The Enlightenment of the Development of Optical Toys for Children's Education

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ABSTRACT: Toys are children's small partners in childhood, and they play a very important role in the process of children's growth. Toys can develop children's intelligence, and can also promote the harmonious development of children's bodies and minds. Children's toys designed and manufactured by optical principle have been going on for a long time. For example, kaleidoscope, optical fiber bouquets and other modern optical toys play a more important role in children's education. Through literature review, it was found that there are few researches on the theory of optical toys at home and abroad as well as its impacts on children's education. Therefore, impacts of it on children's education have not been paid enough attention to. In view of the above phenomenon, in a certain area as an example, the cognition about the education of optical toys of kindergarten teachers and parents of children were investigated and studied in this paper, with an aim to reveal the development of optical toys and its influences on children's education and to try to draw attention to the effects of optical toys for children's education to promote the healthy growth of children.

INTRODUCTION

The emergence of toys is similar to the product of many civilizations, because they have all experienced a relatively profound history of development. The course of development of toys can represent the history at that time, show the spirit of the people at that time, and reflect the scientific level of development at all stages. The design style of toys reflects the educational concept of an era and people's living customs and habits, or some local or the religion or belief in some local or ethnic groups [1]. The application of optical instruments has a relatively profound history in China. With the development of science and technology and the progress of the times, people's cognition of optics has surpassed the original range of optical principle. Optical technology has been widely used in industry and agriculture [2]. We still have traditional optical toys, such as kaleidoscope and fiber bouquets. The traditional kaleidoscope is composed of parts of the plane mirror, and both sides thereof are respectively provided with a human eye position and transparent glass.

After the reflection of three flat mirrors, they are imaged as symmetrical patterns. The resulting image structure likes a blooming flower, but the landscape changes as the shape changes due to random changes in the crystal structure. As a result, we can see both the beauty of the senses and the beauty of the irregular polygon [3].

The development of optical toys represents one of the values of the times and customs, so any feature of an optical toy has a certain educational and teaching value [4]. To some extent, the toy design phase needs to combine some of the toys' little skills to strengthen children's educational training, such as the shape and size of optical toys, and the design of them. Therefore, the educational role of optical toys for children should not be overlooked [5]. There are many kinds of optical toys in our market, so parents have many purchase options. However, through literature review and related data reading, it was found that there are few articles on optical square toys, especially theoretical studies on the influences of children's education [6]. The achievements of reform and opening up are obvious to all, but the improvement of people's living standard makes children's toys become diversified and complex. For parents, they need to think deeply about what kind of toys to buy. According to the problems mentioned above, the development status of optical toys was...
investigated and analyzed in a region as the research area. For toy city, the types and sales of optical toys were investigated. A questionnaire survey was conducted among parents to find out how parents feel about the impact of optical toys on their children's education [7]. In addition, the views of teachers and kindergarten directors on the children's education of light children's toys were discussed. To sum up, through the induction and summary of the theoretical basis of optical toys and related personnel questionnaire analysis, we hope to reveal the mechanism of optical toys for children, so as to promote the positive role of optical toys on children's physical and mental health development.

2. A review of the impact of children's toys on children's education

2.1 The origin and development of children's toys

In terms of the origin and cognition of toys, from the point view of existing research results, there are some different views. Some people think that toys are people's leisure activities in life and work; some people think that they originated from distinctive expressions of folklore or season in different regions [8]. Some scholars believe that toys were inspired by some kind of belief. The archaeologists found that human first found spherical hollow grid structures in ancient sites such as Sichuan and Beijing, and experts believe that these objects may be toys for people to spend their leisure time during working and producing [9]. Toys may also be a form of folklore in a particular period, or a social habit and fashion established in a natural environment. For example, in the Dragon Boat Festival, according to China's traditional festival custom, people will eat dumplings or hold the dragon boat race, while people in some parts of the area may make some tiger artifacts to prepare toys for their children [10]. Many interpretations of religious belief are supernatural theories. Therefore, in order to solve the supernatural phenomenon, people will use some artifacts to express reverence, and some toys will be changed into some folk toys under some local conditions. Thus, the toy is created for people or objects to kill the time in the labor leisure time. Toys has eventually developed into educational toys, and they carry people's beliefs and expectations [11]. Therefore, though toys are small, they can reflect the historical and cultural connotations.

