 2013-2017, China's service robot market size reached $1.84 billion (equivalent to $12.176 billion) in 2018, up 43.8% year-on-year from the previous year. 2018 China's children's intelligent companion robot market size was $2.062 billion, and children's intelligent companion robots accounted for 16.93% of the service robot size share.

Don Norman, a master of emotional design in product design, suggests that the emotional system consists of three distinct but interrelated levels, each of which influences our experience of the world in a particular way. These three levels are instinctive,

behavioral, and reflective. Emotional design: Why do we like or hate everyday things? Each of these three dimensions or levels of study, while closely linked and intertwined in the emotional system, affects design in its own particular way. Instinctive Design - "Focus on Appearance". The hierarchy is primarily concerned with perceptible qualities and how they make the user/observer feel. For example, a large floor standing clock has no more features or chimes than a small one on a mantelpiece, but its intrinsic qualities (ingrained, unconscious, subjective and automatic sensations) distinguish the two in the eyes of the owner.

(Zhu Hongxuan, Zhang Yaoyin, and Xu Bowen, 2016) argued that the design of children's companion robot form research analysis and design practice should consider not only the product itself attributes, but also go to the design application of emotional needs for the analysis and research of children's companion products, and the design research on the appearance of the product shape, color matching, function, and action.(Zhu, 2018) In the design innovation of children's companion robots, attention should be paid to the innovative design concept of humanization and modularity, with emphasis on improving the portability and safety and practicality of children's companion robots, and innovative attempts have been made to the product shape form and usage of companion robots. How to use the basic theories and methods of sensual engineering combined with product shape form to explore the connection between, and the use of sensual appeal to improve the transformation of design applications, in the deep verification through the consumer preference for product shape form in deriving relevant data analysis to improve the innovation of product design (Ma Xianxian, 2018).

With the background of rapid technological development, companion AI products have become the key research content in more fields. With designs for children's enlightenment, games and APP interactions, and voice communication, researchers predict that intelligent companion products will become the core of another technological revolution after the personal computer. However, as products continue to evolve and various design styles compete on the same stage, the styling of smart companion products continues to innovate and challenge. At the same time, more and more intelligent companion robots are applying emotional design in their development, interacting with users through form and function.

Most of today's intelligent companion robots have their own unique perception and self-adaptive capabilities, and also have the ability to self-adjust and provide feedback based on different user operating styles, and even to meet the needs of independent learning and autonomous adaptation. But even so, the capabilities of intelligent companion products at the level of technology creation are given by technicians at the time of creation, and do not yet have the ability to make autonomous judgments and cater to users' emotions.

With the promulgation of various policies, the realization of various systems, the rapid development of the rural economy, the income level of residents also followed, coupled with the parents of left-behind children are 80s and 90s, the modern concept of understanding, they have a trend of diversification, combination and growth of cultural products, most of the parents of families are willing to choose a variety of intelligent accompanying products for the physical and mental health of their children to replace the older generation to raise their children The shortcomings of the children. In addition, nowadays, a variety of public welfare to rural areas, left-behind children are also widely concerned about the problem, if rural families do not have enough conditions to pay for similar intelligent products, you can submit an application, the government free distribution.

As an emerging group of rural children in China, they have a thirst for cheap cultural products in general. However, due to the relatively late start of China's overall cultural industry and intelligent product industry, the corresponding market in rural areas does not have a complete market system, and most rural left-behind children can only passively choose cheap and affordable cultural products. However, most of the urban left-behind children are consumers of luxury cultural products. Their parents are always away and think that buying luxury and expensive cultural products for their children can make up for their fault of not being able to accompany their children, and that an expensive toy can satisfy their children. Therefore, this topic puts aside other elements, the main function is to achieve companionship, whether in rural or urban left-behind children they are eager for affection and the company of their parents.

The next thing is the development of living and studying habits. Due to the lack of proper guidance from parents and the backward education of the older generation, some grandparents blindly spoil their children, some also leave their children aside to live

and grow on their own because of too many household chores, which undoubtedly has an unhelpful impact on the formation of children's values and outlook on life. Therefore, this product should accompany the child while being able to give the child the right education, and make the left-behind children love learning and trust the product itself.

3 ERGONOMICS-CENTERED DESIGN

The English translation of the word "sensual" in sensual engineering is "Kansei", which is derived from the Japanese pronunciation of the word "kansei" (Tang Lingjie, 2008). Early as 1970, researchers at Hiroshima University in Japan designed houses with the emotions and demands of the occupants as the goal, and transformed them into design elements in engineering design, a technique also known as "emotional engineering". Professor Mitsunori Nagamachi, who started the research on emotional engineering, was keenly aware that consumers nowadays are no longer satisfied with mass-produced products in small quantities, but are seeking full satisfaction of their personalities and spiritual pleasure. At first, sensual design was a passive design based on commercial considerations to meet the gradual emergence of sensual consumption, and later, as theoretical research progressed, it developed into a planned and conscious market development with sensual design.

Perceptual engineering can also be called an evaluation method (Sukwadi R., Muafi,Sanjaya H.P, 2018), For the use of the crowd, how to catch the first glimpse of the design form of the use of the crowd is very important, especially in the design form into the perceptual intention expressed in words, as in life often said high-end, atmospheric, upscale, representing the consumer crowd for the design of the perceptual intention of the product, but this statement is relatively vague. Emotional engineering can help consumers to reasonably express their inner thoughts, and can also represent consumers' inner emotional consciousness, thus satisfying consumers' emotional needs and reducing design costs at the same time.

4 CHILDREN'S INTELLIGENT EDUCATIONAL PRODUCT DESIGN

With the Internet era and the rapid development of 5G and virtual reality, the Smart+ approach has driven the development of various industries, as well as the children's education market. The Internet classroom played a great role in the new crown epidemic in 2020, where students and teachers were taught interactively through the Internet. (Wang Zhuli, 2015). The open network classroom, such as think, will prompt the traditional classroom teaching mode to bring change. Children's products from the simplest static toys gradually develop towards the direction of intelligent products, bringing opportunities for the development of the education industry. Many intelligent products incorporate voice recognition, image interaction and other technological elements, and an increasing variety of intelligent educational products for children continue to be developed (Yu Xiaoli, 2016). Nowadays, the post-80s and post-90s have started to become a group of parents, who are also the main force in purchasing intelligent educational products market consumption, and they also prefer to use the convenience brought by intelligent products. Therefore, children's intelligent products can now accompany children well, while making up for the uneven educational resources (Jie Tao, 2009), Parents can also download the educational resources they need in the children's smart products for their children's educational use.

Searching through online platforms, with "intelligence + education" and "artificial intelligence education" as the topics, the search analysis found that the number of papers on artificial intelligence has been increasing from 2016 to 2019, indicating the increasing attention of Chinese domestic Experts and scholars continue to pay attention to AI research. They have conducted research on intelligent education from multiple perspectives, deeply integrating intelligent technology with education, and have achieved certain research results. Domestic research on intelligent education is lagging behind compared with foreign countries, the research fields are relatively scattered, and the world share of talents in artificial intelligence is low (Zhang Xin, Wang Minghui, 2019).Speaking at the International Conference on Artificial Intelligence and Education, Chinese Minister of Education Chen Baosheng said that in order to take a practical approach to the future

development of intelligent education, it is necessary to take the "road of popularization", "road of integration", "road of change" and "road of innovation" (Minister of Education Chen Baosheng Delivers Keynote Address at International Conference on Artificial Intelligence and Education, 2019).Children's intelligent education category is broadly divided into the following categories: game toys, programming robot products, children's educational APP products, early learning machine products.

For example, the children's companion robot "Xiao Wu" produced by Shenzhen Cambrian Intelligent Technology Co. The robot "Buddy", developed by Beijing Qihoo 360 Technology Co. The "Alpha Egg" intelligent robot developed and produced by KU XUNFE is a children's companion robot that integrates the functions of voice video communication, learning and education, voice communication and video on demand, etc. Its shape is small and cute, which is loved by consumers; the intelligent robot "Wukong" jointly developed and produced by Ubiquity and Tencent. Wukong robot image is vivid and lovely, with affinity, can be applied to a variety of scenarios: family care, children's education and office, support face recognition, photo and video, voice dialogue and other functions; fire rabbit company to develop fire rabbit intelligent children's early learning story machine J7pro can read picture books intelligent early learning machine, enlightenment powerful English enlightenment, a machine to get fire rabbit learning machine early learning machine children intelligent robot this Romibo is developed to help special children's groups to treat autism, which can effectively help autistic children to overcome their own language learning difficulties, to be able to communicate and interact with others boldly, so that It can help children with autism overcome their language learning difficulties and interact with others so that they can better integrate into society in the future. Xiaobanlong APP has a high number of downloads and is a well-known early education brand. It is suitable for children aged 0-8 years old, and uses the cartoon image of "Xiaobanlong" to learn together with children. The whole interface is interactive and rich in functions, which can cultivate good habits for children, inspire intelligence and accompany children.

4.1 Children's Intelligent Education Product Design Features

4.1.1 Product Functional Characteristics

Children's educational products are designed according to the physiological developmental characteristics and psychological developmental characteristics of children. As the special characteristics of children's development are taken into account, most of them guide children to use the products in a way that is easy for children to understand and easy to grasp in operation. Children are extremely curious and like to explore new and strange things, so generally product designers add cartoon elements to the content or use form. After attracting children's interest in the product, children are guided to take the initiative to communicate, sing, dance and play games, thus inspiring children's intelligence, exercising physical coordination, training logical thinking skills, developing language skills, etc.The advantage of children's intelligent educational products is that they can follow the growth of children and provide timely and rich learning content to children of the right age. Considering children's playful nature, most of them are designed to lead children to learn and master knowledge through the form of games and the teaching method of "teaching with fun". With the accelerated pace of life, overtime has become the norm for many parents, and intelligent educational products accompanying children's education greatly reduces parents' workload. Products with voice recognition function can talk to the child, tell him stories and so on, but also to achieve the parents and children communicate remotely, always accompany the child.Some products also have a safety monitoring function, which can help parents monitor the safety and physical health of their children. Some full-featured products are not only toys for children, but also play the role of children's teachers and playmates. Many educational products on the market now have complicated functions, similar product functions, generally have voice recognition, voice dialogue, storytelling and other functions, the product education content lacks innovation. From the child's subject knowledge, language skills perspective education of intelligent products more, specifically designed for children's other capabilities of intelligent educational products less.