Toys in China have a very long history. The development history of children's toys in China can be divided into three stages: the early stage of development, the middle period of development and the period of prosperity. Ancient dolls were the prototype of the development of toys. At first, people didn't design and make dolls for leisure. At that time, people made some ceramic portraits mainly used in ancient ritual activities for the expression of thoughts and wishes to dead people [12]. Archaeologists have found palm sized pottery pigs at cultural sites in Shandong, China, and these dolls made a good foreshadowing for the development of later toys. Ancient simple toys were designed to kill the leisure time, so they not only played the role of entertainment, but also helped children to increase and master some skills in life. In accordance with the general classification method, toys can be divided into knowledge toys and recreational toys. Among them, knowledge toys have a profound influence on traditional children's education. Knowledge based scientific toys can apply the scientific mysteries and basic principles to toys, so they can transfer science to children in an interesting way, so as to continuously improve their learning enthusiasms and increase their curiosities and enthusiasms for learning. Figure 1 shows the design case of modern optical toys in China.

2.2 An overview of the theory and design applications of optical toys

Light is known in physics as an electromagnetic wave. The wavelength of electromagnetic waves ranges from nanometer to millimeter. Dividing the electromagnetic property of light by wavelength is a generalized definition method [13]. Popularity speaking, the light that people can see is called the visible light. The eyes of most people can sense the light on retina, and the perceived range of imaging is between 400 and 800 nanometers. According to the difference of the wavelength of the electromagnetic wave, light can be divided into several colors as red, orange, yellow, green, blue, purple, and so on. The violet light has the shortest wavelength, while the red light has the longest wavelength. The wavelength of ultraviolet light is smaller than that of radiation. The
wavelength of an infrared is greater than the wavelength of radiation, as shown in figure 2.

By a wavelength range, a ratio of the wavelength of a light incident to a mirror on a single area of the mirror to the wavelength interval is called the spectral intensity. The expression formula is [14]:

$$ E_\lambda = \frac{d\phi(\lambda)}{dA d\lambda} $$  \hspace{1cm} (1)

The ratio between the power of the radiation and the wavelength spacing of the light source at the given angle and azimuth is called the brightness of the spectral amplitude. The calculation expression formula is [15]:

$$ L_\lambda = \frac{d\phi(\lambda)}{dA \cos \theta d\Omega d\lambda} $$  \hspace{1cm} (2)

Eyes are the important organ of human beings, and under the influence of the external light source, eyes play the role of a relatively high photoreceptor. According to the anatomical features of the biological angle, the main biological structure of eyes is the eyeball and other auxiliary organs. Some of the auxiliary organs of the eye are the external muscles of the orbit and the eyes, and the organs that produce tears. From the basic function of optics, the human eye is an imaging system that contains some kind of instinctive transmissions of refraction, and this system is a very precise optical system. The technique of imaging after photography is based on the imaging theory of human visual optics [16].

The history of applying optics principles to design and make geometric optics toys has been over 3000 years. In the early days, people used concave lenses to collect light. Later, people used flat mirrors to observe human faces. With the progress of society and the development of science and technology, people's cognition of light has developed from the focus of concentration and imaging to the category of geometrical optics. The basic principles and basic techniques of optics have been widely used in agriculture and other industries [17]. Therefore, there are many toys around us that were designed and manufactured by the basic principles of optics, such as shadow play and fiber bouquets, and so on. Kaleidoscope is a typical example of the successful application of geometric optics. Through the small hole, people can observe the patterns of charm [18].