4.1.2 Product Appearance Characteristics

Children's companion robots play an important role in the growth and enlightenment of children, and are children's playmates. As a vulnerable group, children are more susceptible to injuries caused by unreasonable product design, both physiological and psychological, with physiological injuries being the most intuitive. Safety design is the first consideration in the design process of children's companion robots, product safety is mainly reflected in three aspects of product form, color design and functional design.

Product form. Curious and love to move is the nature of children, for their favorite things they will follow their own thoughts to play with, so in the process of using, regardless of the method is right or wrong, it is easy to have accidents. The choice of morphological factors should be based on curves, round balls, etc., to avoid sharp angles.

Color design aspects. Different colors in the product have different warning effects, so you can use these colors with warning effects in the color design of the children's companion robot, and start to cultivate their cognition and learning of the meaning of colors from childhood.

Functional design. The design uses the law of constraint design to limit the degree of error in the use of the product from the physical structure, to highlight the correct way of operation, and to guide children to use the product correctly in terms of its function. At the same time, such guidance and education can be applied to other products, which can avoid unnecessary risks caused by children in the process of using other products.

Children's companion robots are designed for children, and the product specifications should comply with the physiological size of children. Safety is the most important of the many design factors for children's companion robots, and the primary starting point for product design is that children will not be harmed when using the product, even if they operate unconsciously.

The material of the smart companion product also has a certain influence on children, because the nature of the material of the smart companion product used, the corresponding interpersonal relationship, and the environmental scene when it is used will have the greatest impact on the emotions of children left behind, because children's happiness and curiosity are often caused by the material and shape of the product.

The research shows that most of the left-behind children are raised by their grandparents or close relatives, and these relatives do not have high diplomas and cannot give too much education to their children in terms of learning and living habits, so the intelligent accompanying design of this research can give great help to these left-behind children who need accompanying and education. Most of the parents do not know about the newly developed intelligent accompanying products and their corresponding APPs, but they are willing to try them, and they prefer small portable sizes that do not take up much space and colorful colors.

Through the preliminary research, we designed and exported an intelligent accompanying product, the main functions of which revolve around six aspects: improving the living habits of left-behind children, solving the psychological problems of left-behind children, helping left-behind children to tutor their study problems, guaranteeing the safety of left-behind children, cultivating various interests of left-behind children, and assisting left-behind children to make friends and have fun. It can wake up the children on time, train the children's correct biological clock, and help them with their homework within the specified time; it can use the product to communicate with parents by video and transmit their care for the children; it can have a scientific study plan that includes all subjects and allows the children to combine work and play; it can keep an eye on the children's safety while accompanying them, and notify the emergency contact immediately if there is any special situation. The product can infer children's interests by observing their usage and push the corresponding video course to cultivate them; the product can be interconnected with each other, i.e. children can contact their best friends by video and phone and can synchronize their learning and supervise each other.

Main shape of the product is a yellowish chicken, the head of the chicken has a red heart, when the child completes the required content on time, or when the completion of the great, the small red heart will be lit to encourage children. There is a shell on the outside of the chick. When the product is first used, the outer shell cannot be separated and the user can only vaguely see the chick inside through the transparent shell, and the shell will only be separated after the user has used it correctly for a period of time in accordance with the regulations, but only the top half of the shell can be taken away and the chick inside can only be removed after a further period of use. Through the design of the product to better cultivate good living and learning habits of children need to

adhere to, and is not in a hurry, it takes a period of time. This design can help children to develop good habits of life and learning, and willing to accompany this product in their own side; can also improve the children have a very strong curiosity and exploration of an unknown thing, when children are not able to open the eggshell, they will be very interested in seeing what is inside, so there will not be a period of time to use it is not interesting, cast aside the situation; when the chick is When the chick is "hatched" children will have a strong sense of pride and honor, and they will feel that they have made their own efforts to get the chick "out of trouble", so they will care more for the chick in the future, which can help children cultivate the spirit of perseverance, because they know that after perseverance they can This helps children develop a spirit of perseverance because they know that they will see the rainbow after they persevere.

5 SUMMARY

Based on perceptual engineering in children's intelligent educational product design research under the analysis of children's real, Good design always pursues good needs and will put the user in the first place. This paper explores the real needs of children through user-centered design, applies user research methods to the field of children's products, explores and analyzes the physiological, behavioral and cognitive characteristics of children, and fully considers the factors that affect children's experience, so that it can well guide the innovative design of this type of product. It is hoped that the product design process of children's intelligent educational products constructed in this paper can provide new ideas for other designers.

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