The design principle of a kaleidoscope is the principle of light emission, and patterns change with certain angles. At first, the kaleidoscope was invented and designed by an expert from Scotland. Three years later, both China and Japan in Asia learned the technology [19]. The design and invention of kaleidoscope are considered as blooming flowers by children, and it has been included in the annals of design [20]. These optical toys can develop children's abilities to express themselves actively, so they have a great influence on the growth of children.


3.1 The design method of optical toys that can reflect the educational value

Children are easily guided by unknown things during their growing up, so emotional situation is inevitable. Children's own curiosity is often random and aimless. They don't have reasonable language explanations about the outside world, and they can't express their true feelings. Children can identify shapes easily, so they can easily identify simple shapes such as circles or triangles. As children age, their identification of patterns will evolve into more complex patterns such as diamonds. The realistic characteristics of children's intelligence can also determine the way children think. The design of kaleidoscope is to guide children's graphic recognition ability by using the random change characteristics of graphics.

The change of scenery in the kaleidoscope is the imaging law of the mirror body structure. Taking the two mirror structure as an example, two sides of the triangle in the mirror combination are all flat mirrors, but one of the mirrors can't reflect the light source and the substance, so images of both mirrors are circular after imaging. The working principle of kaleidoscope is shown in figure 3.
Of course, if the segmented image can develop into a multi mirror structure, then the complexity of the image will be improved, so that the effect of the image will be more beautiful, as shown in figure 4.

### 3.2 Evaluation methods of optical toy design based on artificial light source

For the development of children's optical toys, their entertainment performances and their educational performances and safety performances should be considered. An ideal irradiance instrument requires a planar detector with a diameter of d to meet the full test requirements, as shown in figure 5. The system in the diagram can show the basic content of the whole process of radiation brightness and spectrum measurement, including the view design process of children's toys in the semiangle. The diameter of the probe shall be less than the range of the receiving light source. According to the standard values for the safe range of light radiation, the maximum reading position should be given in the measurement.

![Figure 5: Schematic diagram of illuminance measurement](image)

The basic method of imaging is to simulate the human's naked eye and to project the light source into an effective field of view in which the diameter can be varied. That is, limiting the aperture to the radiation range of light, as shown in figure 6.

![Figure 6: Schematic diagram of measuring amplitude luminance](image)

The alternative method of calculation is:

\[
\gamma = \frac{F}{r} = \alpha_{\text{eff}}
\]  

\[
E = L \cdot \Omega = \frac{\pi F^2}{4r^2}
\]

### 3.3 Research methods of the investigation of the effect of optical toys on children's education

In order to better understand the children's early childhood teachers' views on the role of optical children's toys in children's development, the form of research interviews was adopted to carry out a research. The questionnaire in the study included the author's own contents and outlines, and the time period was from February in 2017 to April in 2017. Children's kindergartens in twelve different districts of a city were randomly selected as research objectives for interviews. Interviews were carried out on several kindergarten teachers who have had been randomly selected. Because of the special nature of the industry, the teachers were all female. The educational age of early childhood education was at least over 3 years, and the basic information of specific subjects is shown in table 1.
In the study, parents of preschool children were chosen as another group of subjects in the study. The questionnaire still contained the subject and content, and the time period was from February in 2017 to April in 2017. Parents of kindergarten children in a city were investigated about some questions related to children's toys. The questions in the questionnaire were commonly objective problems, and the main purpose of the questionnaire was to understand the parents' concern about the influence of the light children's toys on their children's education. 260 questionnaires were issued and 2421 questionnaires were collected. The basic information about the parents studied is shown in table 2.

<table>
<thead>
<tr>
<th>Garden level</th>
<th>Municipal level</th>
<th>District level</th>
<th>Class one</th>
<th>Class two</th>
<th>Second level</th>
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<td>10</td>
<td>12</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
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<td>28~35</td>
<td>30~35</td>
<td>25~35</td>
<td>30~40</td>
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<tr>
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<td>6~15</td>
<td>8~15</td>
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<td>10~20</td>
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4. Analysis and discussion on the role of optical children's toys in children's education

4.1 Results of investigation and analysis

Figure 7 shows the survey results of kindergarten teachers' awareness of the educational value of optical children's toys. As can be seen from figure 7, nearly 98% of the teachers affirmed the intelligence value of optical toys for the development children's imagination. With the guidance of optical toys, children's emotional intelligence and social skills can be improved. Optical toys play a positive role in language ability training and character formation. However, the awareness level of the perceptual ability and coordination ability of optical toys in education is relatively low. Although optical toys have a profound understanding of children's stereoscopic and abstract thinking abilities, they have not received enough attention in some aspects.

Figure 8 shows the survey results of teacher's recognition of the importance of optical toys in practical teaching practice. It can be seen from figure 8 that, 30% of people thought that the toy is very important in the teaching of optics; 19% of the teachers thought that it has few effects on children's education; only 8% of the teachers thought that the optical toy is not important for children's education. Therefore, from the point view of the reality of the survey data, the recognition of teacher for the help of optical toys to teaching is relatively high.

Figure 9 shows the survey results of parents' perceptions of the importance of optical toys. It can be seen from figure 9 that, 41% of parents thought that optical toys are extremely important for their children's education; 50% of parents thought that optical toys are important for their children's education; 9% of parents thought that they are unimportant. Survey data can show that most parents were positive about the educational value of optical toys in the process of children's growth.
The Enlightenment of the Development of Optical Toys for Children's Education

4.2 Discussion

Children's early education process needs education methods to reflect characteristics of experience and independence and the characteristics of continuous exploration and practice of children. Therefore, for children's growing up, toys should have the function of education. In early childhood education, children have a great demand for toys. Optical toys can reflect the basic principles of optics, so they play an important role in children's daily activities. Through questionnaire analysis, it was found that teachers had positive attitudes towards the development of optical toys and children's early childhood education, and teachers had high awareness of children's optical toys. The development of children's optical toys plays an important role in the promotion of children's imagination and creativity, but some other educational roles have not yet been paid enough attention to by teachers. In addition, children's practical teaching of optical toys is still at the stage of the importance of children's teaching, so some functions of optical toys can't be played in the teaching practice. Optical toys can reflect the deep principles of optics, so the guiding role of parents to children is particularly important. Optical toys have no recreational feature as other toys in entertainment aspect, but it is particularly prominent in developing imaginative and three-dimensional thinking skills, so teachers and parents need to rationally use optical toys to guide the teaching practice, so as to play the teaching function of optical toys.

5. Conclusions

Optical toy is a kind of scientific toy with rich knowledge of optics theory. Optical toys can easily display the knowledge of optics, provide the children with the scientific three-dimensional thinking and imagination, and train children's scientific exploration spirits. In view of the development concept of optical toys and the basic theory of children's optical toys, the research on the development of children's optical toys in light of children's early childhood education was carried out in this paper. In this paper, the basic principles of the human eye imaging applications in optical toys were discussed; the key points that need to be paid attention to in the design and development process of children's optical toys were discussed; in order to better understand the role of the development of optical toys for children's education, some parents and teachers were chosen as the research objects, and views on the teaching role of optical toys of teachers in different classes of kindergartens and parents with different educational backgrounds and work backgrounds were analyzed. The results of the investigation and analysis show that parents and teachers are able to recognize the effect of optical toys on children's imagination and creativity. However, the specific application of optical toys teaching lacks certain specific knowledge, so it failed to play the maximum function. It is recommended that teachers and parents thoroughly understand the concept of optical toys, and adopt edutainment teaching methods to promote children to learn the educational connotation and nutrition of
optical toys, so as to make efforts for children's growth.

6. ACKNOWLEDGEMENT

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7. REFERENCES


